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Biochemical constituents influencing the incidence of leafhoppers on different mango genotypes

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Abstract
Study was carried out at farmer's field, Doddabbigere, Davanagere district during 2016-17. The investigations revealed that the incidence of mango leafhopper was significantly lowest in Totapuri (8.00 mean leafhopper / inflorescence or five sweeps in each direction) followed by Mallika (9.53 leafhopper) and Baneshan (10.69 leafhopper). Whereas, highest number of leafhopper was documented in Alphonso (17.99 leafhopper) followed by Sindhura (14.14 leafhopper), Mulgoa (13.90 leafhopper) and Neelum (13.56 leafhopper). The biochemical studies revealed that significantly lower total reducing sugars, and higher phenols content were noticed in Mallika and Totapuri followed by Baneshan. Whereas, significantly higher in genotypes like Alphonso, Sindhura, Mulgoa and Neelum. Correlation studies revealed that total phenol content was inversely related to the incidence of leafhoppers. Therefore the genotypes Totapuri and Mallika were ranked as tolerant based on the incidence of leafhoppers.

Keywords: Mango genotypes, leafhoppers infestation, total phenols and sugars

1. Introduction
Mango (*Mangifera indica* L.) is the premier fruit of the world belongs to the family Anacardiaceae. It is grown in 111 countries around the world, but this fruit occupies a unique place amongst fruit crops grown for well over 4000 years in the Indian subcontinent [1]. Out of 69 species of mango, all the edible and commercial mango cultivars or genotypes grown throughout the world belong to *Mangifera indica* L. Owing to easy availability of this national fruit for a longer period, an excellent flavour and delicious taste with a uniform blend of sweet and sour and nutritive value, it attains mass appeal and is called 'The King of the fruits'. Besides this fruit possesses a good source of vitamin-A, B-carotene, vitamin-B complex, vitamin-C, minerals, digestible sugars and trace elements. In the past, the only incidence of mango leafhoppers on different mango genotypes were studied however, the biochemical studies with respect to phenols and sugars is scanty. Therefore the study was to investigate the biochemical parameters of different mango genotypes at different stages and correlating them with the incidence of mango leafhoppers.

2. Materials and Methods
2.1 Incidence of leafhoppers on different mango genotypes
A total of seven genotypes that includes six genotypes (Alphonso, Saindura, Baneshan, Totapuri, Mulgoa and Neelum) and a hybrid (Mallika) were selected for recording the incidence of leafhoppers at farmer's field, Doddabbigere, Channagiri taluk, Davanagere district. The following methods were employed for sampling during offseason and flowering.

2.2 Sampling during off season
During off season five sweeps in each direction on the foliage were taken with a standard insect collecting net on the selected trees separately and leafhoppers were collected with an aspirator. Five sweeps were also taken on the tree trunk and this population was added to the total count of leafhoppers. Later leafhoppers were identified and recorded species wise and data will be correlated with the weather parameters.

2.3 Sampling during flowering period
During flowering period two inflorescences in each direction (North, West, East and South) were selected. Total adults and nymphs (species wise) were recorded separately by visual

counting. Observations were also recorded on the tree trunk by taking five sweeps with standard insect collecting net and the population was added to the total count.

2.4 Estimation of biochemical components of different mango genotypes

Genotypes selected for screening were used for estimation of biochemical components. During flowering season, the samples involving two stages *viz.,* new flush, and inflorescence at full bloom stage were collected. During off season tender leaves were collected and were used for biochemical analysis. The biochemical parameters selected for study were total phenols (mg/g), total reducing sugars (mg/g).

3. Results and Discussion

The perusal of the data presented in table 1 revealed that in Alphonso, at the initiation of the study, the population was 11.54 leafhoppers / 5 sweeps during the first fortnight of May 2016 and then after the population declined to the level of 2.05 leafhoppers by the first fortnight of September 2016. From second fortnight of September 2016 the population rapidly increased reaching the first and smaller peak of 35.47 leafhoppers / inflorescence during the first fortnight of February 2017 and more or less the same level was maintained till first fortnight of March 2017. Thereafter, the population declined to 16.38 leafhoppers/ 5 sweeps by the second fortnight of April 2017. Similar trend of population dynamics of mango leafhoppers was noticed in Sindhura, Baneshan, Totapuri, Mulgoa, Neelum and Mallika.

In Sindhura highest peak of 31.27 leafhoppers / inflorescence occurred in the first fortnight of February 2017 and lowest population was recorded in the second fortnight of August 2016 (1.60 leafhopper/ 5 sweeps). In Baneshan highest peak of 24.18 leafhoppers / inflorescence occurred in the second fortnight of February 2017 and lowest population was recorded in the first fortnight of September 2016 (1.25 leafhopper / 5 sweeps). In Totapuri highest peak of 18.16 leafhoppers / inflorescence occurred in the second fortnight of February 2017 and lowest population was recorded in the first fortnight of September 2016 (0.80 leafhopper / 5 sweeps). In Mulgoa highest peak of 31.25 leafhoppers / inflorescence occurred in the first fortnight of February 2017 and lowest population was recorded in the first fortnight of September 2016 (1.25 leafhopper / 5 sweeps). In Neelum highest peak of 31.08 leafhoppers / inflorescence occurred in the first fortnight of March 2017 and lowest population was recorded in the first fortnight of September 2016 (1.40 leafhopper / 5 sweeps). However, in Mallika highest peak of 22.62 leafhoppers / inflorescence occurred in the second fortnight of February 2017 and lowest population was recorded in the first fortnight of September 2016 (1.10 leafhopper / 5 sweeps).

3.1 Varietal influence on the seasonal incidence of mango leafhoppers* at Doddabbibere, Channagiri

During offseason of 2016-17, significantly lower leafhoppers were registered in Totapuri (3.47 leafhopper / 5 sweeps) and was on par with Mallika (4.18 leafhopper / 5 sweeps) followed by Baneshan (5.10 leafhopper / 5 sweeps). However, significantly highest leafhoppers were noticed in Alphonso (10.13 leafhopper / 5 sweeps) and was on par with Sindhura (7.29 leafhopper / 5 sweeps), Mulgoa (7.13 leafhopper / 5 sweeps) and Neelum (6.75 leafhopper / 5 sweeps) (table 2). During the flowering season of 2016-17, significantly lower leafhoppers were registered in Totapuri (12.53 leafhopper / inflorescence) followed by Mallika (14.88 leafhopper / inflorescence), Baneshan (16.28 leafhopper / inflorescence).

Table 1: Incidence of mango leafhoppers on different genotypes at Doddabbibere, Channagiri

Dates	Mean no. of leafhoppers* /inflorescence or five sweeps						
	Alphonso	Sindhura	Baneshan	Totapuri	Mulgoa	Neelum	Mallika
I FN May 2016	11.54	8.13	6.10	4.98	8.00	7.81	5.67
II FN May 2016	10.18	7.34	3.96	3.10	6.48	5.37	3.42
I FN June 2016	7.60	5.00	2.85	2.25	3.25	4.55	2.75
II FN June 2016	4.40	2.80	2.25	1.15	3.85	2.85	1.55
I FN Jul 2016	4.25	3.80	2.00	1.10	3.00	2.70	1.15
II FN Jul 2016	4.50	4.49	2.20	1.52	4.15	2.90	1.25
I FN Aug 2016	4.35	3.80	1.80	1.30	3.90	3.00	1.10
II FN Aug 2016	4.75	1.60	2.50	1.20	4.10	3.65	1.25
I FN Sept 2016	2.05	4.50	1.25	0.80	1.25	1.40	1.10
II FN Sept 2016	9.98	5.75	3.48	2.00	5.00	5.15	2.50
I FN Oct 2016	13.50	8.60	6.00	3.15	8.40	8.10	4.86
II FN Oct 2016	16.80	11.50	9.12	6.35	12.75	12.00	8.50
I FN Nov 2016	23.80	15.83	12.57	9.00	16.14	15.15	10.14
II FN Nov 2016	25.60	19.78	15.14	11.86	19.75	19.50	14.00
I FN Dec 2016	28.40	22.14	17.27	14.21	23.46	22.10	16.23
II FN Dec 2016	31.26	26.92	19.00	15.29	24.67	24.00	16.98
I FN Jan 2017	34.49	28.37	21.36	16.04	28.20	26.14	18.10
II FN Jan 2017	33.16	29.41	23.00	17.00	30.16	27.68	19.42
I FN Feb 2017	35.47	31.27	23.70	17.94	31.25	28.38	21.54
II FN Feb 2017	32.10	27.18	24.18	18.16	29.21	29.00	22.62
I FN March 2017	30.14	26.00	18.41	15.10	25.14	31.08	22.00
II FN March 2017	25.72	19.70	15.48	12.13	19.00	18.72	12.30
I FN Apr 2017	21.43	14.56	12.80	9.84	13.97	15.13	12.00
II FN Apr 2017	16.38	10.82	10.04	6.54	8.52	9.20	8.29
Grand mean ± SD	17.99 ± 11.31	14.14 ± 9.80	10.69 ± 7.90	8.00 ± 6.25	13.90 ± 10.04	13.57 ± 9.96	9.53 ± 7.53

FN- Fortnight, * Mean leafhoppers (*Idioscopus nitidulus* + *I. nagpurensis* + *Amritodus atkinsoni*), During off season- Mean no. of leafhoppers / five sweeps in each direction, During flowering season- Mean no. of leafhoppers / inflorescence.

Whereas, highest number of leafhoppers was documented in Alphonso (25.86 leafhopper / inflorescence) followed by Sindhura (20.99 leafhopper / inflorescence) which was on par with Mulgoa (20.67 leafhopper / inflorescence) and Neelum (20.38 leafhopper / inflorescence). Irrespective of seasons, Totapuri documented lowest leafhoppers (8.00 leafhoppers) followed by Mallika (9.53 leafhoppers) and Baneshan (10.69 leafhoppers). Whereas, highest number of leafhoppers was documented in Alphonso (17.99 leafhoppers) followed by Sindhura (14.14 leafhoppers) which was on par with Mulgoa (13.90 leafhoppers) and Neelum (13.56 leafhoppers). Regardless of genotypes, flowering season (6.29 leafhoppers) and off season (18.79 leafhoppers) reported highest and lowest leafhopper populations respectively. These results are in line with [2] who rated mallika as a tolerant genotype.

Table 2: Varietal influence on the seasonal incidence of mango leafhoppers* at Doddabbibere, Channagiri

Treatments/genotypes	Mean leafhoppers** 2016-17		
	S1#	S2#	Mean
Alphonso	10.13 (3.06)[a]	25.86 (5.05)[a]	17.99 (4.2)[a]
Sindhura	7.29 (2.65)[b]	20.99 (4.53)[b]	14.14 (3.71)[b]
Baneshan	5.10 (2.21)[c]	16.28 (4.00)[c]	10.69 (3.23)[c]
Totapuri	3.47 (1.84)[d]	12.53 (3.52)[e]	8.00 (2.80)[e]
Mulgoa	7.13 (2.60)[b]	20.67 (4.48)[b]	13.90 (3.68)[b]
Neelum	6.75 (2.52)[b]	20.38 (4.45)[b]	13.56 (3.63)[b]
Mallika	4.18 (1.98)[d]	14.88 (3.82)[d]	9.53 (3.04)[d]
Mean	6.29 (2.58)[b]	18.79 (4.37)[b]	-
S.E.M. ±	0.05	0.04	0.048
CD (P=0.05)	0.14	0.12	0.17

* Mango leafhoppers (*Idioscopus nitidulus + I. nagpurensis + Amritodus atkinsoni*)
** Mean leafhoppers- mean no.of leafhoppers/5 sweeps/inflorescence
# S1- Offseason (June-November)S2- On season (December-May)
Note: Means followed bythe same letter (s) in the column are not differed significantly at 5 per cent probability level
Figures in parentheses are √x + 0.5 transformation values

According to [3], Alphonso was highly susceptible to this pest. Similarly [4] recorded incidence of leafhoppers on different hybrids and genotypes and found baneshan, khadar, neelgoa, rumani as tolerant and neelum and neeleshan as susceptible. Thus, the present findings are in accordance with the earlier reports.

3.2 Estimation of biochemical components of different mango genotypes

The estimated mean values of various biochemical contents such as total reducing sugars (mg/g) and total phenols (mg/g) in the leaf as well as inflorescence of different mango genotypes are presented in Table 3.

Total reducing sugars

Significantly higher total reducing sugars content was noticed in Sindhura (36.83 mg/g) in new flush which is on par with Alphonso (35.91 mg/g), Mulgoa (35.83 mg/g) and Neelum (33.17 mg/g). Total reducing sugar content in Totapuri was 21.05 mg/g which was on par with Baneshan (20.29 mg/g). Significantly lower total reducing sugar content was noticed in Mallika (16.51 mg/g).

At full bloom stage, significantly higher total reducing sugar content was noticed in Alphonso (30.33 mg/g) which was on par with Neelum (29.77 mg/g). The total reducing sugar content among Mulgoa, Sindhura and Baneshan varies significantly and least total reducing sugar content was noticed in Mallika (13.55 mg/g) followed by Totapuri (16.70 mg/g).

At tender leaf stage, significantly higher total reducing sugar content was noticed in Mulgoa (12.41 mg/g) followed by Alphonso (10.50 mg/g) which was on par with Neelum (10.09 mg/g) and Baneshan (9.68 mg/g). Significantly lower total reducing sugar content was noticed in Totapuri (2.80 mg/g) which was closely followed by Mallika (5.12 mg/g) and Sindhura (8.19 mg/g).

Total phenols

Significantly higher total phenols were registered in Mallika (81.32 mg/g) in new flush followed by Totapuri (73.04 mg/g), Baneshan (65.37 mg/g), Mulgoa (41.88 mg/g), and Alphonso (34.48 mg/g). However, lowest phenols were noticed in Neelum (30.80 mg/g) and were statistically on par with Sindhura (31.81 mg/g).

At full bloom stage, significantly higher total phenols were registered in Mallika (76.41 mg/g) followed by Totapuri (68.45 mg/g), Baneshan (54.61 mg/g) and Mulgoa (32.27 mg/g) which was on par with Alphonso (30.41 mg/g). However, lowest phenols were noticed in Neelum (27.95 mg/g) and were statistically on par with Sindhura (28.83 mg/g).

At tender leaf stage, significantly higher total phenols were registered in Mallika (61.58 mg/g) followed by Totapuri (54.96 mg/g), Baneshan (49.43 mg/g) and Mulgoa (27.74 mg/g) which was on par with Sindhura (25.82 mg/g). However, lowest phenols were noticed in Neelum (23.35 mg/g) and were statistically on par with Alphonso (23.90 mg/g).

Table 3: Biochemical constituents of mango genotypes

Varieties	Total reducing sugars (mg/g)			Total phenols (mg/g)		
	On season		Off Season	On Season		Off season
	NF	FB	TL	NF	FB	TL
Alphonso	35.91 (6.03)[a]	30.33 (5.55)[a]	10.50 (3.31)[b]	34.48 (5.91)[e]	29.41 (5.46)[e]	23.90 (4.94)[ef]
Sindhura	36.83 (6.11)[a]	25.47 (5.09)[c]	8.19 (2.95)[c]	31.81 (5.68)[f]	28.83 (5.41)[e]	25.82 (5.13)[de]
Baneshan	20.29 (4.56)[c]	19.20 (4.44)[d]	9.68 (3.19)[b]	65.37 (8.12)[c]	54.61 (7.42)[c]	49.43 (7.06)[c]
Totapuri	21.05 (4.64)[c]	16.70 (4.15)[e]	2.80 (1.81)[e]	73.04 (8.58)[b]	68.45 (8.30)[b]	54.96 (7.45)[b]
Mulgoa	35.83 (6.02)[a]	27.45 (5.29)[b]	12.41 (3.59)[a]	41.88 (6.51)[d]	32.27 (5.72)[d]	27.74 (5.31)[d]
Neelum	33.17 (5.80)[b]	29.77 (5.50)[a]	10.09 (3.25)[b]	30.80 (5.59)[f]	27.95 (5.33)[e]	23.35 (4.88)[f]
Mallika	16.51 (4.12)[d]	13.55 (3.75)[f]	5.12 (2.37)[d]	81.32 (9.04)[a]	76.41 (8.77)[a]	61.58 (7.88)[a]
S. E. m ±	0.062	0.058	0.059	0.048	0.051	0.071
CD (P=0.01)	0.248	0.231	0.235	0.191	0.204	0.284
CV (%)	2.636	2.708	4.588	1.531	1.735	2.634

N= 5, NF – New flush, FB – Full bloom, TL – Tender leaves *****Values in the parentheses are $\sqrt{x+1}$ transformed value; Means followed by same letters do not differ significantly by DMRT (P=0.05)

3.3 Correlation and regression studies between biochemical constituents and mango leafhoppers population at Doddabbibere during 2016-17

Correlation and regression between incidence of mango leafhoppers and biochemical constituents are presented in the Table 4a and 4b.

A correlation coefficient of biochemical constituents of new flush, full bloomed inflorescence and tender leaves revealed that total reducing sugars (r = 0.865*, 0.898* and 0.734*) showed positive, whereas total phenols (r = -0.867*, -0.875* and -0.862*) had negative correlation with the incidence of hoppers.

The multiple linear regression equation between incidence of leafhoppers during flowering season and total reducing sugars in new flush and full bloomed inflorescence showed R^2 value of 0.812 indicating 81.20 per cent influence of total reducing sugars on leafhopper incidence. The regression equation was Y= 4.779 + (0.106) **x** NF + (0.474) **x** FB

Similarly multiple linear regression equation between incidence of leafhoppers during off season and total reducing sugars in tender leaves showed R^2 value of 0.538 indicating 53.80 per cent influence of crude proteins on leafhopper incidence. The regression equation was Y= 2.142 + (0.494) **x** TL

The multiple linear regression equation between incidence of leafhoppers during on season and total phenols in new flush and full bloomed inflorescence showed R^2 value of 0.765 indicating 76.50 per cent influence of total phenols on leafhopper incidence. The regression equation was Y= -37.830 + (-0.159) **x** NF + (2.778) **x** FB

Similarly multiple linear regression equation between incidence of leafhoppers during off season and total phenols in tender leaves showed R^2 value of 0.743 indicating 74.30 per cent influence of crude proteins on leafhopper incidence. The regression equation was Y= 10.771 + (-0.118) **x** TL

Significantly higher contents of total reducing sugars (35.91 mg/g) with lower content of total phenols (34.48 mg/g) in new flush as well as higher contents of total reducing sugars (30.33 mg/g) total phenols (30.41 mg/g) in full bloomed inflorescence and also with higher contents of total reducing sugars (10.50 mg/g) and lower content of total phenols (23.90 mg/g) in tender leaves recorded in highly susceptible cultivar Alphonso, followed by Sindhura, Mulgoa and Neelum.

Significantly lower content of total reducing sugars (16.51 mg/g) with higher content of total phenols (81.32 mg/g) in new flush as well as lower contents of total reducing sugars (13.55 mg/g) with higher content of total phenols (76.41 mg/g) in full bloomed inflorescence and also with lower contents of total reducing sugars (5.12 mg/g) and higher content of total phenols (61.58 mg/g) in tender leaves were recorded in highly tolerent variety Totapuri where lowest incidence of leafhoppers was registered and was closely followed by Mallika. However moderate tolerance to incidence of leafhoppers was seen in Baneshan.

Table 4a: Correlation and regression studies between biochemical constituents and mango leafhopper population during flowering season

Biochemical parameters	Stages		Regression equation	R^2
	New flush (X_2)	Full bloom (X_3)		
Total reducing sugars (mg/g)	0.865*	0.898*	Y= 4.779 + (0.106) **x** X_2 + (0.474) **x** X_3	0.812
Total phenols (mg/g)	- 0.867*	- 0.875*	Y= 27.487 + (-0.014) **x** X_2 + (-0.176) **x** X_3	0.765

Note: # Mango leafhoppers (*Idioscopus nitidulus + I. nagpurensis + Amritodus atkinsoni*)
*Significant at 5% level

Table 4b: Correlation and regression studies between biochemical constituents and mango leafhopper population during off season

Biochemical parameters	Stage	Regression equation	R^2
	Tender leaves (X_4)		
Total reducing sugars (mg/g)	0.734*	Y= 2.142 + (0.494) **x** X_4	0.538
Total phenols (mg/g)	- 0.862*	Y= 10.771 + (-0.118) **x** X_4	0.743

Note: # Mango leafhoppers (*Idioscopus nitidulus + I. nagpurensis + Amritodus atkinsoni*)
*Significant at 5% level

These results are in line with [5] whose results revealed that, higher content of reducing sugars and lower phenols were observed in susceptible genotypes like padiri, neelum, sindura, peter and mulgoa. Lower content of sugars was witnessed in resistant khader, baneshan, bangalora and chinnarasam genotypes. Therefore all the 7 genotypes were

ranked based on the Relationship of biochemical contents on incidence of leafhoppers (table 5). Totapuri, Mallika were grouped under I rank and were considered as tolerant genotypes. Baneshan was ranked as II (moderately tolerant) whereas; Neelum, Mulgoa, Sindhura and Alphonso were ranked as III (susceptible genotypes).

Table 5: Relationship of biochemical contents on incidence of leafhoppers

Varieties	Rank*	Mean no. of leafhoppers /inflorescence or five sweeps	Total phenols (mg/g)	Total reducing sugars (mg/g)
Totapuri	I- Tolerant	8.00	65.48	13.52
Mallika		9.53	73.10	11.73
Beneshan	II- Moderately tolerant	10.69	56.47	16.39
Neelum	III- Susceptible	13.57	27.37	24.34
Mulgoa		13.90	33.96	25.33
Sindhura		14.14	28.82	23.50
Alphonso		17.99	29.6	25.58

* Ranking based on mean incidence of leafhoppers

4. Conclusion

Studies on screening of different genotypes of mango against leafhoppers reveals that Totapuri and Mallika harboured lowest leafhoppers (8.00 and 9.53 leafhoppers) followed by Baneshan (10.69 leafhoppers). Whereas, highest number of leafhoppers was documented in Alphonso (17.99 leafhoppers) followed by Sindhura (14.14 leafhoppers), Mulgoa (13.90 leafhoppers) and Neelum (13.56 leafhoppers). Results of biochemicals estimation revealed that significantly lower total reducing sugars, and higher phenols content were noticed in Mallika and Totapuri followed by Baneshan but this is opposite in genotypes like Alphonso, Saindura, Mulgoa and Neelum. Correlation studies shows that total reducing sugars has significantly positive correlation whereas, total phenol content was inversely related to the incidence of leafhoppers as evidenced by the presence of negative correlation between phenol content and incidence of leafhoppers.

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