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# Screening of round gourd varieties for resistance against fruit fly, *Bactrocera cucurbitae* (Coquillett)

**Sita Nehra, Swaroop Singh, RG Samota, SK Choudhary and AL Choudhary**

**Abstract**
The investigations on the "Screening of round gourd varieties for resistance against fruit fly, *Bactrocera cucurbitae* (Coquillett)" were carried out at Horticultural farm of SKN college of agriculture, Jobner, Jaipur during Summer, 2016. Out of seven varieties of round gourd screened against the fruit fly, Arka Tinda and Tinda Ludhiana (12.20, 13.98 and 12.13, 13.92% fruit infestation on number and weigh basis, respectively) were found less susceptible, Mahi Tinda, Mahi-1 and Amol (16.67,18.78, 20.31 and 16.07, 17.98, 19.87% fruit infestation on number and weigh basis, respectively) as moderately susceptible and Ujjawal and JKSPL (23.37, 22.05 and 22.20, 22.07% fruit infestation on number and weigh basis, respectively) as highly susceptible. In the physical characters *viz*., hair density and tenderness of fruit rind, varieties having hard rind of fruits were less susceptible. The variety having densely hairy was found less susceptible and less hairy varieties were found susceptible against fruit fly infestation, whereas, the shape and colour of fruits has not affect the susceptibility. The biochemical parameters *viz*: total phenol and silica content had negative correlation while, total soluble solids had positive correlation with fruit fly infestation.

**Keywords:** Screening, variety, resistance, *Bactrocera cucurbitae*, round gourd

## Introduction
Round gourd or squash melon, *Citrullus vulgaris var. fistulosus* (Watt) commonly known as Tinda. Which is one of the most popular summer and rainy season vegetable crop, commercially cultivated in the Indo- Gangatic plains of North India, especially in Rajasthan, Punjab and Western Uttar Pradesh. In the warm and rainy months, the flies were more active as compared to that of dry and winter months (Laskar and Chatterjee, 2010) [14]. In Rajasthan cucurbits are extensively cultivated because of greater suitability of climate and soil.

India is the second largest producer of vegetable in the world after china, accounting for about 10% of the world`s production. In India the area under the cultivation of vegetables during 2015-16 was 9775.38 thousand hectares, with an annual production of 166608.16 thousand ton and productivity of 17.04 ton per hectare (Anonymous, 2015-16) [1]. In Rajasthan the area under the cultivation of round gourd during 2015-16 was 6645 hectares, with an annual production of 14650 metric ton and productivity of 2.20 metric ton per hectare (Anonymous, 2016) [2].

There is a challenge to achieve the target of 182 million ton of vegetables production to fulfill the recommended requirement by 2020 and also their recommended requirement of 300 g per capita per day of vegetables for a balanced diet (ICMR) whereas, the present per capita intake of vegetables at 135 g / day is very low in comparison to recommended balanced diet. However, in past three decades, India has made a quantum jump in vegetable production in the world. Cucurbits are important crops grown throughout the country. Round gourd crop is also gaining importance in terms of foreign exchange earner on depicted from policies of central government promoting its export.

The continuous growing of round gourd crop in the region has made it susceptible to the attack of several insect pests like fruit fly, *Bactrocera cucurbitae* (Coquillett); red pumpkin beetle, *Aulacophora foveicollis* (Lues); hadda beetle, *Epilachna dodecastigma* (Wiebemal); Jassid, *Amrasca biguttula biguttula (*Ishid) and mites, *Tetraynchus cinnabarinus* (Boisduvol). Among these pests, the fruit fly, *Bactrocera cucuribitae* (Coquillett) (Diptera: Tephritidae), is the most serious constraints in round gourd cultivation in all the parts of the country. The pest is active throughout the year except in severe cold. The fruit fly species is considered a serious insect pest and is classified as an organism subject to quarantine restrictions (Bateman, 1972; Shukla and Prasad, 1985) [4, 21].

The fruit fly females puncture soft and tender fruits and lay eggs on the fruit in the cavity, 2-4 mm deep (Muthukrishnan *et al*. 2005) [16]. After hatching the maggots, bore into the ripening fruits, begin to rot and drop, thereby, reducing the yield and quality. Growing of resistant varieties is an ideal component of IPM at no additional cost and has been replaced by new high yielding varieties, hence in the present study some new varieties were included to screen for their susceptibility against fruit fly in round gourd crops.

**Materials and Methods**

The details of the materials used and methodology adopted during the course of investigation are given as below. Seven varieties (Mahi Tinda, Tinda Ludhiana, Amol, Mahi-1, JKSPL, Arka- Tinda and Ujjawal) of round gourd were screened for their relative susceptibility to fruit fly. These were sown on 15th February, 2016 in randomized block design in the plots of 3 x 1.5 $m^2$ size, row to row and plant to plant distance 1.5 m and 0.60 m, respectively with three replications. All the recommended agronomical practices except pest control were followed to raise the crop.

**Method of observations**

The crop was constantly observed for fruit fly damage from the initiation of fruit formation to last picking of the fruits. The extent of damage of fruit fly was estimated on the basis of per cent fruits infestation. The per cent infestation of fruit was worked out on number and weight basis. Per cent fruit infestation of each variety was calculated by picking fruits of marketable size at three days interval. The fruits of round gourd were harvested and examined all harvested fruits for fly punctures and healthy fruits. Infested and healthy fruits were counted and weighed separately, percentage of fruit damage on number and weight basis was worked out by the following formulae (Preetha and Nadarajan, 2006) [18].

$$\text{Per cent infestation (Number basis)} = \frac{\text{Total number of infested fruit}}{\text{Total number of picked fruits}} \times 100$$

$$\text{Per cent infestation (Weight basis)} = \frac{\text{Total weight of infested fruit}}{\text{Total weight of picked fruits}} \times 100$$

The data on per cent fruit infestation on number and weight basis were subjected to analysis after angular transformation. The varieties of round gourd were categorized on the basis of peak fruit infestation recorded during the crop season using following formula:

$\underline{X} \pm \sigma$

Where,

$\overline{x}$ = Mean of peak infestation, σ = Standard deviation for insect population

The categories were made as (i) least susceptible ($<\underline{X} - \sigma$), (ii) moderately susceptible ($X - \sigma$ to $X + \overline{\sigma}$), and (iii) highly susceptible ($>X + \sigma$). Grouping was done on the basis of range value calculated by considering the value of general mean (X) and standard deviation (σ) (panda, 1979) [17].

**Screening of round gourd varieties based on physical and biochemical characters**

For this study, five fruits were randomly picked from the experimental plots of each variety and analyzed for physical and biochemical characteristics by following methods.

**Physical characters**

**Tenderness of fruits rind**

Tenderness of fruit rind was tested by tenderometer and expressed in terms of hard, semi hard and soft. For this, tenderometer was placed on surface of the fruit and was pressed till the fruit surface ruptured and this point pressure was noted on the five randomly selected fruit of each variety and then grouped into different categories as soft ($<X- \sigma$), semi hard ($X- \sigma$ to $X+ \sigma$) and hard ($>X+ \sigma$) as per modified method described by Panda (1979) [17].

**Fruit shape**

Fruit shape was measured through fruit diameter, five fruits of marketable size of each variety were randomly taken and the diameter of each fruit was measured from center of fruit to different points with the help of vernier calipers, mean was calculated. It expressed in term of flattish round and round.

**Hair density**

The numbers of fruit hairs were counted from five fruits of each variety picked at marketable size. Compound microscopic was used for counting the number of fruit hairs on around the fruit rind. For this purpose a round disc of fruit with an area of 1.0 $cm^2$ was cut for counting the hair number by keeping it under the microscope. Care was taken in taking fruit rind from a fix point in all the fruits. On the basis of number of fruit hairs present per $cm^2$ area, the fruits were classified into four categories viz., (i) Less hairy (ii) Moderately hairy (iii) Hairy (iv) Densely hairy.

**Colour of fruits**

Colour of fruits was observed by visual method. The same age of each variety was observed by visual method matched with colour chart and expressed as green, whitish green, dark green and light green.

**Biochemical characters**

**Preparation of sample for analysis.**

The fresh picked fruits were washed with ordinary water and cut into small pieces. They were dried completely in an oven at 65°c - 70°c temperature for 72 hours. After drying the fruit material, the grinding of fruit samples was done separately for different varieties with the help of electric grinder to fine powder. These grinded fruits samples were used for analysis.

**Estimation of total phenol**

Total phenol was estimated by the method described by Bray and Thorp (1954) [5]. One gram of dried fruit powder was taken and homogenized in 5-6 ml of 80% hot alcohol at 5000 rpm for 10 minutes. The supernatant thus separated was cooled and final volume was made to 10 ml with 80% alcohol. Out of this 0.5 ml aliquot was made up to 1 ml with distilled water. To this folin ciocalteau 0.5 ml was added and it was kept at room temperature for three minutes. Sodium carbonate 20 % one ml solution freshly prepared, then 10 ml distilled water was added and mixed well. The test tube was placed in a boiling water bath for 1 minute. The mixture was cooled and absorbance measured at 650nm with the help of spectrophotometer. Standard curve was prepared by taking the known amount of phenol and with the help of this the actual amount of phenol in unknown samples were estimated.

**Estimation of silica content**

The amount of silica in the round gourd fruits were estimated by gravimetric method described by Jackson (1962) [11]. The 100 mg fruit powder was taken in flat bottom kjeldahl digestion flask, 4 ml of chloric acid and 15 ml nitric acid were added to ensure complete oxidation of the organic matter. Then 2 ml of sulphuric acid was added and mixed with the contents of the flask by swirling and heated gently at low heat on an open radiation type hot plate until the first appearance of dense brown fumes. When dense brown fumes appeared, the flask was removed from the heater after five minutes. The flask was replaced from the heater and digestion was allowed to continue until the appearance of dense white fumes. The liquid become colourless after completion of the digestion. Thereafter, it was cooled and 20 ml of water was added. The silica was filtered off through a retentive ash less paper from the soluble salts and washed with 0.5 N HCL until of got salt free. The silica was transferred to a platinum crucible and the crucible was placed in an oven at 100°c until it dried completely. The crucible was cooled for 10 minutes and weighed. This process was repeated until the crucible and contents were brought to constant weight. The final weight was recorded.

**Estimation of total soluble solids**

The total soluble solids were estimated by zeisis hand refractometer and values obtained were corrected at 20°c.

**Results and Discussion**

The data presented in table 1 and 2 revealed that none of the variety was found completely free from the infestation of fruit fly (table 1 and 2). The first observation was recorded on 16th March, 2016. The mean observed infestation ranged from 2.66- 6.42 percent on number and 4.11-5.22 per cent on the weight basis. The maximum infestation was recorded in variety Ujjawal with 6.42 per cent on number and 5.22 per cent damage on weight basis followed by JKSPL 6.20 per cent on number and 5.22 per cent damage on weight basis. The minimum damage of 2.66 per cent on number and 4.11 on per cent on weight basis was found in variety Arka Tinda. The similar trend of fruit fly infestation in round gourd was observed in 2nd, 3rd, 4th, 5th, and 6th observations, in which maximum infestation was recorded in variety Ujjawal and minimum damage was in variety Arka Tinda on number and weight basis, respectively.

The fruit fly infestation was gradually increased and reached to its peak in eighth observation (6th April) and ranged from 21.43 to 36.49 per cent on number and 22.12 to 36.92 per cent on weight basis. The least infestation was recorded in variety Arka Tinda, 21.43 per cent on number and 22.12 per cent on weight basis which was at par with Tinda Ludhiana, 24.04 per cent on number and 24.58 per cent on weight basis. The infestation was recorded on different varieties screened against fruit fly *viz*., Mahi Tinda, 30.18 per cent on number basis and 30.44 per cent on weight basis, Mahi-1, 31.29 per cent on number and 30.66 per cent on weight basis and Amol, 32.27 per cent on number and 32.03 per cent on weight basis, all these varieties were categorized as moderately susceptible and found at par with each other on both number and weight basis. The maximum damage was recorded in variety Ujjawal with 36.49 per cent on number and 36.92 per cent on weight basis followed by JKSPL, 35.90 per cent on number and 35.80 per cent fruit damage on weight basis which were found at par with each other. There after declined the infestation of fruit fly. The variability of resistance at peak infestation was in the order of Arka Tinda >Tinda Ludhiana >Mahi Tinda >Mahi-1 >Amol >JKSPL >Ujjawal.

On the basis of overall mean (both number and weight basis fruit damage) the minimum fruit fly damage was recorded in the variety Arka Tinda with 12.20 per cent on number and 12.13 per cent on weight basis followed by Tinda Ludhiana, 13.98 per cent on number and 13.92 per cent fruit on weight basis however, both have significantly difference among them. The infestation on remaining varieties *viz*., Mahi Tinda, Mahi-1 and Amol were 16.67, 18.78 and 20.31 per cent, respectively, fruit damage on number and 16.07, 17.98 and 19.87 per cent fruit damage on weight basis, respectively, however, The varieties Mahi-1 and Amol both were found at par with each other. The maximum damage was found in the variety Ujjawal, 23.37 per cent on number and 22.20 per cent on weight basis, followed by JKSPL, 22.05 fruit damage per cent on number and 22.07 per cent fruit damage on weight basis, both were found at par with each other.

The data presented in table 3 revealed that the peak fruit fly infestations of round gourd varieties screened were categorized on the basis of formula $X \pm \sigma$. The varieties having infestation of fruit fly were categorized on the basis of susceptibility. Fruit infestation was categorized on the number basis below 24.56 per cent damage was least susceptible, 24.56 to 35.88 per cent infestation moderately susceptible and above 35.88 per cent infestation was categorized highly susceptible. Similarly, on the weight basis was categorized below 25.23, 25.23 to 36.09 and above 36.09 per cent fruit infestation less susceptible, moderately susceptible and highly susceptible group, respectively. Taking the above criterion, all the varieties were divided into three groups' *i.e.* Arka Tinda and Tinda Ludhiana less susceptible group. Mahi Tinda, Mahi-1 and Amol, moderately susceptible group and JKSPL and Ujjawal came under highly susceptible group. The results of present investigation are in agreement with that of Muthukrishnan *et al.* (2005) [16] and Verma (2008) [22] who reported that variety Arka Tinda was observed as resistant to fruit fly. Similarly, Shivananda (2013) [20] and Gogi *et al.* (2009) [8] reported that during the screening of different varieties of cucurbits, few varieties were found less susceptible.

**Table 1:** Relative susceptibility of round gourd varieties against fruit fly, *B. cucurbitae* (based on number of fruits) during Summer, 2016

| Varieties | Percent infestation of fruits at different picking (Three days interval)# | | | | | | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Date of observation | | | | | | | | | | | |
| | 16.3.2016 | 19.3.2016 | 22.3.2016 | 25.3.2016 | 28.3.2016 | 31. 3.2016 | 3.4.2016 | 6.4.2016* | 9.4.2016 | 12.4.2016 | 15.4.2016 | |
| Mahi Tinda | 4.77 | 7.40 | 9.83 | 13.18 | 16.71 | 21.39 | 26.31 | 30.18 | 23.73 | 17.25 | 12.62 | 16.67 |
| | (12.62) | (15.79) | (18.27) | (21.29) | (24.13) | (27.55) | (30.86) | (33.32) | (29.15) | (24.54) | (20.81) | (23.48) |
| Tinda Ludhiana | 4.52 | 6.70 | 8.67 | 9.80 | 12.50 | 18.30 | 20.75 | 24.04 | 20.25 | 15.10 | 13.18 | 13.98 |
| | (12.27) | (15.00) | (17.12) | (18.24) | (20.70) | (25.33) | (27.10) | (29.36) | (26.74) | (22.87) | (21.29) | (21.46) |
| Amol | 6.00 | 9.20 | 12.73 | 17.73 | 21.54 | 26.31 | 29.92 | 32.27 | 28.62 | 20.65 | 18.49 | 20.31 |
| | (14.18) | (17.66) | (20.90) | (24.90) | (27.65) | (30.86) | (33.16) | (34.62) | (32.34) | (27.03) | (25.47) | (26.25) |
| Mahi-1 | 5.18 | 8.20 | 11.18 | 15.10 | 19.40 | 24.53 | 27.47 | 31.29 | 28.90 | 18.40 | 16.97 | 18.78 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (13.16) | (16.64) | (19.53) | (22.87) | (26.13) | (29.69) | (31.61) | (34.01) | (32.52) | (25.40) | (24.33) | (25.08) |
| Arka Tinda | 2.66 | 6.00 | 6.70 | 8.77 | 10.96 | 12.73 | 18.32 | 21.43 | 20.35 | 15.21 | 11.10 | 12.20 |
| | (9.39) | (14.18) | (15.00) | (17.23) | (19.33) | (20.90) | (25.34) | (27.58) | (26.81) | (22.95) | (19.46) | (19.83) |
| JKSPL | 6.20 | 10.11 | 14.22 | 18.87 | 22.22 | 28.52 | 32.52 | 35.90 | 31.57 | 22.22 | 20.25 | 22.05 |
| | (14.42) | (18.54) | (22.15) | (25.75) | (28.12) | (32.28) | (34.77) | (36.81) | (34.19) | (28.12) | (26.74) | (27.34) |
| Ujjawal | 6.42 | 10.42 | 15.38 | 19.04 | 24.50 | 29.41 | 34.41 | 36.49 | 33.33 | 25.63 | 22.00 | 23.37 |
| | (14.68) | (18.83) | (23.09) | (25.87) | (29.67) | (32.84) | (35.92) | (37.16) | (35.26) | (30.42) | (27.97) | (28.34) |
| SEm± | 0.11 | 0.33 | 0.39 | 0.44 | 0.50 | 0.56 | 0.62 | 0.67 | 0.63 | 0.57 | 0.48 | 0.48 |
| CD at 0.5% | 0.31 | 0.97 | 1.12 | 1.28 | 1.46 | 1.63 | 1.81 | 1.93 | 1.82 | 1.65 | 1.38 | 1.40 |

* = Peak infestation
# = Mean of three replication
Figures in parentheses are angular transformed values

**Table 2:** Relative susceptibility of round gourd varieties against fruit fly, *B. cucurbitae* (based on weight of fruits) during Summer, 2016

| Varieties | Percent infestation of fruits at different picking (Three days interval)# | | | | | | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Date of observation | | | | | | | | | | | |
| | 16.3.2016 | 19.3.2016 | 22.3.2016 | 25.3.2016 | 28.3.2016 | 31.3.2016 | 03.4.2016 | 06.4.2016 | 09.4.2016 | 12.4.2016 | 15.4.2016 | |
| Mahi Tinda | 4.92 | 5.22 | 9.91 | 10.95 | 14.74 | 22.58 | 25.87 | 30.44 | 23.15 | 16.34 | 12.68 | 16.07 |
| | (12.82) | (13.21) | (18.35) | (19.32) | (22.58) | (28.37) | (30.57) | (33.49) | (28.76) | (23.84) | (20.86) | (22.92) |
| Tinda Ludhiana | 5.18 | 5.4 | 8.62 | 10.44 | 12.14 | 15.95 | 20.80 | 24.58 | 20.82 | 15.98 | 13.22 | 13.92 |
| | (13.16) | (13.44) | (17.07) | (18.85) | (20.39) | (23.54) | (27.13) | (29.72) | (27.15) | (23.56) | (21.32) | (21.39) |
| Amol | 4.82 | 7.52 | 10.64 | 15.49 | 23.78 | 27.89 | 29.42 | 32.03 | 26.42 | 21.17 | 19.44 | 19.87 |
| | (12.68) | (15.92) | (19.04) | (23.18) | (29.19) | (31.88) | (32.85) | (34.47) | (30.93) | (27.39) | (26.16) | (25.79) |
| Mahi-1 | 5.94 | 8.11 | 9.20 | 13.22 | 18.98 | 23.47 | 26.77 | 30.66 | 28.70 | 18.20 | 14.53 | 17.98 |
| | (14.11) | (16.55) | (17.66) | (21.32) | (25.83) | (28.98) | (31.16) | (33.62) | (32.39) | (25.25) | (22.41) | (24.48) |
| Arka Tinda | 4.11 | 5.76 | 5.10 | 6.34 | 10.64 | 13.22 | 18.38 | 22.12 | 20.18 | 15.25 | 12.32 | 12.13 |
| | (11.70) | (13.89) | (13.05) | (14.58) | (19.04) | (21.32) | (25.39) | (28.06) | (26.69) | (22.99) | (20.55) | (19.75) |
| JKSPL | 5.12 | 9.31 | 13.45 | 17.67 | 25.12 | 28.70 | 32.18 | 35.80 | 28.64 | 21.25 | 25.54 | 22.07 |
| | (13.08) | (17.77) | (21.51) | (24.86) | (30.08) | (32.39) | (34.56) | (36.75) | (32.36) | (27.45) | (30.36) | (27.38) |
| Ujjawal | 5.22 | 8.36 | 14.74 | 18.33 | 25.56 | 29.19 | 32.45 | 36.92 | 32.03 | 21.19 | 20.18 | 22.20 |
| | (13.21) | (16.81) | (22.58) | (25.35) | (30.37) | (32.70) | (34.73) | (37.42) | (34.47) | (27.41) | (26.69) | (27.43) |
| SEm± | 0.26 | 0.15 | 0.36 | 0.41 | 0.50 | 0.55 | 0.62 | 0.59 | 0.61 | 0.55 | 0.47 | 0.46 |
| CD at 0.5% | 0.76 | 0.42 | 1.05 | 1.20 | 1.46 | 1.58 | 1.78 | 1.70 | 1.78 | 1.59 | 1.37 | 1.34 |

* = Peak infestation
# = Mean of three replication
Figures in parentheses are angular transformed values

**Table 3:** Degree of susceptibility in different varieties of round gourd during Summer, 2016

| S. No. | Varieties | Peak per cent fruit infestation | | Degree of susceptibility |
|---|---|---|---|---|
| | | Based on number | Based on weight | |
| 1 | Mahi Tinda | 30.18 | 30.44 | Moderately susceptible |
| 2 | Tinda Ludhiana | 24.04 | 24.58 | Less susceptibility |
| 3 | Amol | 32.27 | 32.03 | Moderately susceptible |
| 4 | Maha-1 | 31.29 | 30.66 | Moderately susceptible |
| 5 | Arka Tinda | 21.43 | 22.12 | Less susceptible |
| 6 | JKSPL | 35.90 | 35.80 | Highly susceptible |
| 7 | Ujjawal | 36.49 | 36.92 | Highly susceptible |
| | x ± σ | 30.23 ± 5.66 | 30.36 ± 5.43 | |

**Screening of round gourd varieties based on physical and biochemical characters**

**Physical characters of fruits**

Morphological (physical) resistance factors interfered the mechanism of feeding and oviposition of the any insect. Shape of the fruit may also play a role in insect orientation but in round gourd there was no any impact of shape of the fruit infestation. Such morphological factors were investigated so that it could be possible to develop rapid screening techniques based on these factors.

**Tenderness of fruit rind**

During present investigation the fruits of varieties Arka Tinda and Tinda Ludhiana had hard rind and observed less infestation of fruit, 12.20 per cent and 13.98 per cent, respectively (table 4). The varieties Mahi Tinda and Mahi-1 had semi hard rind registered 16.67 and 18.78 per cent fruit fly damage and existed in moderate susceptible group. The varieties Amol, JKSPL and Ujjawal having soft fruit rind, which were found more fruit infestation, 20.31, 22.05 and 23.37 per cent fruit damage, respectively. The present findings are in conformity with the observation of Gogi *et al.* (2010) [9] who reported that fruit toughness, height of small ridges, height of longitudinal ribs and pericarp thickness, were highest in resistant and lowest in susceptible genotypes of bitter gourd. Similar finding was also reported by Kapoor (2001) [13] who observed that melon fruit fly preferred young green and tender fruit as compared to bigger ones with hard rind for egg laying.

**Table 4:** Physical characters of different varieties of round gourd in relation to fruit fly, *B. cucurbitae* infestation during Summer, 2016

| S. No. | Varieties/ cultivars | Fruit infestation (%)# | Tenderness of fruit rind | Shape of fruit | Colour of fruit | Hair density |
|---|---|---|---|---|---|---|
| 1 | Mahi Tinda | 16.77 | Semi-hard | Round | Dark green | Moderately hairy |
| 2 | Tinda Ludhiana | 13.98 | Hard | Flattish round | Light green | Moderately hairy |
| 3 | Amol | 20.31 | Soft | Round | Light green | Hairy |
| 4 | Mahi-1 | 18.78 | Semi –hard | Round | Green | Hairy |
| 5 | JKSPL | 22.05 | Soft | Flattish round | Light green | Hairy |
| 6 | Arka Tinda | 12.20 | Hard | Round | Light green | Densely hairy |
| 7 | Ujjawal | 23.37s | Soft | Round | Green | Hairy |

# = Mean of three replication and per cent fruit damage

**Shape, colour and hair density**

There was no role of fruit shape for the infestation of fruit fly in the round gourd. However, the round shape of fruit was observed in varieties *viz*: Arka Tinda, Mahi Tinda, Amol, Mahi-1 and Ujjawal. The varieties of Tinda Ludhiana and JKSPL were found flattish round shape. Present finding partially corroborates with that of Reddy and Vasugi (2002) [19] who reported that in guava fruits, the fruit-shape did not show any effect on the incidence of pest. The colour of fruits was observed green in varieties Mahi-1 and Ujjawal. The varieties Tinda Ludhiana, Amol, JKSPL and Arka Tinda were found light green colour fruits, whereas variety Mahi Tinda had dark green fruits. Similar observation was also recorded by Kapoor (2001) [13] who stated that melon fruit fly preferred yellow green colour and tender fruit as compared to bigger ones. The hair density played the important role for intensity of infestation of fruit. The hair density of round gourd fruits varied from less hairy, moderately hairy and densely hairy fruits in different screened varieties. The variety Arka Tinda was found densely hairy, with minimum fruit damage of fruit fly. The varieties Mahi Tinda and Tinda ludhiana were found moderately hairy whereas, varieties Amol, Mahi-1, JKSPL and Ujjawal were found less hairy. The maximum infestation of fruit fly was observed with less hairy fruit. In conformity to the above observation by Chanana *et al*. (1992) [6] who reported that the hairy character of peach fruits showed no consistent relationship with tolerance against fruit fly. Similarly, Gogi *et al*. (2010) [9] reported that the number of longitudinal ribs / fruit and number of small ridges / $cm^2$ were lowest in resistant and highest in susceptible genotypes of bitter gourd. The shape and colour of the fruits of round gourd varieties screened had no clear cut impact to the preference of fruit fly. However, varieties Arka Tinda and Tinda Ludhiana had round and flattish round; respectively and light green coloured fruits emerged as less susceptible to fruit fly.

**Biochemical characters of fruits**

Biochemical studies can only follow a successful discovery of a source of resistance. It is well established that chemical stimuli play a major role in host plant selection by insect for both oviposition and feeding (Maxwell and Jennings, 1980) [15]. Resistance in the field is an outcome of many complex phenomenon's and generally no single chemical can accounts for it. The role of some biochemical constituents of fruits which influenced the relationship between fruit fly and host fruit of round gourd has been discussed here.

**Total phenol**

The total phenol content (table 5) in fruits of different varieties of round gourd was negatively correlated with per cent fruit infestation (r = -0.976). The varieties Arka Tinda and Tinda Ludhiana had less fruit fly infestation with 12.20 and 13.98 per cent fruit damage and more total phenol with 0.98 and 0.96 per cent, respectively as compared to the other varieties. The varieties Ujjawal and JKSPL contained low amount of total phenol, 0.86 and 0.87 per cent, respectively, which exhibited maximum fruit fly infestation of, 23.37 and 22.05 per cent fruit damage, respectively. The remaining varieties *viz* : Mahi Tinda, Mahi-1 and Amol were having moderate phenol of, 0.92, 0.91 and 0.89 per cent, respectively, which were categorized as moderate infestation of, 16.67, 18.78 and 20.31 per cent fruit damage, respectively. No work is available on total phenols of round gourd fruit in relation to fruit fly infestation hence; it has been discussed with other studies on other vegetables. This observation is in conformity with the findings of Haldhar *et al*. (2015) [10] who reported that the contents of phenols, tannins and total alkaloids were highest in resistant and lowest in susceptible varieties of water melon. Similar observation was also made by Arora *et al*. (2000) [3] who reported that negative correlation was observed between total phenol and per cent fruit infestation in guava against *B. dorsalis*. It may be due to the antibiosis effect of phenol on the biology of fruit fly.

**Amount of silica**

The data presented in table 5 revealed that the significant negative correlation (r = -0.963) between fruit fly infestation and silica content of the fruits of different varieties of round gourd. The varieties Arka Tinda and Tinda Ludhiana had significantly higher silica content of, 1.36 and 1.26 per cent respectively, with minimum fruits damage of, 12.20 and 13.98 per cent, respectively, then the other varieties. The amount of silica was found comparatively low, 0.87, 0.90 and 0.97 per cent, respectively, in varieties Ujjawal, JKSPL and Amol which were categorized as susceptible group with maximum fruits damage of, 23.37, 22.05 and 20.31 per cent, respectively. The varieties Mahi-1 and Mahi Tinda had medium silica content of, 1.12 and 1.16 per cent, respectively, which were categorized as moderately susceptible. These findings are in agreement with the observation of Chelliah and Sumbandam (1974) [7] who reported that resistance to fruit fly; *D. cucurbitae* appeared to be associated with high silica content of the fruits. It is concluded that higher amount of total phenol and silica content of fruits of resistant varieties may be responsible for imparting resistance against fruit fly in round gourd.

**Table 5:** Biochemical characters in different round gourd varieties and their correlation with fruit fly, *B. cucurbitae* infestation during Summer, 2016

| S. No. | Varieties/ cultivars | Fruit infestation (%)# | Total phenol (%) | Amount of silica (%) | Total soluble solid (%) |
|---|---|---|---|---|---|
| 1. | Mahi Tinda | 16.67 | 0.92 | 1.16 | 4.67 |
| 2. | Tinda Ludhiana | 13.98 | 0.96 | 1.26 | 4.21 |
| 3. | Amol | 20.31 | 0.89 | 0.97 | 5.20 |
| 4. | Mahi-1 | 18.78 | 0.91 | 1.12 | 4.86 |
| 5. | JKSPL | 22.05 | 0.87 | 0.90 | 5.27 |
| 6. | Arka Tinda | 12.20 | 0.98 | 1.36 | 4.18 |
| 7. | Ujjawal | 23.37 | 0.86 | 0.87 | 5.29 |
| | | | r = -0.9765** | r= -0.963** | r = 0.961** |

r = correlation coefficient

** = significant at 1% level of significance

# = Mean of three replication and per cent fruit damage

**Table 6:** Yield performances of different round gourd varieties during Summer, 2016

| S. No. | Varieties | Yield (q/ha) |
|---|---|---|
| 1 | Mahi Tinda | 69.15 |
| 2 | Tinda Ludhiana | 72.08 |
| 3 | Amol | 56.75 |
| 4 | Mahi-I | 63.67 |
| 5 | Arka Tinda | 75.18 |
| 6 | JKSPL | 44.50 |
| 7 | Ujjawal | 41.33 |
| | SEm ± | 1.34 |
| | CD (P=0.05%) | 3.88 |

**Total soluble solids**

The total soluble solids (TSS) had significantly positive correlation (***r*** = 0.961) with fruit fly infestation in different round gourd varieties. The data clearly indicated that varieties Arka Tinda and Tinda Ludhiana were having low per cent total soluble solid with 4.18 and 4.21 per cent, respectively, which were observed with less infestation of fruit fly. The varieties Amol, JKSPL and Ujjawal were found higher TSS content of 5.20, 5.27 and 5.29 per cent, respectively, which had more fruit fly infestation of, 20.31, 22.05 and 23.37 per cent, respectively. The TSS was observed medium where the values varied 4.67 and 4.86 per cent in Mahi Tinda and Mahi-1 having moderate infestation of, 16.67 and 18.78 per cent, respectively. This observation is in conformity with the findings of Jalaluddin and Sadkhulla (1999) [12] and Arora *et al*. (2000) [3] who found positive correlation between total soluble solids and per cent infestation of *B. dorsalis* in guava fruits.

**Conclusion**

In the present study it can be concluded that out of seven varieties of round gourd screened against fruit fly, Arka Tinda and Tinda Ludhiana were found less susceptible; these varieties having hard fruit rind were found less susceptible. The variety Arka Tinda having densely hairy was found less susceptible, the total phenol and amount of silica had negative correlation and total soluble solids had positive correlation with fruit fly infestation.

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