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Physiology of Bhendi Yellow Vein Mosaic Disease Infected Plant

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A B S T R A C T

The major production constraint for okra is yellow vein mosaic disease, causing losses with regard to the quality and as well as the yield. This is a viral disease occurring on bhendi. Yellowing of the entire network of veins in the leaf blade is the characteristic symptom. In severe infections, the younger leaves turn yellow to become entirely chlorotic and the plant is highly stunted. Hence, we have studied the photosynthetic rate, Transpiration rate and Stomatal conductance in the virus infected plant and was compared with the non – infected plant with same moisture content. There was a very high difference in the photosynthetic rate of infected plant and healthy non -infected plant. Virus infected plant was recorded with zero photosynthetic rate (-0.71) and healthy plant was recorded with a photosynthetic rate of 11.29 at the fruit development stage of bhendi. At the same moisture content, the transpiration rate of infected plant was near equivalent to the healthy non infected plant which confirmed that the transpiration and stomatal conductance is occurring in infected plant and only the disturbance in the plant system is due to lack of chlorophyll and photosynthesis.

Introduction

The major production constraint for okra is yellow vein mosaic disease, causing losses with regard to the quality and as well as the yield wherever the crop is grown. This is a viral disease occurring on bhendi (Okra/Lady's Finger). Yellowing of the entire network of veins in the leaf blade is the characteristic symptom. In severe infections, the younger leaves turn yellow to become entirely chlorotic and the plant is highly stunted. The veins of the leaves will be cleared by the virus and interveinal area becomes completely yellow or white. The veins become considerably thickened. The infection may start at any stage of plant growth. Infection restricts flowering and fruits, if formed, may be smaller and harder. The affected plants produce fruits with yellow or white colour and they are not fit for marketing. Bhendi vein clearing virus is a serious disease of Bhendi and causes huge economic loss. The yellow vein mosaic disease of okra (YVMD) is caused by *Bhendi yellow vein mosaic virus* (BYVMV) and was first reported in 1924 from the erstwhile Bombay Presidency (Kulkarni, 1924). The virus belongs to the genus *Begomovirus*, family *Geminiviridae* (Fauquet and Stanley,

2005). Recently, BYVMD complex was shown to be associated with the virus with a genomic component typical of monopartite begomoviruses, homologous DNA A and a single-stranded betasatellite (Jose and Usha, 2003). This species is believed to have originated from India (Usha, 2008) and its only known methods of transmission are through whitefly (*Bemisia tabaci* Gennadius) and grafting. The DNA A component has seven open reading frames encoding several multifunctional proteins involved in rolling circle replication, gene transcription, cell-to-cell and long-distance movement, suppression of host gene silencing, and encapsidation of the viral genome (Lazarowitz, 1992). Betasatellites are approximately half the size of their helper begomoviruses required to induce typical disease symptoms in their original hosts (Briddon *et al.,* 2001). A survey on begomoviruses associated with okra in India revealed that the occurrence of YVMV incidence ranged from 23.0 to 67.67% in Karnataka, 45.89 to 56.78% in Andhra Pradesh, 23 to 75.64% in Tamil Nadu, 42.45 to 75.64% in Kerala, 23 to 85.64% in Maharashtra, 24.85 to 65.78% in Haryana, 35.76 to 57% in Uttar Pradesh, 45.45% in Delhi, 67.78% in Chandigarh and 45.89 to 66.78% in Rajasthan (Venkataravanappa, 2008). The weather condition in India is more congenial to the vector whitefly survival throughout of the region i.e. the warm and humid condition. Another issue is that whitefly is polyphagus in nature resultantly survive on other crop. Hence, we have documented the physiology of infected plant and non – infected plant.

Materials and Methods

In a standing bhendi seed production plot at B Block, Agricultural College and Research Institute, Madurai, there was severe infection with bhendi yellow mosaic disease and the observation on photosynthetic rate, Transpiration rate and stomatal conductance was recorded in healthy and virus infected crop using IRGA, Photosystem II Lci T model on 24.8.2020 between 10.00 and 10.30 am. The CO_2 concentration in the atmosphere is about 472 ppm at the time of observation. The difference in the photosynthetic efficiency with virus infected and non – infected plant is reported (Fig. 1 and 2).

Results and Discussion

Observation on photosynthetic rate, Transpiration rate and Stomatal conductance was observed in Bhendi yellow mosaic virus infected plant and non – infected plants and was given in the Table 1.

The results revealed that there was a very high difference in the photosynthetic rate of infected plant and healthy non infected plant. Virus infected plant was recorded with zero photosynthetic rate also (-0.71) and healthy plant was recorded with a photosynthetic rate of 11.29 at the fruit development stage of bhendi. There was no moisture stress in the field and the transpiration rate of infected plant was near equivalent to the healthy non infected plant which revealed that the transpiration and stomatal conductance is occurring in infected plant and only the disturbance is due to lack of chlorophyll and photosynthesis.

This was in accordance with the findings of Koiwa *et al.,* (1992) reported that virus infection inhibits PSII activity selectively by the decomposition of light harvesting antenna complex of PSII (LHCII), based on their findings on the ratio of particles in the surface of the thylakoid membranes in tomato plants infected with TMV. Similarly, Eupatorium makinoi leaves infected with tobacco leaf curl geminivirus (TLCV) the amount of LHCII decreased in the chloroplasts (Funayama *et al.,* 1997).

Table.1 Physiology of virus infected and healthy non – infected plants in Bhendi

Description	Photosynthetic rate µ mol/m^2 /Sec	Transpiration rate m mol/m^2 /Sec	Stomatal Conductance mol /sec
Virus infected plant			
1.	-1.65	6.99	0.38
2.	-2.19	3.67	0.14
3.	1.04	6.64	0.34
4.	-0.94	4.40	0.21
5.	0.21	6.49	0.29
Mean	**-0.71**	**5.64**	**0.27**
Healthy Non - infected plant			
1.	4.92	6.56	0.38
2.	7.00	7.94	0.50
3.	13.18	7.27	0.42
4.	18.10	6.84	0.81
5.	13.26	6.20	0.27
Mean	**11.29**	**6.96**	**0.48**

Fig.1 Bhendi Mosaic Infected

Fig.2 Healthy plant

The same changes as well as the increase of respiration were observed in tobacco leaves infected with tobacco etch potyvirus (TEV) (Hopkins and Hampton, 1969). Depending on the time of inoculation, the plastids differentiated irregularly. The ratio of degenerated plastids changed with the time course of symptom development. The myelin-like or tubular structure was not formed by the disruption of the existing lamellae, but by their irregular development. In the case of BSMV infected etiolated barley seedlings we reported not only the accelerated senescence but the inhibition of chlorophyll biosynthesis (Almási *et al.*, 2000).

Virus infection resulted in decreased photosynthesis (*c.* 50%). Stomatal limitation was unaffected in virus-infected plants, demonstrating that stomatal closure was not causing photosynthesis decreases. Chlorophyll fluorescence and limitation analysis suggested that the inhibition of primary light reactions was only a minor effect of virus infection. By contrast, mesophyll conductance to CO_2 and Rubisco activity substantially decreased in virus- infected plants, corresponding to increases in the limitations to photosynthesis imposed by mesophyll conductance and carboxylation. For the synthesis of virions the parasite uses the metabolites and energy of the host plant, which are produced in the course of photosynthesis. It is evident that the physiological processes of the virus and the plant are linked in complex ways, the structure and the function of the chloroplasts are disturbed (Zaitlin and Hull, 1987). Disturbances in the translocation of the photosynthetic assimilates may be related to the synthesis of viral movement protein (MP) (Lucas *et al.*, 1993). As the infection had been progressed this tendency inverted: CO_2-uptake was decreasing in the infected tissues (Doke and Hirai, 1970).

In conclusion, there was a very high difference in the photosynthetic rate of infected plant and healthy non -infected plant. Virus infected plant was recorded with zero photosynthetic rate (-0.71) and healthy plant was recorded with a photosynthetic rate of 11.29 at the fruit development stage of bhendi. At the same moisture content, the transpiration rate of infected plant was near equivalent to the healthy non infected plant which confirmed that the transpiration and stomatal conductance is occurring in infected plant and only the disturbance in the plant system is due to lack of chlorophyll and photosynthesis.

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