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Physiological response of yellow vein mosaic virus-infected okra [*Abelmoschus esculentus*]

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Abstract
The effect of okra yellow vein mosaic virus infection on relative water content, mucilage content and chlorophyll content changes in field-grown okra (*Abelmoschus esculentus*) leaves was studied. Changes in relative water content, mucilage content and chlorophyll content in yellow vein mosaic virus- infected okra leaves were investigated. It was observed that highly resistant varieties to YVMV had recorded high chlorophyll content, lowest relative water content and crude fibre content whereas highly susceptible varieties to YVMV had recorded high relative water content, less chlorophyll content, mucilage content and minimum crude fibre content. Virus infection caused marked inhibition of chlorophyll. Studies on 19 varieties of okra was conducted to record the Physiological response of yellow vein mosaic virus-infected okra.

Keywords: *Abelmoschus esculentus*, chlorophyll, relative water content, yellow vein mosaic virus

Introduction
The main constraint on the production of bhendi or okra (*Abelmoschus esculentus*), an important Indian vegetable crop, is yellow vein mosaic disease. A combination of the monopartite begomovirus, bhendi yellow vein mosaic virus (BYVMV, family: Geminiviridae), and a tiny satellite DNA b component causes this disease [1]. The illnesses and insect pests that attack okra change from year to year. Their occurrence, frequency, and severity are determined by the host's resistance or vulnerability, as well as environmental factors. YVMV is spread by white flies (Bemisia tabaci Gen.). 90 percent of white fly-transmitted virus species are members of the Begomovirus genus [2]. White fly-transmitted begomoviruses are gradually growing in tropical and subtropical nations, and begomovirus-specific probes have been created [3].
Infection of 100 percent of plants in a field is common, with yield losses ranging from 50 to 94 percent depending on the stage of crop growth at the time of infection [4]. On young leaves, the first sign is a widespread, mottled appearance. Interveinal yellow patches can be found on older leaves. About 15-20 days after infection, the tiny veins begin to clear towards the leaf margins at various points. The vein clearing then progresses to vein chlorosis. The newly grown leaves have an intertwined network of yellow veins that surround the leaf's green areas. Fruits that are developing on infected plants exhibit uneven yellow spots that are aligned longitudinally. The fruits are also deformed and smaller than usual. The fruits are primarily yellow in colour, tiny, stiff, and fibrous in texture [5].
All these pathological changes are closely related to reduced rates of photosynthesis as well as high relative water content and crude fibre content. Virus infection caused marked inhibition of chlorophyll. Studies on 19 varieties of okra was conducted to record the Physiological response of yellow vein mosaic virus-infected okra. The aim of the present work was to test the hypothesis that the yellow vein mosaic virus infection induced effects on photosynthesis, relative water content and mucilage content. In this connection, it was of interest to study the physiological response of virus-infected bhendi leaves, by comparing the biochemical and physiological parameters of virus infected plants with healthy plants.

Materials and Methods
Plant materials
Bhendi (A. esculentus) leaves used in this study were collected from field-grown YVMV infected plants. The YVMV infected leaves and the healthy leaves of the same cultivar were sampled and examined at the same time.

Chlorophyll content (µmol m-2)
Chlorophyll content was measured in 3rd leaf of each tagged plant and it was estimated using OPTI- SCIENCES (CCM- 200 Plus).

Crude fibre content (Per cent)
Two gram of the plant sample was transferred to a 500 ml beaker and 200 ml of 1.25 percent sulphuric acid was added and make a mark for the 200 ml of level of the beaker. The contents were boiled for 30 minutes maintaining the volume at 200 ml by adding hot water. The residue was filtered through a muslin cloth and washed with hot water till the filtrate ran free of acid (2/3 filtrate in test tube + 1 drop of phenolphalein + 1 drop of 0.1 N KOH to get permanent pink colour). The residue was transferred to the same beaker using 75 ml hot water. Then 100 ml of 2.5 percent sodium hydroxide was added and the volume was made up to 200 ml using hot water.
The contents were boiled exactly for 30 minutes maintaining the volume at 200 ml by adding hot water. The contents were filtered through the same muslin cloth and washed with water till the filtrate ran free of alkali (2/3 filtrate in a test tube plus one drop of phenolphthalein - absence of pink colour). Then the contents were washed with 10 ml of acetone of 95 per cent to remove fat followed by 3 washings with hot water to remove acetone. The residue was transferred to a weighed silica basin (W) by using minimum quantity of water. The water was

evaporated over a water bath and dried in air oven: the contents were cooled in desiccator and weighed. The contents in the silica basin were ignited over a burner till all the carbonaceous materials were destroyed i.e., complete ashing. The contents were cooled in a desiccator and the weight (W) was determined. The loss in weight represents the crude fibre content of the sample. From the crude fibre weight, the percentage of curde fibre in the sample was calculated (Sadasivam and Manickam, 1996).

$$\text{Crude fibre} = \frac{\text{Loss in weight on ignition (W2−W1) - (W3 -W1)}}{\text{Weight of the sample}} \text{x100}$$

Where,
W1 = Weight of empty silica crucible
W2 = Weight of silica crucible + dry residue = Weight of silica crucible + ash

Mucilage content (Per cent)
Take 20 g of fresh fruit sample taken were ground adding 80 ml of distilled water and kept undisturbed for 24 hours. The content was then filtered using a muslin cloth and 50 ml of alcohol was added to the filtrate. The filtrate was again filtered through a pre weighed filter paper. The filter paper along with the residue was dried and weighed. The mucilage content was worked out by the following equation and was expressed in per cent (Sadasivam and Manickam, 1996).

$$\text{Mucilage content} = \frac{\text{Weight of mucilage (g)}}{\text{Weight of sample (g)}} \text{ x } 100$$

Results

Relative water content (Per cent)
Relative water content among the eighteen genotype was ranged from 40.57 per cent to 49.73 per cent. Among all the genotypes, the relative water content was the maximum in SCOH-1003 (49.73 Per cent). The mean relative water content for genotypes were 47.02 per cent. (Table 1).

Chlorophyll content
The chlorophyll content among the genotype ranges from 27.53 to 58.40. The chlorophyll content was the highest in genotype SCOH-1005 (58.40), while it was the lowest in SCOH-1014 (32.70). The mean value for genotypes were 44.92 (Table 1).

Crude fibre content (Per cent)
The mean value for genotypes were 13.72 per cent (Table 1). The crude fibre content was the maximum in SCOH-1002 (22.00 per cent), while it was the minimum in SCOH-1004 (8.57 per cent) presented in Table 1.

Mucilage content (Per cent)
The genotype SCOH-1012was found to have the lowest mucilage content (0.43 per cent), while the highest was recorded by SCOH-1003 (1.70 per cent). Among the all genotypes six genotypes had same percentage of mucilage content (1.60) and were obtained from infected leaves (Table 1).

Table 1: Performance of genotypes for physiological and quality characters in okra

Genotypes/varieties	Relative water content (Per cent)	Chlorophyll content(per cent)	Crude fibre content (per cent)	Mucilage content (per cent)
SCOH-1001	39.22	50.43	11.83	0.70
SCOH-1002	49.28	41.87	22.00	1.40
SCOH-1003	49.73	43.00	10.87	1.70
SCOH-1004	40.57	50.43	8.57	0.60
SCOH-1005	49.43	58.40	14.37	1.20
SCOH-1006	46.25	48.30	14.67	1.17
SCOH-1007	47.28	39.60	13.00	1.60
SCOH-1008	39.22	43.07	14.57	0.90
SCOH-1009	48.18	44.27	12.53	1.60
SCOH-1010	47.27	43.30	20.30	1.60
SCOH-1011	40.21	50.27	14.17	1.60
SCOH-1012	44.67	39.63	12.37	0.90
SCOH-1012	46.52	44.50	17.03	0.43
SCOH-1014	49.31	32.70	16.87	0.50
SCOH-1015	46.50	47.40	13.70	0.67
SCOH-1016	47.36	45.00	10.50	0.90
SCOH-1017	44.35	47.00	16.00	0.90
SCOH-1018	46.20	37.53	16.23	1.60
SCOH-1019	47.47	44.37	11.43	1.60

Discussion

Among the 19 Genotype, (fig 1) SCOH-1001 which was highly resistant to YVMV had recorded high chlorophyll content, lowest relative water content and crude fibre content. The genotype SCOH-1003 was highly susceptible to YVMV had recorded high relative water content, chlorophyll content, mucilage content and minimum crude fibre content.

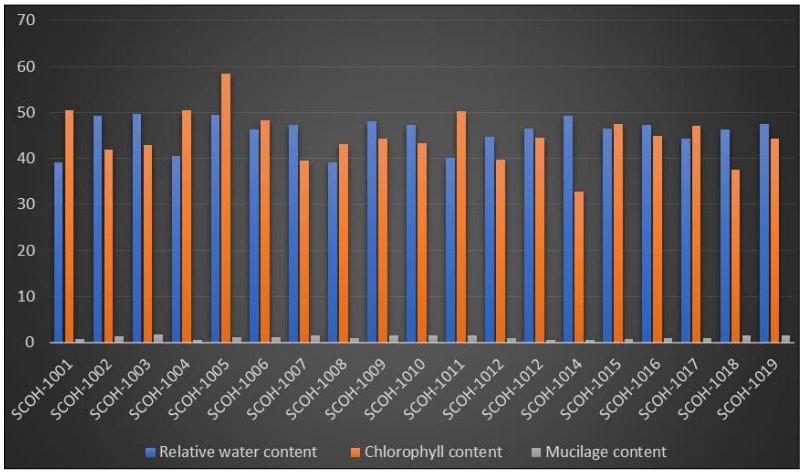

Fig 1: Comparison of genotypes for physiological characters.

From the current study it can be concluded that the okra genotype having high relative water content are prone to YVMV infection while the genotype having less relative water content can be consider as moderately resistant genotype (Rahoutei *et al*., 2000) [12].

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