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Biochemical constituents of different okra (*Abelmoschus esculentus* L.) varieties in relation to infestation of okra mite (*Tetranychus cinnabarinus*, Boisduval)

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Abstract
The present investigation was carried out to find biochemical factors in Okra, (*Abelmoschus esculentus* L.) Moench infesting Mite (*Tetranychus cinnabarinus*, Boisduval) during 2004-2005. The infested and healthy leaves of different okra varieties were examined for different biochemical parameters using standard techniques. Total soluble sugars and silica contents were higher in healthy leaves in comparison to damaged leaves, while protein and phenols were low as compared to infested leaves in all the varieties. The reduction in total soluble sugars in mite infested leaves might be due to impaired photosynthesis and subsequent utilization by *T. cinnabarinus*. observations recorded on different biochemical attributes for both the years also indicated that total soluble sugars and silica contents were higher in healthy leaves in comparison to damaged leaves while, protein and phenols were low in healthy leaves as compared to infested leaves. The biochemical analysis of leaves of different varieties showed highly positive correlation between total soluble sugars and total soluble protein with mite population while such correlations were negative with regards to total phenol and total silica.

Keywords: okra, varieties, sugars and biochemical

Introduction
Okra (*Abelmoschus esculentus* L.) Moench also known as Bhindi or lady‟s finger, is grown throughout India for its immature fruits and occupies an important position among vegetables. Its plants are also used for treating diseases like stones in kidney, leucorrhoea, backache and goiter in human beings. Mucilage extract of stem and root are used for clarifying sugarcane juice for making jaggery (molasses). The fully ripened fruits and stem contain carbohydrate (7.7%), protein (2.2%), fat (0.02%), fibres (1.2%), minerals (0.7%), calcium (0.9%) and are also good source of iron, iodine and vitamins (Chauhan, 1965) [5]. The okra crop is attacked by several species of insect pests, right from the germination to the harvest (Ambegaonkar and Bilapate, 1984) [1]. Among the vegetable crops, okra and brinjal are the most affected by mites causing economic loss throughout the country. The red spider mites *viz.*, *Tetranychus cinnabarinus* (Boisduval), *Tetranychus ludeni* Zacher and *Tetranychus neocaledonicus* Andre are of major significance to vegetable crops in India (Gupta, 1991 and Rai *et al.*, 1991) [7].
Among the mite pests, *T. cinnabarinus* become abundant and cause appreciable damage to okra crop particularly during dry months of the year, even under drought conditions, as high as 20 per cent loss in okra has been estimated (Shankarappa *et al*., 1981) [13]. The crop loss in Parbhani Kranti variety of okra was reported to be: Navsari (23.7%); Hisar (11-25%); Varanasi (13-13.6%) and Pusa (45-52%), (Anonymous, 2004) [2]. Expanding vegetable cultivation due to availability of high yielding hybrids, is providing sufficient food and congenial environment for the mite to multiply on regular basis. A considerable work has been done in India on the management of red spider mite *T. cinnabarinus* but no systemic work seems to be carried out on its ecology and management specially in semi-arid of Rajasthan.

Material and Methods
The experiment was conducted of horticulture farm of S.K.N. College of Agriculture, Jobner in kharif, 2004 and 2005 for screening different varieties of okra for their relative susceptibility and resistance by the determination of biochemical factors in plant leaves.

The experiment was laid in RBD with ten treatments that were replicated three times in each treatment. The samples were collected from the experimental plots and brought into the laboratory to study the plant resistance based on biochemical constituents present in, healthy as well as damaged leaves of all okra varieties at its peak infestation were analyzed in laboratory for different biochemical parameters using standard techniques *viz.,* total soluble sugar (Dubois *et al.* (1951) [6], total soluble proteins (Lowry *et al.* 1951) [10], total phenols (Bray and Thorpe 1954) [5] and total silica content (Jackson, 1962) [8].

Results & Discussion

The infested and healthy leaves of different okra varieties were examined for different biochemical parameters using standard techniques.

Table 1: Biochemical constituents of different okra varieties/cultivars leave in relation to infestation of okra mite (*Tetranychus cinnabarinus,* Boisduval) in *Kharif*, 2004.

S. No.	Variety/ cultivar	Mite# population	Total soluble sugar (mg g^{-1})		Total soluble protein (mg g^{-1})		Total phenols (q g g^{-1})		Total silica (mg g^{-1})	
			Healthy	Infested	Healthy	Infested	Healthy	Infested	Healthy	Infested
1	Arka Anamika	4.98	4.20	4.10	3.80	3.90	6950	7375	2.0	1.5
2	Parbhani Kranti	10.80	5.10	4.70	4.60	4.80	5925	6100	1.5	1.0
3	Bhanu Priya	7.38	4.80	4.40	4.30	4.50	6775	6850	2.5	2.0
4	Varsha Uphar	10.98	5.00	4.90	4.70	5.00	5950	6100	2.0	2.0
5	VRO-6	5.19	4.40	3.80	3.80	3.90	7035	7375	2.5	2.0
6	Pusa Saw ani	10.98	5.10	4.80	4.80	5.10	6015	6150	1.5	1.5
7	VRO-5	5.40	4.20	4.00	3.80	4.00	7025	7415	2.5	2.0
8	GO-2	10.59	5.20	4.80	4.90	5.00	6400	6810	1.5	1.0
9	D-108	7.20	4.80	4.20	4.30	4.40	6915	6890	2.5	2.0
10	Hybrid No.18	6.99	4.80	3.80	4.50	4.70	6935	6875	2.0	1.5
	SEm ±	0.09	0.34	0.31	0.31	0.32	427.83	461.68	0.14	0.12
	CD at 5%	0.29	1.00	0.92	0.92	0.99	1271.15	1371.74	0.43	0.35
	Correlation coefficient (r)		0.927**	0.919**	0.933**	0.944*	-0.945**	-0.927**	-0.762*	-0.499*

= Mean mite population /3 leaves Figures in parentheses are $\sqrt{X + 0.5}$

* Significant at p = 0.05, ** Significant at p = 0.01

The data pertaining to the mite population to the total soluble protein, Total soluble sugar, Total phenols and Total silica has been presented in the table 1. Among okra varieties or cultivars, Varsha Uphar being at par with Pusa Swami recorded the highest mite population and both of them was at par with Parbhani Kranti. The least mite population was recorded on Arka Anamika which was found to be at par with VRO-6. The reason owing to less infestation of mite in Arka Anamika or VRO-6 might be attributed to higher total phenol in the respective verities has phenol being secondary metabolite involves in developing resisting against pest infestation. The data pertaining to the Total soluble sugar to the total soluble protein, Total mite population, Total phenols and Total silica has been presented in the table 1. In case of healthy plants GO-2 recorded with highest significantly total soluble sugar was at par with rest of the varieties and in case of Infested plants Varsha Uphar being at par with Pusa Swami and GO-2 recorded the Total soluble sugar. Total soluble protein of healthy plants GO-2 verities being at par with Varsha Uphar and in case of infested plants Pusa Swami being at par with GO-2 varieties of Okra. Total phenols of healthy plants VRO-6 okra varieties being at par with VRO-5 and in case of infested plants VRO-5 being at par with VRO-6 and Arka Anamika varieties. Total silica of healthy plants to the D-108 being at par with more than one variety and in case of infested plants Bhanu Priya at par with more than one variety.

The data presented in Table 1 indicated a significant positive correlation among total soluble sugars (r = 0.927, 0.919) and total soluble protein (r = 0.933, 0.944) with mite population in 2004, while such correlations were significantly negative with regards to total phenols (r = -0.945, -0.927) and total silica (r = -0.762, - 0.499) in healthy and infested leaves, respectively.

Table 2: Biochemical constituents of different okra varieties/cultivars leave in relation to infestation of okra mite (*Tetranychus cinnabarinus,* Boisduval) in *Kharif*, 2005

S. No.	Variety/ cultivar	Mite population	Total soluble sugar (mg g^{-1})		Total soluble protein (mg g^{-1})		Total phenols (q g g^{-1})		Total silica (mg g^{1})	
			Healthy	Infested	Healthy	Infested	Healthy	Infested	Healthy	Infested
1	Arka Anamika	5.19	4.30	4.10	3.90	4.00	7000	7450	2.5	2.0
2	Parbhani Kranti	10.98	5.00	4.60	4.80	4.90	5950	6100	1.5	1.0
3	Bhanu Priya	7.20	4.90	4.30	4.30	4.40	6875	6900	2.0	1.5
4	Varsha Uphar	10.59	5.10	4.80	4.90	5.10	5975	6125	2.0	2.0
5	VRO-6	4.98	4.40	3.90	3.80	3.90	7045	7415	2.5	2.5
6	Pusa Saw ani	11.19	5.20	4.80	4.90	5.10	6025	6115	1.0	1.0
7	VRO-5	5.79	4.10	3.90	3.90	4.00	7025	7450	2.0	1.5
8	GO-2	10.20	5.10	4.70	5.00	5.10	6410	6835	1.5	1.0
9	D-108	7.38	4.80	4.00	4.40	4.50	6925	6875	2.0	1.5
10	Hybrid No.18	8.19	4.90	3.90	4.50	4.60	6945	6775	2.0	1.5
	SEm ±	0.10	0.34	0.30	0.32	0.33	452.29	462.04	0.12	0.10
	CD at 5%	0.30	1.00	0.90	0.94	0.97	1343.84	1372.81	0.37	0.30
	Correlation coefficient (r)	-	0.896**	0.873**	0.974**	0.977**	-0.926**	-0.942*	-0.847**	-0.680*

= Mean mite population /3 leaves Figures in parentheses are $\sqrt{X + 0.5}$

* Significant at p = 0.05, ** Significant at p = 0.01

The data pertaining to the mite population to the total soluble protein, Total soluble sugar**,** Total phenols and Total silica has been presented in the table 2. Among okra varieties or cultivars, Pusa Swami being at par with Parbhani Kranti recorded the highest mite population and both of them was at par with GO-2 and Varsha Uphar. The data pertaining to the Total soluble sugar to the total soluble protein, Total mite population, Total phenols and Total silica has been presented in the table no. 2. In case of healthy plants Pusa Swami recorded with highest significantly total soluble sugar was at par with GO-2 and Varsha Uphar varieties and in case of Infested plants Varsha Uphar and Pusa Swami being at par with Parbhani Kranti and GO-2. Total soluble protein of healthy plants GO-2 verities being at par with Varsha Uphar and Parbhani Kranti and in case of infested plants Varsha Uphar being at par with rest of the varieties of Okra. Total phenols of healthy plants VRO-6 okra varieties being at par with VRO-5 and Arka Anamika in case of infested plants VRO-5 and Arka Anamika being at par with VRO-6 and Bhanu Priya varieties. Total silica of healthy plants to the Arka Anamika Varieties was higher significantly with, the Varsha Uphar And Bhanu Priya

The observations recorded on different biochemical attributes for both the years also indicated that total soluble sugars and silica contents were higher in healthy leaves in comparison to damaged leaves while, protein and phenols were low in healthy leaves as compared to infested leaves.

The results presented in Table 2 indicated more or less similar trend with regards to biochemical parameters as observed in 2004. The corresponding figures for total soluble sugars and total soluble protein were (r = 0.876, 0.873) and (r = 0.974, 0.977) in healthy and infested leaves, respectively. However, such values were (r = -0.926, -0.942) and (r = -0.847, -0.680) for total phenols and total silica in healthy and infested leaves, respectively.

During present investigations, it was found that total soluble sugars and silica contents were higher in healthy leaves in comparison to damaged leaves, while protein and phenols were low as compared to infested leaves in all the varieties. The reduction in total soluble sugars in mite infested leaves might be due to impaired photosynthesis and subsequent utilization by *T. cinnabarinus* Nangia *et al.*, 1999) [11]. Likewise, Bhagel *et al.* (1994) [3] reported significantly high total soluble sugar contents in healthy mango panicles as compared to malformed panicles infested by *Aceria mangiferae* and these observations support the present findings.

During the present investigations, protein and phenols were higher in infested leaves get support from the work of Kielkiewicz (1991) [9] who reported increased phenolic content in infested leaves of tomato infested by *T. cinnabarinus* and further reported that this could be considered as a part of defense system which developed in plant shortly after mite feeding.

Conclusion

Total soluble sugars and silica contents were higher in healthy leaves in comparison to damaged leaves, while protein and phenols were low as compared to infested leaves in all the varieties. observations recorded on different biochemical attributes for both the years also indicated that total soluble sugars and silica contents were higher in healthy leaves in comparison to damaged leaves while, protein and phenols were low in healthy leaves as compared to infested leaves. The studies carried out in 2004 indicated a significant positive correlation among total soluble sugars (r = 0.927, 0.919) and total soluble protein (r = 0933, 0.944) with mite population, while such correlations were negative with regards to total phenols (r =-0.945, -0.927) and total silica (r = 0.762, -0.499) in healthy and infested leaves respectively. Similar trend was also evident in 2005.

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