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Screening of advanced sugarcane genotypes against rust mite

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ABSTRACT

In the screening trial, among the nineteen sugarcane genotypes screened for the reaction to sugarcane rust mite, *Abacarus sacchari*, only 2 genotypes (009-64 and 0961-07) harboured >1 mites /2 cm^2 leaf area while remaining all the genotypes harboured <2 mites/2 cm^2 leaf area for the entire crop duration. Morphological characters of genotypes revealed that interveinal distance, leaf area and trichome density were found to influence the *A. sacchari* negatively. The genotype with high phenol and lower amount of total sugar, reducing sugar, crude protein was found with the lower level of incidence of mites. The study on the role of leaf nutrient on the mite population revealed that genotype with higher potassium content and lower nitrogen levels were found with the minimum incidence of *A. sacchari.*

Keywords: Antixenosis, Antibiosis, Nutrients, Resistance, Sugarcane

Sugarcane is an important industrial crop which is cultivated in more than 10 countries. It is an important cash crop in India and processed for sugar, jaggery and Khandsari. Sugarcane is grown under diverse agro-climatic conditions both in tropical and subtropical regions. Pests are known to inflict considerable losses on cane yield as well as sugar output. The sugarcane rust mite, *Abacarus sacchari* Channabasavanna (Acari: Eriophyidae) was first identified by Channabasavanna from India (Channabasavanna 1996). *A. sacchari* has been known for more than five decades, but the impact on sugarcane has not been well understood. The microscopic size and symptom similarity are often mistaken and misidentified as a rust disease caused by *Puccinia* spp. of rust pathogen on sugarcane. This mite feeds on sugarcane leaves which potentially affects plant photosynthesis and reduce crop yield. The damage symptoms can be recognized as orange, brown, to reddish colored flecking on abaxial and adaxial leaf surfaces. The colored flecking may be caused by cell damage and oxidative processes (Duso *et al.* 2010). As a consequence, the mite infestation and its influence on growth and development of sugarcane has increased in Cauvery command area of Mandya district in Karnataka. Hence, the present study was planned to screen the advanced sugarcane genotypes for their reaction to sugarcane rust mite.

MATERIALS AND METHODS

The present experiment was conducted at the Zonal Agricultural Research Station, V. C. farm, Mandya, Karnataka, India during 2016–17. The experiment was laid out in a randomised block design with nineteen genotypes (six rows of six-meter length of each genotype) and replicated twice along with two popular varieties to identify morphological, biochemical and nutrient parameters for resistance to *A. sacchari* (Table 1,2). The mite population was expressed as the mean number of mites per 2 cm^2 of leaf area (Mohan 2017). From each genotype five randomly selected plants were observed for different morphological parameters. The number of fully opened green leaves on a plant was recorded from each of the five plants. For measuring the length of leaves, three green leaves were taken from five randomly selected plants and length was measured from the place of joint of leaf sheath with leaf (ligule) to the tip of the leaf. Breadth was measured at the three places of leaf, i.e. at tip, from the middle and at the base of leaf. Leaf angle was taken from five plants in each plot with help of protractor. Thickness of leaf was measured by disc method. The height of the plant was recorded by measuring with scale from the ground level to tip of the leaf. Trichome density was estimated by following the method suggested by Maite *et al*. (1980). Leaf area was measured by disc method and was expressed in cm^2. Fifty discs of known size were taken through a cork borer from randomly selected leaves. Leaf area was calculated by using the formula suggested by Vivekanandan *et al*. (1972). Interveinal distance was measured from top, middle and bottom portion of the leaf with the help of micrometre. Two types of distances were measured first one was distance at the base of the veins, *i.e.* from the base of one vein to base adjacent vein, second one was distance from the top of one vein to top on adjacent vein. Leaf moisture was calculated

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Table 1 Influence of morphological parameters of different sugarcane genotypes on the incidence of *A. sacchari*

Genotype	Mites/ 2 cm^2	Distance at the base of the vein (µm)	Distance from one vein to another vein (µm)	Leaf moisture (%)	Length of the leaf (cm)	Width of the leaf (cm)	No. of leaf/ plant	Height of the plant (cm)	Leaf area (cm^2)	Thickness of the leaf (g/cm^2)	Leaf inclination (°)	Trichome density/ mm^2
10-43-06	0.17	70.3	224.0	52.80	98.33	2.60	6.70	124.10	205.7	0.0024	25.50	95.00
1035-04	0.19	58.0	196.0	48.20	98.52	3.50	7.00	128.60	294.8	0.0029	26.20	90.00
0965-04	0.19	79.3	186.0	59.33	91.80	3.00	6.80	131.50	225.4	0.0028	28.60	115.00
12-44-01	0.19	74.8	242.7	56.20	92.86	3.80	8.10	133.10	302.9	0.0021	24.40	126.00
10-65-01	0.10	82.0	256.7	51.25	96.86	2.50	7.40	127.30	192.2	0.0022	20.00	110.00
0960-04	0.11	60.7	189.7	50.20	92.60	3.10	7.10	124.20	237.1	0.0022	25.50	102.00
10-38-07	0.33	60.7	222.3	54.21	94.20	2.80	7.30	122.10	213.8	0.0024	34.50	120.80
0961-05	0.27	72.0	186.7	50.14	95.88	2.20	7.60	120.30	160.9	0.0026	35.30	85.00
0706-05	0.14	80.7	238.0	56.15	96.00	2.80	8.50	125.20	218.8	0.0030	29.50	98.00
10-17-05	0.37	65.0	200.7	53.13	93.10	2.50	6.00	130.10	182.8	0.0027	18.30	91.00
0815-06	0.11	48.3	135.3	50.18	93.82	3.10	8.20	128.60	240.8	0.0031	25.50	91.00
0961-07	0.92	50.6	201.3	48.34	98.12	2.90	6.50	132.50	234.5	0.0026	24.50	89.30
0930-01	0.17	60.7	186.7	40.26	96.10	4.30	7.80	128.60	363.2	0.0024	25.30	91.00
0960-06	0.20	79.3	312.7	47.26	91.90	4.20	7.10	130.50	336.0	0.0024	29.50	112.50
1014-16	0.12	74.7	200.1	48.24	92.00	2.60	6.90	130.10	189.2	0.0031	26.20	98.00
1057-07	0.02	88.7	211.1	56.30	95.92	3.90	6.60	128.60	324.1	0.0026	28.60	90.50
0961-02	0.21	58.0	214.7	48.20	93.64	2.50	6.80	131.50	184.1	0.0028	24.40	111.00
0929-04	0.24	74.7	144.7	51.22	97.66	2.70	7.60	129.10	213.7	0.0022	28.00	83.00
009-64	0.58	70.5	181.7	55.44	94.20	2.80	6.00	120.30	213.8	0.0021	18.00	96.00
Co 62175	0.42	51.0	139.5	56.30	98.50	2.00	7.00	130.10	195.3	0.0022	29.50	97.70
Co 86032	0.56	63.0	139.2	54.40	97.80	2.00	6.50	130.20	153.0	0.0022	28.00	95.80
SEm±	-	1.4	1.3	NS	NS	NS	NS	NS	6.3	NS	NS	0.80
CD @ P=0.05		4.3	3.8						18.7			2.20

NS: Non-significant

Table 2 Influence of biochemical constituents of different sugarcane genotypes and nutrients on the incidence of *A. sacchari*

Genotype	Mites/ 2 cm^2	Phenol (µg/g)	Total sugar (%)	Reducing sugar (%)	Crude protein (%)	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	S (%)	Na (%)
10-43-06	0.17	85.41	9.80	0.049	12.06	1.93	0.130	3.01	2.20	0.10	0.220	0.046
1035-04	0.19	97.05	8.00	0.050	11.87	1.90	0.154	3.28	1.80	0.20	0.180	0.013
0965-04	0.19	153.62	7.40	0.048	10.81	1.73	0.165	3.85	2.40	2.10	0.330	0.032
12-44-01	0.19	178.55	8.00	0.035	12.25	1.96	0.153	3.51	2.60	1.30	0.201	0.008
10-65-01	0.10	152.43	8.60	0.033	10.81	1.73	0.167	4.28	2.50	0.40	0.300	0.014
0960-04	0.11	105.11	11.40	0.061	9.93	1.59	0.152	3.42	2.10	1.20	0.260	0.016
10-38-07	0.33	154.52	7.40	0.018	10.81	1.73	0.167	4.14	2.40	1.70	0.173	0.015
0961-05	0.27	105.86	25.46	0.032	10.62	1.70	0.169	3.30	1.80	1.20	0.190	0.013
0706-05	0.14	68.10	11.20	0.025	11.87	1.90	0.162	4.06	2.00	1.00	0.182	0.015
10-17-05	0.37	75.11	25.40	0.028	12.56	2.01	0.198	2.83	1.50	2.00	0.177	0.030
0815-06	0.11	79.14	10.00	0.025	12.06	1.93	0.162	2.12	2.20	4.20	0.205	0.040
0961-07	0.92	102.13	13.40	0.025	11.87	1.90	0.166	3.59	2.00	0.90	0.217	0.013
0930-01	0.17	83.92	8.40	0.039	11.18	1.79	0.159	3.55	1.70	1.70	0.180	0.045
0960-06	0.20	83.32	9.80	0.023	12.06	1.93	0.174	3.69	2.00	0.60	0.206	0.037
1014-16	0.12	85.26	9.60	0.028	10.81	1.73	0.196	3.85	2.30	1.40	0.206	0.012
1057-07	0.02	110.79	8.60	0.030	12.37	1.98	0.169	3.59	2.20	0.60	0.209	0.015
0961-02	0.21	84.52	8.40	0.035	11.18	1.79	0.192	3.69	2.40	1.10	0.210	0.035
0929-04	0.24	71.38	10.00	0.021	12.06	1.93	0.187	3.07	1.80	0.40	0.235	0.050
009-64	0.58	89.29	9.60	0.034	12.56	2.01	0.442	3.51	1.90	1.10	0.226	0.011
Co 62175	0.42	144.22	25.40	0.079	11.18	1.79	0.159	3.50	2.30	1.20	0.230	0.008
Co 86032	0.56	180.04	11.00	0.050	10.31	1.65	0.164	3.45	1.60	0.90	0.320	0.050
SEm±	-	3.28	1.02	0.004	1.86	0.10	NS	0.30	0.10	0.10	0.010	0.001
CD @ P=0.05		10.42	3.60	0.012	6.10	0.30		0.80	0.40	0.30	0.030	0.004

based of fresh weight and dry weight of sheath.

$$\text{Per cent moisture} = \frac{\text{Fresh weight} - \text{dry weight}}{\text{Fresh weight}} \times 100$$

For biochemical parameters, the plant samples were collected from the field at 60 days after planting (DAP). Uninfested leaf samples from 60 days old plants of test entries were collected and analyzed. To estimate total and reducing sugars in the extracts, the method suggested by Somogyi (1952) was followed. Estimation of total phenols in leaves of the plant tissue were done by following Folin-Ciocalteau method suggested by Bray and Thorpe (1954). For plant nutrient analysis, the leaf samples were collected 120 days after planting (DAP) from each genotype. The method adopted for nutrient analysis was followed as suggested by Piper (1966). Sulphur present in di-acid digested mixture of the plant materials was determined by precipitating the sulphate with barium chloride and turbidity was measured at 420 nm using spectrophotometer as described by Page *et al.* (1982). The diluted di-acid digested mixture was fed to a calibrated flame photometer. By comparing the flame photometer reading of the sample with the standard calibration curve of sodium, the per cent sodium in the leaf sample was calculated (Piper 1966). The data on morphological parameters, biochemical parameters and plant nutrients were subjected to ANOVA and correlated with the incidence of mite.

RESULTS AND DISCUSSION

Influence of morphological characters on population of A. sacchari: The mite population of *A. sacchaari* on different sugarcane genotypes was found in moderate level. The result revealed that the maximum number of mites (0.92 mites/2 cm^2 leaf area) was found on the genotype 0961-07 and minimum on the genotype 1057-07 (0.02 mites/2 cm^2 leaf). The effect of different morphological parameters and their correlation on the incidence of *A. sacchari* population presented in Table 1 and 3. The distance at the base of the veins was maximum (88.7 µm) in the genotype, 1057-07 and significant negative correlation (r= -0.45) was found between distance at the base of the veins and *A. sacchari* population. The distance from one vein to another vein was maximum (256.7 µm) in the genotype, 10-65-01 and non-significant negative correlation (r= -0.25) was found. The high amount of leaf moisture (56.30%) was found in the genotype, 1057-07 and showed non-significant difference among the genotypes. The length of the leaf was maximum (98.52 cm) in the genotype, 1035-04 and

Table 3 Correlation between morphological characters, biochemical constituents and nutrient composition of different sugarcane genotypes and incidence of *A. sacchari*

Morphological parameter	Correlation with average mite per 2 cm^2 leaf area	Biochemical constituents	Correlation with incidence of *A. sacchari*	Nutrient composition	Correlation with incidence of *A. sacchari*
Distance at the base of the vein (µm)	-0.45*	Phenol (µg/g)	-0.08	N (%)	0.13
Distance from one vein to another vein(µm)	-0.25	Total sugar (%)	0.29	K (%)	0.004
Trichome density/mm^2	-0.18	Reducing sugar (%)	0.01	Ca (%)	-0.33
Leaf area (cm^2)	-0.30	Crude protein (%)	0.08	Mg (%)	-0.07
				S (%)	-0.08
				Na (%)	-0.08

*Correlation is significant at 0.05 level

non-significant difference was found. The maximum width of leaf was recorded in genotypes, 0930-01 (4.30 cm) and non-significant difference was found. The maximum numbers of leaves were recorded in genotype, 07-06-05 (8.50 leaves/plant) and showed non-significant difference. The plant height was maximum (133.10 cm) in the genotype 12-44-01. In the genotype 0961-05, 0.27 mites/2 cm^2 leaf area was recorded while on the genotype 009-64, 0.58 mites/2 cm^2 leaf area was recorded. The plant height was found to have non-significant difference among the genotypes. The higher leaf area (363.2 cm^2) was recorded in the genotype 0930-01. Leaf area was found to have non-significant negative correlation (r=0.30) with the mite population. The genotype, 1014-16 had thick leaf (0.0031 g/ cm^2) was found to harbour 0.12 mites/2 cm^2 leaf area. The leaf thickness was found to have non-significant difference among the genotypes. Leaf angle was found high (35.30º) in the genotype 0961-05 with the population of 0.27 mites/2 cm^2 leaf area and found to have non-significant difference among the genotypes. The leaf trichome density showed significant difference among the genotypes. The high trichome density (126.00 trichomes/mm^2) was found in the genotype 12-44-01 with the population of 0.19 mites/2 cm^2 leaf area. A significant negative correlation (r=-0.18) was observed between trichome density and *A. sacchari* incidence on different genotypes.

Among the morphological characters, leaf morphology plays an important role in the preference and feeding by mites. Similarly, the present investigation, Mukherjee *et al.* (1989) found that interveinal distance does not play any role on the *Oligonychus oryzae* infesting paddy. Khanna and Ramanathan (1947) studied the morphology of sugarcane leaves and concluded that grooves between the veins provides shelter for the mites, this might be the possible factor for the higher incidence of this mite in some of the genotypes and varieties where interveinal distance is more comfortable harbour sugarcane rust mite, *A. sacchari*. Leaf area and trichome density were found to be negatively correlated with the population of rust mite, *A. sacchari.* The trichome density plays a prominent role in the buildup of mite population because leaf with high trichomes creates hindrance in the movement (Shakoor *et al.* 2010). From the present investigation, it can be concluded that no single morphological factor is responsible in mite population fluctuation but all the factors work in compliment with each other.

Influence of biochemical constituents on population of A. sacchari: The influence of different biochemical constituents and their correlation on the incidence of *A. sacchari* population presented in Table 2 and 3. Total sugar was highest (25.46%) in the genotype, 0961-05 with 0.27 mites/2 cm^2 leaf area and lowest (7.40%) in the genotype, 0965-04 with 0.19 0.33 mites/2 cm^2 leaf area. The correlation study between total sugars and mite population revealed non-significant positive relationship (r= 0.29). Reducing sugar was highest (0.050%) in the genotype, 1035-04 with 0.19 mites/2 cm^2 leaf area and was lowest (0.021%) in the genotype, 0929-04 with 0.24 mites/2 cm^2 leaf area. The correlation study between reducing sugar and mite revealed non-significant positive relationship (r= 0.01) with the abundance of mite population. The genotype, 10-38-07 contained significantly high amount of phenol (154.52 µg/g) with 0.33 mites/2 cm^2 leaf area. Low amount of phenol was found in the genotype, 0706-05 (68.10 µg/g) with 0.14 mites/2 cm^2 leaf area. Phenol content of leaf showed non-significant inverse relation (r= -0.08) with the mite population. High crude protein (12.56%) was found in the genotype, 009-64 with 0.58 mites/2 cm^2 leaf area and lower crude protein (9.93%) content was found in 0960-04 with 0.11 mites/2 cm^2 leaf area. The crude protein content showed significant difference among the genotypes. Results of correlation study revealed that crude protein showed non-significant positive correlation (r= 0.08) with the population of mite.

Biochemical components play an important role in regulating the biotic factors on the plants. The present finding is in agreement with Ahmed *et al*. (2000) who reported tannins, phenols and chlorophyll were found to have negative correlation with mite (*Polyphagotarsonemus latus*) incidence. Total sugars and protein content had positive association with mite incidence. In the present study, the results showed phenolic compounds constitute one of the major defensive mechanisms in host plants against mite attack which were on par with the results noticed by Mitra *et al.* (2015). The present findings were in close agreement with the earlier observations made by Vishnupriya *et al.* (2016) who reported total sugar and reducing sugar had positive influence and phenol content had negative influence on the eriophyid mite. Allah *et al.* (2010) also noticed that an increase in total phenol content likely suppressed mite infestation, whereas increase of total sugar may have a phagostimulatory effect on spider mite, *Tetranychus urticae* on strawberry plants.

Influence of nutrients on population of A. sacchari: The influence of nutrients and their correlation on the incidence of *A. sacchari* population are presented in Table 2 and 3. Significantly high nitrogen (2.01%) content was found in the genotype, 10-17-05 with 0.37 mites/2 cm^2 leaf area. The results of simple correlation between the mite and nitrogen content revealed a non-significant positive correlation (r= 0.13). High phosphorous content (0.198%) was noticed in the genotype, 10-17-05 with 0.37 mites/2 cm^2 leaf area. The leaf phosphorous content showed non-significant difference among the genotypes. Higher potassium content (4.28%) was found in the genotype, 10-65-01 with 0.10 mites/2 cm^2 leaf area. Result of correlation between potassium content and mite population revealed a non-significant positive relationship (r= -0.004). The results of calcium content in the leaf revealed that high calcium (2.60%) was found in the genotype, 12-44-01 with 0.19 mites/2 cm^2 leaf area and low calcium (1.50%) in the genotype, 10-17-05 with 0.37 mites/2 cm^2 leaf area. Calcium content in the leaf showed significant difference among the genotypes. The correlation studies revealed a non-significant negative correlation (r= -0.33) between mite and calcium content of the leaf. High magnesium content (2.10%) was found in the genotype, 0965-04 with 0.19 mites/2 cm^2 leaf area and magnesium content showed non-significant negative relationship (r= 0.07). Sulphur content in the leaf tissue showed significant difference among the genotypes. High sulphur content (0.330%) was found in 0965-04 with 0.19 mites/2 cm^2 leaf area and revealed a non-significant negative relationship (r= -0.08). High sodium content (0.050%) was found in the genotype, 0929-04 having 0.24 mites/2 cm^2 leaf area and showed non-significant negative correlation (r=0.08). The nutritional quality of the plants is one of the factors which determine the insects to select the host as food source. These findings are in agreement with the findings of Ahmed *et al.* (2000) who observed that potassium, calcium and magnesium were having negative correlation with mite incidence. Nitrogen content exhibited positive correlation with mite incidence. In the present investigation, potassium content in the leaf showed significant negative relation with the mite incidence and similar results were noticed by Allah *et al.* (2010).

From the present study, it was found that low trichome density, high nitrogen content, low level of potassium, high amount of total sugar, reducing sugar, crude protein and low amount of phenol in the sugarcane leaf makes it suitable as a host for the sugarcane rust mite infesting sugarcane leaf. Genotypes found with low incidence of mites and could be selected for the development of mites' resistance sugarcane varieties.

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