

Screening of *Luffa acutangula* (L.) Roxb Genotypes for Resistance Against Tomato Leaf Curl New Delhi Virus, the Causal Agent of Yellow Mosaic Disease of Ridge Gourd

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Abstract Ridge gourd [*Luffa acutangula* (L.) Roxb.] is a popular cucurbitaceous crop on Indian sub continent. Tomato leaf curl New Delhi virus, the causal agent of yellow mosaic disease of ridge gourd belongs to begomovirus has recently been reported causing crop damage up to 100% under favorable epidemic condition. Screening for to identify resistance genotype was carried out using twenty one

varieties and seven hybrids of ridge gourd, collected different places. Screened these for resistance through challenge inoculation using viruliferous whitefly with a purified strain of the virus under insect-proof greenhouse conditions in order to find out resistance source against yellow mosaic disease. Results reveal by using disease incidence and vulnerability index that all the hybrids/varieties of ridge gourd resistance to Tomato leaf curl New Delhi virus associated with yellow mosaic disease of ridge gourd are found highly susceptible reaction where as one (URRG-39) showed susceptible reaction.

Keywords Resistance, Ridge gourd, Screening, Yellow mosaic disease, Whitefly.

Introduction

Among the various cultivated cucurbitaceous vegetable grown worldwide, Ridge gourd [*Luffa acutangula* (L.) Roxb.] also known as ribbed gourd is very popular in the tropical and subtropical regions. In India, it is cultivated on both commercial scale and in kitchen gardens during the spring-summer and rainy season. It is a viny vegetable as it requires a trellis or support for its growth and development and is identified with its ridges on fruit. India is considered to be the center of origin of *Luffa* species and belongs to cucurbitaceae family having chromosome number, $2n=26$. Like all other cucurbitaceous veg-

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Table 1. Scale used to evaluate the varieties/hybrids (Sohrab, 2005).

Score	Symptoms	Genotype class
1	Mild mosaic of young leaves covering the leaf surface <10% of the surface	Resistant (R)
2	Mosaic of young leaves covering the leaf surface <25% of the surface	Moderately Resistant (MR)
3	Mosaic of young leaves covering the leaf surface <50% of the surface, blistering and puckering of leaves	Moderately Susceptible (MS)
4	Severe mosaic of young leaves covering the leaf surface <75% of the surface, distortion of leaves	Susceptible (S)
5	Severe mosaic of young leaves covering the leaf surface >75% of the surface, distortion of leaves and stunting of the plants	Highly Susceptible (HS)

etables, it is severely affected by several diseases, with high crop damage. The viral diseases yellow mosaic disease of ridge gourd caused by Tomato leaf curl New Delhi virus (ToLCNDV; genus *Begomovirus*, family *Geminiviridae*) is a recently reported disease and may cause yield losses up to 100% [1, 2].

Yellow mosaic disease of ridge gourd seems to be newly emerged particularly in hot season due to begomovirus infection. This is a newly emerged threat in ridge gourd growing areas. The causal agent has been identified as a begomovirus based on symptomatology, transmission [1], molecular detection and characterization [2]. *Begomovirus* is one of the genera among the seven genera of *Geminiviridae* [3]. Begomoviruses can either have a bipartite genome, with the DNA-A component encoding five or six proteins and the DNA-B component encoding two proteins, each component being 2.5 to 2.8 kb in size, or a monopartite genome encoding six proteins [4]. Begomoviruses are one of the limitations for growing of cucurbits in India since last decade [5] diseases caused by begomoviruses have been reported in many cucurbits [2, 6–12].

The diseased plant is characterized by typical symptoms such as yellow spots appearing on newly emerging leaves, followed by a chlorosis, mosaic ap-

pearance and upward curling of the upper leaves some time downward curling and cupping, blistering of leaves, with stunted growth. In cases of severe attack, the leaves of the plant are small and distorted, and misshapen fruits are produced. The virus is transmitted through whitefly vector whose members belong to the *Bemisia tabaci* (Genn.) (Hemiptera-Aleyrodidae). Sibling species group [13–15] it leads to difficulties in viral disease management, the use of resistant varieties is the most important and practical approach for combating the menace and one of the corner stone to successfully breeding resistant or tolerant genotypes is the sensitive and efficient screening of genotypes against pathogens.

Here we report our results to measure the level of disease incidence for resistance to ToLCNDV associated with yellow mosaic disease in the germplasm of ridge gourd collected from various locations.

Materials and Methods

Germplasm collection

The plant material used in our investigation comprised 21 varieties and 7 hybrids of ridge gourd collected from various places. The URRG series collected from Indian institute of vegetable research, Varanasi through the facilities of the National Bureau of Plant Genetic Resources, New Delhi and remaining are collected from different part of Karnataka. These are maintained as inbreds at the Department of Plant Pathology, KRC College of Horticulture, Belagavi, Karnataka.

Screening for resistance through challenge inoculation under greenhouse conditions

In order to find out the resistance source against yellow mosaic disease of ridge gourd. A virus-free stock of whiteflies (*Bemisia tabaci*) were initially collected and reared on cotton in insect proof net house in a controlled environmental condition Figure 1. Twenty eight genotypes of ridge gourd were screened for resistance to yellow mosaic disease in the insect-proof greenhouse. Seeds were sown in pots (15 × 10 cm²).

Table 2. Evaluation of ridge gourd varieties/hybrid against yellow mosaic disease of ridge gourd for resistance by means of virus inoculation using *Bemisia tabaci*. AAP=24 h, IAP=24 h 30 whiteflies are used for inoculation, I=Immune, R=Resistant, MR=Moderately Resistant, MS=Moderately Susceptible, S=Susceptible, HS=Highly Susceptible, *As per the Sohrab [16].

Sl. No.	Variety / Hybrid	Number of plants inoculated	Disease incidence (%) (Weeks after inoculation)					Vulnerability index	Category
			1	2	3	4	5		
1	Gadag local	26	56.6	70	80	93.3	100	93.3	HS
2	Chitrada local	28	75	75	85	85	100	85	HS
3	URRG-11/10	30	66.6	80	80	93.3	100	93.3	HS
4	URRG-7/10	27	70.3	77.7	85.1	92.5	100	92.5	HS
5	URRG-3/10	29	68.9	75.8	86.2	96.5	100	96.5	HS
6	URRG-12/10	25	72	84	92	92	100	92	HS
7	IC-398594	21	76.1	80.9	90.4	90.4	100	90.4	HS
8	URRG-38	28	75	82.1	89.2	96.4	100	96.4	HS
9	URRG-8/10	30	70	73.3	93.3	93.3	100	93.3	HS
10	URRG-4/2010	28	75	82.1	89.2	96.4	100	96.4	HS
11	URRG-110	25	84	88	92	100	100	100	HS
12	URRG-11	30	60	76.6	86.6	93.3	100	93.3	HS
13	URRG-103	20	70	80	85	90	100	90	HS
14	URRG-89	25	68	80	84	92	100	92	HS
15	URRG-6A	25	76	84	88	92	100	92	HS
16	URRG-112	26	76.9	80.7	88.4	92.3	100	92.3	HS
17	URRG-39	26	43.8	59.2	68.6	73.4	100	73.4	S
18	URRG-9	27	70.3	74	88	92.5	100	92.5	HS
19	URRG-78	25	76	80	88	92	100	92	HS
20	URRG-5A	26	69.2	76.9	84.6	92.3	100	92.3	HS
21	URRG-6	28	67.8	75	85.7	92.8	100	92.8	HS
22	UGR-113 (United genetics)	30	40	50	70	80	100	80	HS
23	Saniya-4 (PHS seeds)	30	66.6	76.6	83.3	90	100	90	HS
24	Pallavi (Sungro seed)	30	73.3	83.3	90	93.3	100	93.3	HS
25	Avanathi green (Somani seed)	26	73	80	88.4	96.1	100	96.1	HS
26	BSS-582 (Kalash seeds)	30	63.3	76.6	83.3	96.6	100	96.6	HS
27	Pradham padmini (Pradham seeds)	26	69.2	80.7	88.4	96.1	100	96.1	HS
28	Anamika (Kalash seeds)	25	72	80	84	84	100	84	HS

One plant per pot was used for inoculation. Whitefly inoculation was carried out as described by Sohrab [16]. The whiteflies were allowed acquisition access for 24 h to yellow mosaic-infected ridge gourd plants maintained under green conditions [17]. Viruliferous whiteflies were then allowed access for 24 h to 15-day-old healthy plants at the two true leaf stage (twenty whiteflies per plant) in the confined area of an inoculation cage made of transparent polycarbonate sheet. Disease scoring was performed at 7 days post-inoculation (dpi) and continued at weekly intervals up to eight weeks post-inoculation.

Estimation of vulnerability index

Ridge gourd genotypes were screened against yellow

mosaic disease by using the below mentioned scale given in Table 1 by Sohrab [16] and categorized them into R, MR, MS, S and HS, based on their respective disease reactions based on the number of infected plants after eight weeks of inoculation out of number of inoculated plants.

The vulnerability index (V) values were calculated for each genotype for a better comparison of resistance among the genotypes using the following equation, as adopted by Silbernag and Jafari [18] for measuring resistance on snap bean (*Phaseolus vulgaris*) to Beet curly top virus and modified by Bos [19].

$$\text{Vulnerability index (V)} = \frac{(0n_0 + 1n_1) + 2n_2 + 3n_3 + 4n_4 + 5n_5}{(n_c - 1)} \times 100$$



Fig. 1. Whitefly *Bemisia tabaci* adults maintained on cotton plants in insect proof net house.

Where, $n_0, n_1, n_2, \dots, n_5$ = Number of plants in score 0, 1, 2, ... 5, n_t = Total number of plants, n_c = Total number of categories.

On the basis of the vulnerability indices, the genotypes were categorized into five categories, namely, immune, where $V=0$; resistant, where $V=1-25\%$; moderately resistant, where $V=26-50\%$; moderately susceptible, where $V=51-75\%$; susceptible, where $V=76-100\%$. A single plant of each genotype was selected for selfing, and the seeds of the selfed plants were collected for further study.

Results and Discussion

Screening of ridge gourd germplasm for resistance to yellow mosaic disease

The aim of this experiment was to identify a source of

resistance to yellow mosaic disease caused by ToLCNDV in the available germplasm of ridge gourd.

The diseases incidence percent and vulnerability indices of all genotypes study are presented in the Table 2. The genotypes are screened for diseases incidence percent in order to find out source of resistance up to eight weeks but with in fifth week only all the genotypes showed 100% severity. Results found that all the hybrids/varieties showed highly susceptible reaction where as one (URRG-39) showed susceptible reaction. None of the varieties showed resistant reaction. The symptoms appeared simultaneously in all of the plants of highly susceptible lines, but in susceptible lines the symptoms appeared sporadically in few plants.

The vulnerability index ranged from 73.4 to 100 under the challenge inoculation conditions (whitefly inoculated), disease symptoms under the challenge inoculation conditions started appearing at 7 dpi as minute yellow spots on the youngest leaf of susceptible and highly susceptible lines. The line URRG-39 assessed to be susceptible line and remaining are highly susceptible lines Gadag local, Chitrada local, URRG-11/10, URRG-7/10, URRG-3/10, URRG-12/10, IC-398594, URRG-38, URRG-8/10, URRG-4/2010, URRG-110, URRG-11, URRG-103, URRG-89, URRG6A, URRG-112, URRG-9, URRG-78, URRG-5A, URRG-6, UGR 113 (United genetics), Saniya-4 (PHS seeds), Pallavi (Sungro seed), Avanathi green (Somani seed), BSS-582 (Kalash seeds), Pradham padmini (Pradham seeds) and Anamika (Kalash seeds).

In this experiment, we made an effort to find the genetics of resistance to ToLCNDV causing yellow mosaic disease of ridge gourd in twenty eight genotypes of ridge gourd including hybrids by screening for resistance through challenge inoculation under greenhouse conditions. Results reveals that the 73.4 to 100% disease incidence was recorded within four weeks after inoculation and 100% disease incidence was recorded in all genotypes at the end of eight weeks after inoculation. Similar type of results are recorded by Ramdas [1] by evaluating twenty nine varieties/hybrids and by Chandrakant [2] recorded the highly susceptible reaction in all twenty two varieties/hybrids which were used in study. Islam [20]

recorded the 3.33 to 100% vulnerability index 30 genotypically diverse genotypes of sponge gourd. 0 to 100% vulnerability index was reported in 30 germplasm of sponge gourd by Islam [20].

In case of viral disease management, identification of resistant source/genotypes is one of the aspects which have got prime importance and is going to be a best practice to reduce the yield loss due to the occurrence of the viral disease, we made an effort to discover resistance genotype among twenty eight genotype but we not find any resistance gens or lines in those genotypes so there is need to put continuous effort to screen and identify more number of ridge gourd genotypes to find out source of resistance against to the yellow mosaic disease.

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