

Susceptibility of different genomic banana cultivars to banana leaf and fruit scar beetle, *Nodostomasubcostatum* (Jacoby)

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ABSTRACT

The research programme was drawn "Susceptibility of different genomic banana cultivars to banana leaf and fruit scar beetle, *Nodostomasubcostatum* (Jacoby)". The experiment was conducted during 2019 to 2022 in Uttar Banga Krishi Vishwavidyalaya, Pundibari, Cooch Behar, West Bengal. Twelve cultivars (local and wild group) were evaluated and screened. Among them highest scar beetle population/plant was found on G9 (22.21) followed by G9 TC (21.71) and Malbhog (19.86). Keeping parity with beetle population highest leaf infestation (scar/20 cm² area of leaf) was also observed highest on G9 (33.83) followed by G9 TC (32.80) and Malbhog (30.20). In accordance with leaf infestation highest no of scar/finger was recorded again on G9 (85.31), followed by G9 TC (83.73) and Malbhog (64.54). Following the similar trend percentage of infested fruit/bunch was observed highest in G9 (81.70) followed by G9 TC (80.59) and Malbhog (78.87). On the contrary the lowest scar beetle population/plant was found on Red banana (4.80) followed by Manua (5.33) and Thellachakrakeli (5.93). Lower leaf infestation was denoted by scar/20 cm² area of leaf was observed on Red banana (8.95), followed by Thellachakrakeli (9.21) and Manua (9.67). On fruit, lowest scar/finger was recorded again on red banana (20.99), followed by Thellachakrakeli (24.06) and Manua (31.10). Lowest percentage of infestation was also followed similar trend and it was again recorded lowest Red banana (24.66) followed by Thellachakrakeli (29.55) and Manua (33.17).

Varietal characters viz. Cuticular thickness of leaf, fruit peel thickness, leaf moisture percentage of all the twelve cultivars evaluated were significantly correlated with beetle population and its infestation level. This phenomenon indicates increment of those varietal characters caused significant reduction of beetle population and damage potential. These parameters were found significantly correlated and positive with the above character studied. Hence, this is the reason of lower population beetle and infestation level to the cultivars Red banana, Thellachakrakeli and Manua, and being higher population on G9, G9 TC and Malbhog. It can therefore be said that among the twelve cultivars studied Red banana, Thellachakrakeli and Manua are relatively resistant and G9, G9 TC and Malbhog are susceptible to leaf and fruit scar beetle.

Keywords: Plant, variety, resistance, susceptible, scar, infestation

Introduction

Banana (*Musa paradisiaca* Linnaeus) is an important fruit crop in India and plays a major role in the dietary supplements. It was originated in South-East Asia (Simmonds, 1966) and one of the important fruit crops of the region. India ranks first in terms of area (830 ha) and production (29780 MT) with a productivity of 35.9 MT/ha (Anonymous, 2021). Bananas are grown in more than 150 countries, producing 105 million tonnes of fruit per year (Anonymous, 2000). The global production of banana is around 102028.17 thousand tons of which India contributes 32% of the total global banana production (Anonymous, 2020). The year-round fruiting habit of the crop ensures food security at household level and provide a source of income for the majority of smallholder as well as large holder growers in the country. The major constraints on present and future production of bananas and plantains are pests and diseases attacking at different growth stages of the plants.

More than 470 species of insects and mites have been recorded pest attacking on banana. Of these, 250 are foliage feeders, 10 are pseudostem borers, 70 feed on roots and rhizomes, 130 feed on fruits and flowers, and more than 10 are disease vectors. Among different insect pests attack banana, leaf and fruit scarring beetle, *Nodostomasubcostatum* Jacoby (Coleoptera: Chrysomelidae) has been recognized as a most serious one. It causes considerable damage to leaves as well as fruits during summer and rainy seasons resulting in heavy economic losses (Sen and Prasad, 1953). The extent of damage inflicted upon banana crop by this pest has been reported to be around 80 per cent (Roy and Sharma, 1952) and in case of severe infestation, the percentage of infested orchards and intensity of the pest have been recorded up to 100 per cent. The damage caused to skin of the fruit, leaves the bunch so badly scarred as to lose its commercial value, which affect both quality and productivity of the fruits.

The physical appearance of peel is especially important in the export market. As it is a serious pest causing scars on the fruits, the fruits affected by this pest have poor market acceptability. On the contrary there are some varieties/ types of banana which are found free from beetle attack. Moderate to high levels of resistance among cultivated genotypes can be exploited in an IPM strategy to control the banana Scar beetle. The use of resistant cultivars in IPM acts by reducing the rates of a pest population build up and this could be effectively achieved with moderate levels of host resistance, especially if it is antibiotic in nature (de Ponti, 1982; Pathak, 1991). It was reported that banana cultivar varied significantly in their reaction to scarring beetle. Therefore, varietal screening becomes one of the non-insecticidal tools for protecting the banana crop against scarring beetle (Kumar, 1989; Chaudhury et al., 1996). Among the evaluated cultivars at Poovan, Ladie's finger, Bhimkel and Kanchkel were recorded as highly resistant (HR), whereas Champa, Polyan and Chinia were categorized as resistant (R) on the other Kanthali, Malbhog, Agni sagar and Vellary were graded moderate susceptible (MS). The variety such as Neypoovan, Srimanti, Kothia and Raja Vazhai were found susceptible (S) and Barsai, Dwarf cavandish, Sinduri, Monthon, Kasturi and Robusta were found highly susceptible (HS).

Materials and Methods

The experiment was conducted in Horticultural instructional Farm UBKV during 2019-2022 to evaluate the selected banana cultivars Susceptible/Resistance to the scar beetle. In this experiment twelve cultivars were selected to study namely Katchakela, Bichikela, Modhubash, ChiniMalbhog, Malbhog, G9,

List of screened banana cultivars and their genome

Sl. No.	Cultivar	Genome	Sub-group
1	Katchakela	ABB	Local group
2	Bichikela	BB	Wild group
3	Modhubash	ABB	Wild group
4	ChiniMalbhog	AAB	Local group
5	Malbhog	AAB	Local group
6	G9	AAA	Local group
7	G9 Tissue Culture (TC)	AAA	Local group
8	Red Banana	AAA	Local group
9	Manua	ABB	Wild group
10	ThellachakraKeli	AAA	Wild group
11	AmritSagar	AAA	Local group
12	AmritSagar Tissue Culture (TC)	AAA	Local group

The resistance and susceptibility attributes of banana cultivar has been assessed on the basis of varietal characters such as leaf moisture percentage (% age), cuticle thickness of leaves (mm) and peel thickness of fruits (mm) were also assessed along with their role in pest population and infestation. For analysis of these biochemical different stages of plant such as young (furled) and old (unfurled) leaves and unripe and ripe fruit peel from infested leaves and fruits were drawn separately from each of the selected cultivar and they were subjected to quantification.

Result and Discussion

Beetle population: The significantly highest and on par beetle population was recorded in cultivar G9 (22.21/ plant) followed

G9 tissue culture, Red banana, Thellachakrakeli, Manua, Amrit Sagar and Amrit Sagar tissue culture. The experiment was laid out in RBD with each cultivar replicated thrice consisting of ten plants. Observations on ten plants of each cultivar were recorded with respect to beetle population, Scar/ 20cm² area of leaf, Scar/ finger, percentage infested fruit/ bunch, length and diameter of fruit, weight of single fruit and Yield/ bunch. Beetle population per plant and damage caused by them as scar/20 cm² leaf area per plant of each selected cultivar was observed throughout the year on weekly basis. The counting of beetle population was done by net collection method and mean beetle population was calculated. Scar on leaves were calculated on 20cm² area of freshly opened leaves from each cultivar and the mean was worked out. Scar on fruit were calculated by counting the no of scars per fruit in single hand from the emergence of fruit to till harvest. After harvest, length and breadth of fruit, weight of single fruit and weight of bunches were recorded, and mean were calculated. Percentage infested fruit/ bunch were calculated by counting total number of healthy as well as infested fingers and finally mean percent finger infestation was calculated. The cultivars were finally categorized into different groups of resistant/susceptible with certain modifications of the scale given by Kumar (1989) as per details given below:
 Highly Susceptible (HS) = More than 80 per cent infestation
 Susceptible (S) = 60 to 80 per cent infestation
 Moderately Susceptible = 40 to 60 (MS) per cent infestation
 Resistant (R) = 20 to 40 per cent infestation
 Highly Resistant (HR) = Less than 20 per cent infestation
 % Fruit Infestation = No. of infested finger per bunch x 100/ Total no. of finger/ bunch.

by G9 TC (21.71/ plant). Comparatively higher populations 19.86 and 16.15 beetles/ plant were recorded in Malbhog and ChiniMalbhog respectively. The infestation was same in Modhubash (12.58 beetles/plant), Amrit Sagar (13.66 beetles/ plant) and Amrit Sagar TC (13.21 beetles/ plant). The lowest population was recorded in Red banana (4.80 beetles/ plant) which was found at par with Manua (5.33 beetles/ plant) and Thellachakrakeli (5.93 beetles/ plant). Comparatively lower population was observed in cultivar Katchakela (8.71 beetles/ plant) and Bichikela (7.80 beetles/ plant).

Leaf infestation: The significantly highest leaf infestation was recorded in cultivar G9 (33.83 scar/ 20 cm² area of leaf) and G9

TC(32.80scar/ 20 cm² area of leaf).Comparatively higher leaf infestation was recorded in cultivar Malbhog (30.20 no. of scar/ 20 cm² area of leaf),Amrit Sagar (26.29 scars/ 20 cm² area of leaf), Amrit Sagar TC (25.64 scars/ 20 cm² area of leaf) and ChiniMalbhog (22.02 no. of scar/ 20 cm² area of leaf). Modhubash and Katchakela were recorded significantly on par infestation 16.46 and 14.38 no. of scar/ 20 cm² area of leaf. The least infestation on leaf was recorded in cultivar Red banana (8.95scar/ 20 cm² area of leaf), Thellachakrakeli (9.21scar/ 20 cm² area of leaf), Manua (9.67 scar/ 20 cm² area of leaf) and Bichikela (10.63scar/ 20 cm² area of leaf).

Scar per finger: Fruit infestation due to scar beetle population was highest in G9 (85.31 scar/ finger) and G9 TC (83.73 scar/ finger). The other cultivar such as Malbhog (64.54no. of scar/ finger), Amrit Sagar (58.20 no. of scar/ finger) and Amrit Sagar TC (59.42 no. of scar/ finger) were found comparatively higher infestation. The comparatively lower infestations were recorded Katchakela (50.21, 49.65, 47.92 and 46.50 no. of

scar/ finger), ChiniMalbhog (50.21, 49.65, 47.92 and 46.50 no. of scar/ finger), Modhubash (50.21, 49.65, 47.92 and 46.50 no. of scar/ finger) and Bichikela (50.21, 49.65, 47.92 and 46.50 no. of scar/ finger). The least infestation was recorded in Red Banana (20.99no. of scar/ finger) followed by Thellachakrakeli (24.06 and 31.10 no. of scar/ finger) and Red banana (24.06 and 31.10 no. of scar/ finger).

Percent fruit infestation

The highest percentage of infested fruit per bunch was observed in G9 (81.70%) non-significantly followed by G9 TC (80.59%) and Malbhog (78.87%). The infestation in Amrit Sagar and Amrit Sagar TC were 67.66 and 71.44 %/ bunch and they were at par with each other. The cultivar ChiniMalbhog (59.39%/ bunch), Katchakela (57.83 %/ bunch), Modhubash (57.42%/ bunch) and Bichikela (48.73%/ bunch) were comparatively less infested. The least infestation was observed in Red Banana (24.66%), Thellachakrakeli (29.55%) and Manua (33.17%) and they were statistically at par with each other.

Table-1: Categorization of susceptible reaction of the banana cultivars against scar beetle population as per Kumar (1989)

Mean insect-pest population	Category	Cultivar
>80 per cent infestation	Highly Susceptible (HS)	G9, G9 Tissue Culture (TC)
60 to 80 per cent infestation	Susceptible (S)	Malbhog, Amrit Sagar, Amrit Sagar Tissue Culture (TC)
40 to 60 per cent infestation	Moderately Susceptible	Katchakela, Modhubash, Bichikela
20 to 40 per cent infestation	Resistant (R)	Red banana, Thellachakrakeli, Manua
<20 per cent infestation	Highly Resistant (HR)	-

Correlation between beetle population and %fruit infestation (0.934) showed highly significant and positive relation at 1% and 5 % level of significance (Table-5). Similarly, the correlation between scar/ 20cm² area of leaf and % fruit infestation/ Bunch (0.941) also found highly significant and positive at 1% and 5 % level of significance.

Table-2: Correlations of beetle population, leaf infestation, fruit infestation and % infested fruit/ Bunch

	Beetle/plant	Scar/ 20 cm ² Leaf area	Scar/Finger	% infested Finger/bunch
Beetle/plant	1.00000	0.95663 <.0001	0.92212 <.0001	0.93449 <.0001
Scar/ 20 cm ² Leaf area		1.00000	0.91600 <.0001	0.94165 <.0001
Scar/finger			1.00000	0.97070 <.0001
% infested finger/bunch				1.00000

The obtained results are in accordance with Mishra *et al.* (2015) and Paul *et al.* (2020) who reported the highest population of 32.2 and 24.81 beetles/ plant and 35.00 and 28.4 scars/ 20 cm² area of leaf in Cavandish group of bananas in Assam and Tripura. Mishra *et al.*, (2015) also reported highest fruit scars on Dwarf-Cavendish. Paul *et al.* (2020) recorded 9.62 number of beetles/plants in cultivar Katchakela which is at par with the present result. But they recorded 0.67 number of beetle population/plants in cultivar Attia Kela. Das and Baruah (2018) recorded lower level of leaf and fruit infestation in banana cultivars such as Bhimkel, Bichikela and Katchakela and considered as moderately resistant, while Malbhog, Chinichampa and Amrit Sagar recorded higher leaf infestation and considered as susceptible to scar beetle in Assam. They recorded 90 to 100% leaf and 85-100% fruit infestation in Grand Nain (G9), GaintGoverner, Jahaji and Barjahaji and considered as highly susceptible to scar beetle. The findings of present study also support Sen and Prasad (1953) where Alpan, Champa and Malbhog were seriously affected by the beetle and appeared as susceptible to scar beetle in Bihar. The results

under present investigation closely resemble the findings of Ahmad *et al.* (2003) and Mukherjee (2006) where the maximum damage by banana scarring beetle on fruits were noticed on Barsai, Shabri and Amrit Sagar.

Fruit length (cm):The longest fruit in cultivar G9 (22.89 cm) and G9 TC (22.28 cm). The cultivar Amrit Sagar (17.60 cm) and Bichikela (16.88 cm), Amrit Sagar TC (16.78 cm) and Katchakela (16.28 cm) had statistically same fruit length. The fruit length of cultivar Red banana (14.55 cm), Manua (14.04 cm) and Thellachakrakeli (13.19 cm) were also found statistically at par. On the other hand, the lowest fruit length was observed in ChiniMalbhog (11.05 cm) and Modhubash (11.81 cm).

Fruit diameter (cm):The highest fruit diameter was recorded in cultivar Bichikela (5.83 cm). It was followed by G9 Tissue culture (4.25 cm) and Katchakela (4.23 cm), and Amrit Sagar TC (4.22 cm) and they were found statistically at par with each other. Similarly, the cultivar Amrit Sagar (4.12 cm) and G9 (4.05 cm) and found at par with each other.

The fruit width was at par in Red Banana (3.80 cm), Modhubash (3.75 cm), Thellachakrakeli (3.70 cm) and Manua (3.58 cm). The lowest fruit diameter was recorded in ChiniMalbhog (2.72 cm) and Malbhog (3.18 cm).

Fruit weight (gm): Highest fruit weight (202.17g/finger) was recorded in cultivar Bichikela. The fruit weight of other cultivar in descending order was, Katchakela (164.17g/finger), G9 (148.67g/finger), G9 TC (138.50g/ finger) and Modhubash (117.83g/ finger). The cultivar Amrit Sagar (102.17g/finger), Amrit Sagar TC (96.50g/finger) and Red banana (96.50g/finger) recorded same weight. The cultivar Manua and Thellachakrakeli recorded 88.50g/finger and 81.33g/finger. The lowest fruit weight was recorded in ChiniMalbhog (71.17g/finger) and followed by Malbhog (74.83g/finger).

Yield (Kg/ Bunch): Highest yield of 18.26 kg/ bunch in cultivar G9, and Bichikela (17.60kg/bunch). The cultivar Katchakela, Modhubash and G9 TC yielded 14.69, 10.84 and 17.40 kg/bunch respectively. In Amrit Sagar and Amrit Sagar TC the yield was 8.79 and 8.20 kg/bunch. The cultivar Red banana (7.56 kg/bunch), Manua (7.54 kg/bunch) and Malbhog (7.35kg/bunch) yielded statistically same. The minimum yield was recorded in Thellachakrakeli (6.14kg/ bunch) and ChiniMalbhog (6.83 kg/ bunch).

These findings of yield parameters are found in accordance with Sah *et al.* (2018) who reported that the damage caused to skin of the fruit, left the bunch so badly scarred and due to this damage, photosynthetic area was reduced and ultimately growth of fruit (length, width and weight) and ultimately yield was affected.

Moisture Percentage of leaves (%): The highest percentage of leaf moisture was recorded from Bichikela (85.92%) and Red Banana (85.23%) and Thellachakrakeli (84.33%). The cultivar Katchakela (83.04%) and Manua (83.31%) had statistically at par leaf moisture. Moisture of Malbhog, Modhubash and ChiniMalbhog leaves was statistically same 80.19%, 79.77% and 78.66%. The moisture in Amrit Sagar (76.11%) and Amrit Sagar TC (75.23%) were statistically at par with each other. The lowest moisture percentage was recorded in the leaves of both

G9 (74.21%) and G9 TC (73.50%). The relation between moisture percentage of leaves with beetle population and infestation caused by them was found negative and significant. It indicates that leaf moisture gets inversely affected due to feeding by beetle leads into loss of moisture and desiccation of leaves after scar formation.

Cuticular thickness of leaves (mm): The significantly thick cuticle was recorded in Bichikela (0.131 mm) and Thellachakrakeli (0.124 mm). The cultivar Red Banana, Manua and Katchakela cuticle thickness was recorded as 0.114, 0.114 and 0.108 mm respectively and they were statistically at par. The cultivar Malbhog (0.11 mm), G9 (0.108 mm) and G9 Tissue Culture (0.108 mm) recorded at par cuticle thickness. The significantly thinnest cuticle was observed in ChiniMalbhog (0.094 mm), Modhubash (0.094 mm), Amrit Sagar TC (0.095 mm) and Amrit Sagar (0.096 mm) leaf. The relation between cuticle thickness of leaves with beetle population and infestation caused by them was significant and negative. The reason behind this might be due to thick cuticle caused hindrance to the beetle to scrape the epidermal layer of leaves and thereby reflected on scar development. The Cuticular thickness of leaves is a varietal genetic character which varies with varieties.

Thickness (mm) of fruit Peel: Thickest peel was recorded in Modhubash (3.70mm) and Bichikela (3.60mm) and they were statistically at par. The cultivar Red Banana, Katchakela, Manua and Thellachakrakeli recorded moderately thick peel (3.26, 3.25, 3.12 and 3.10 mm respectively). The cultivar G9 (2.70 mm) and G9 Tissue Culture (2.75 mm) recorded at par peel thickness. The significantly thinnest peel was observed in ChiniMalbhog (1.52mm), Amrit Sagar (1.62 mm) and Amrit Sagar TC (1.67 mm) and Malbhog (1.70 mm). The relation between Peel thickness (mm) of fruit with beetle population and infestation caused by them was found negative and significant. The reason behind the negative correlation may be due to hindrance of beetle population to make scar on the fruits. The fruit peel thickness is a genetic character of varieties and it varies over the varieties.

Table-3: Correlations of beetle population, leaf infestation with moisture content and Cuticular thickness of leaves

Parameters	Cuticular thickness of leaves	Moisture content of leaves
Beetle/plant	-0.43903 <.0001	-0.84285 <.0001
Scar/ 20 cm ² Leaf area	-0.49386 <.0001	-0.90563 <.0001

Table-4: Correlations of beetle population, scar/ finger, % infested fruit/bunch and peel thickness of fruit

Parameters	Fruit Peel thickness
Beetle/plant	-0.535 <.0001
Scar/finger	-0.399 <.0001
% Infested finger/bunch	-0.514 <.0001

Conclusion

The present studies reveal a wide range of variation in susceptibility, among the selected cultivars against banana leaf and fruit scarring beetle, however the physical characters, namely cuticular thickness, fruit peel thickness and moisture percentage showed significant difference.

The resistance and susceptibility attributes of banana cultivars has been assessed with different varietal characters and their role on pest population and thereby infestation. Since the beetles scrape the surface of leaf and peel of the tender fruits, the leaf thickness, peel thickness and moisture content has played an important role on the magnitude of the damage. Among the cultivars thickness of leaves (mm) was found highest on Bichikela (0.131) followed by Thellachakrakeli (0.124), Red banana and Manua (0.114). Peel thickness (in mm) was recorded highest in Modhubash (3.70) followed by Bichikela (3.60), Red banana (3.26) and Katchakela (3.25). Following leaf infestation moisture %age of leaves observed highest in Bichikela (85.92) followed by Red banana (85.23) and Thellachakrakeli (84.33). On the contrary thinner leaf cuticle (mm) was found in Modhubash and ChiniMalbhog (0.94) followed by Amrit Sagar TC (0.95) and Amrit Sagar (0.96).

The thinnest peel of fruit (mm) was recorded in ChiniMalbhog (1.52) followed by Amrit Sagar (1.62) and Amrit Sagar TC (1.67). Lower moisture percent in leaf was observed in G9TC (73.5) followed by G9 (74.21) and Amrit Sagar TC (75.22).

It is noteworthy to mention here that almost all selected varietal parameters namely Cuticular thickness of leaf, fruit peel thickness, leaf moisture percentage were significantly correlated with beetle population and its infestation level. This phenomenon indicates increment of those characters in different cultivars caused reduction of beetle population.

It can therefore be said that among the twelve cultivars studied Red banana, Thellachakrakeli and Manua are relatively resistant and G9, G9 TC and Malbhog are susceptible to leaf and fruit scar beetle.

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