



SURVEY AND HOST RANGE STUDIES OF YELLOW MOSAIC VIRUS INFECTING RIDGE GOURD (*Luffa accutangula* L.)

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ABSTRACT

Yellow mosaic disease caused by a Begomovirus is an important production constraint in vegetable cultivation in India. The disease consisted of yellow mosaic accompanied with slight curling on leaves. The whitefly (*Bemisia tabaci*) population was also observed in the vicinity. The characteristic disease symptoms and whitefly population indicated the possibility of begomovirus infection. Survey conducted during 2013-14 to assess the incidence of yellow mosaic virus in ridge gourd in four districts of southern Karnataka, revealed that the occurrence of the disease in the range of 37.5 to 86.0 per cent. Among the districts, the highest disease incidence of YMV on ridge gourd was recorded in Chikballapur (67.098%), followed by Kolar (60.278%), Bangalore (57.09%) and least in Ramanagar (49.88%). Ridge gourd yellow mosaic virus was successfully transmitted to cucumber, ridge gourd, bottle gourd, pumpkin, ash gourd and squash through whiteflies (*Bemisia tabaci*). However the virus could not be transmitted to other plant species of Solanaceae, Fabaceae, Asteraceae and weed plants tested.

KEY WORDS: Survey, Host range, Yellow mosaic virus, Ridge gourd, Whitefly.

INTRODUCTION

Ridge gourd (*Luffa acutangula* L. Roxb) popularly known as Kalitori or angled gourd and belongs to *Cucurbitaceae* family. The name “Luffa” is of Arabic origin and refers to the spongy characteristics of the mature fruit (Bose and Som, 1986). It contains a gelatinous compound called luffein which has medicinal importance. Fruits contain protein (0.5%), carbohydrate (3%), carotene (37 mg) and vitamin C (18 mg) per 100 g of edible portion. Ridge gourd originated in India and it is cultivated in the tropics for its tender edible fruits both on commercial scale and in kitchen gardens throughout India. It is a popular vegetable both as spring summer and rainy season crop (Yawalkar, 1985). It is cultivated in India, Indonesia, Malaysia, Myanmar, Philippines, Sri Lanka and Taiwan. The total area under cucurbits in India is about 0.5 million ha, which is about 12 percent of the total vegetable growing area excluding potato (Seshadri, 1996). In India, it is largely grown in Karnataka, Andhra Pradesh, Kerala, Tamil Nadu, Uttar Pradesh, Madhya Pradesh and Maharashtra states. Among the cucurbitaceous vegetables grown in India, gourd vegetables occupy an area of 73273 ha with an annual production of 685224 tonnes. In Karnataka, it occupies an area of 2,753 ha with an annual production of 18,706 tonnes of fleshy fruits (Anon., 2004). Cucurbits suffer from many fungal, bacterial and viral diseases. Among viral diseases, yellow mosaic begomovirus has been considered as an important limiting factor in cucurbits productivity. Losses due to yellow mosaic disease ranged from 4.7 to 36% per cent depending on the cultivar susceptibility and time of infection. The disease incidence sometimes reaches 100 per cent. (Sohrab *et al.*, 2003). Characteristic symptoms of yellow mosaic disease on cucurbits include leaf curling, yellow spot on the newly emerged leaves, chlorosis and mosaic, vein

banding and severe mosaic mottling (Tiwari *et al.*, 2012). The occurrence and host range studies of YMV infecting ridge gourd has not been studied in detail. This paper reports about the incidence of the disease and host plants susceptible to the virus.

MATERIALS AND METHODS

Survey for the incidence of Yellow mosaic virus disease on ridge gourd

Surveys were carried out during the 2013-2014 to know the per cent disease incidence of yellow mosaic disease of ridge gourd in Southern districts of Karnataka; Bengaluru rural, Chikballapur, Ramanagara and Kolar. In each district, a minimum of three taluks, in each taluk three villages and in each village three fields were surveyed for the occurrence of the disease. The per cent disease incidence was assessed by recording the number of plants showing disease symptoms, out of the total number of plants examined by using the formula mentioned below (Sunkad *et al.* 2012). The diseased samples collected during the survey were used for transmission studies through a vector whitefly, *Bemisia tabaci* under glass house conditions.

$$\text{Percent disease incidence} = \frac{\text{Number of diseased plants}}{\text{Total number of plants examined}} \times 100$$

During the survey the additional information's such as, stage of the crop, area, varieties grown, symptoms and presence of whitefly were recorded.

Host range of yellow mosaic virus infecting ridge gourd

Virus culture was maintained by inoculating healthy ridge gourd plants using viruliferous adult *B. tabaci*. The culture of indigenous whiteflies (*B. tabaci* Genn.) used for

transmission were maintained on cotton, *Gossypium hirsutum* cv. Varalakshmi.

Twenty one crop plants and three weed species belonging to six different families were tested for their susceptibility to yellow mosaic virus. Seeds of these species were raised in an insect-proof glass house. Plants at the two to three-leaf stages were inoculated with 20–25 viruliferous whiteflies with a 24-h acquisition access period (AAP) and 24-h inoculation access period (IAP). The inoculated seedlings were kept in insect proof glasshouse for development of symptoms.

RESULTS & DISCUSSION

Symptoms of yellow mosaic disease on ridge gourd:

During the survey, observed the different kind of symptoms of yellow mosaic virus on ridge gourd plants were; mild to severe yellow mosaic, chlorosis, leaf curling, mottling, networking of yellow veins, followed by thickening of veins and vein lets, puckering, leaf distortions, stunting of whole plant, misshapen fruits and reduced fruit yield (Fig. 1).

TABLE 1. Incidence of yellow mosaic virus disease of ridge gourd in Bengaluru, Ramanagara, Kolar and Chikkaballapur district

District	Taluk	Village	Age of the crop (days)	Area (acre)	Variety grown	Average disease incidence (%)
Bengaluru	Devanahalli	Yaluvahalli	50	1.5	Arka sumeet	50.0
		Mandibele	40	1.0	Naga	58.0
		Boodihal	55	1.0	MHRG7	63.2
	Doddaballapur	Konaghatta	45	0.5	Naga	53.6
		Dodda Belavangala	30	2.0	MHRG7	68.2
		Halekote	40	0.5	Arka sumeet	52.0
	Hoskote	Magabala	50	0.5	Jindian	53.0
		Manchappanahalli	45	1.0	Naga	60.0
		Thavekare	25	1.0	Naga	47.0
	Nelamangala	Tavarekere	55	0.5	Local	55.2
		Byranhalli	40	1.5	Akshay	65.0
		Thymagandlu	30	1.0	Naga	58.5
Ramanagara	Ramanagara	Abburu	35	1.0	Naga	37.5
		Dasawara	45	1.0	Arka sumeet	55.9
	Magadi	Bilagumba	40	1.0	Naga	54.6
		Sathnur	35	0.5	MHRG7	42.0
	Channapattana	Kali Hosure	50	1.0	Arka sumeet	42.0
		Doddamallur	60	1.5	Arka sumeet	45.0
	Bidadi	Hejala	35	1.0	Naga	72.0
		M.Karenahalli	40	1.0	Arka summet	53.0
		K.Karenahalli	50	1.0	Naga	58.0
	Bangarpet	Chattakamadenahalli	40	1.5	Akshay	65.0
		Bethamangala	50	0.5	Akshay	55.2
		Kavaraganahalli	40	1.0	Arka sumeet	56.4
	Malur	Huralagere	50	1.5	MHRG7	59.4
		Vakleri	55	0.4	Arka sumeet	56.4
Kolar	Kolar	Baterhalli	50	1.5	MHRG7	68.5
		Hudukulla	60	0.8	Local	64.3
		Laxmipura	35	1.0	Arka sumeet	62.9
	Srinivasapura	Kolature	45	0.8	Akshay	55.2
		Neeltur	35	1.5	Naga	62.2
		Tayalure	40	1.5	Naga	68.0
	Mulbagal	Vaddahalli	50	1.5	Arka sumeet	52.1
		Tupahalli	45	1.2	Naga	53.6
		Kamatanapalli	50	2.0	Naga	70.9
	Chikkaballapur	Manchenahalli	50	2.0	MHRG7	68.0
		Upparahalli	55	1.5	MHRG7	86.0
		Kanaganakoppa	50	2.0	Arka sumeet	55.3
	Sidlaghatta	Chikadasahalli	35	1.0	Naga	68.0
		Marappanahalli	55	1.5	Arka sumeet	72.7
		Handighalli	45	2.0	Jindian	66.0
Chikkaballapur	Bagepalli	Kothakote	50	1.0	MHRG7	66.9
		Karekallahalli	55	0.5	Arka sumeet	72.3
	Gauribidanur	kalludi	60	1.5	MHRG7	64.9
		Kaderpalli	50	1.5	Arka sumeet	67.5

Survey for the incidence of Yellow mosaic virus disease on ridge gourd

Surveys carried out in ridge gourd growing areas of selected districts viz., Chikkaballapura, Kolar, Bengaluru rural and Ramanagara districts to assess the disease incidence revealed the occurrence of the disease at all the locations, with varied levels of incidence. The incidence of

yellow mosaic virus (YMV) disease on ridge gourd was ranged from 37.5 to 86.0 per cent. Among the districts surveyed, highest disease incidence recorded in Chikkaballapur district (67.098%), followed by Kolar (60.278%), Bangalore (57.09%) and Ramanagar district (49.88%) (Table 2).



FIGURE 1: Field view of ridge gourd crop infected with yellow mosaic virus

In Bangalore district the incidence of yellow mosaic disease on ridge gourd varied from 47 to 68.2%. Incidence of disease on ridge gourd was highest in Nelamangala taluk (59.50%) and lowest in Hoskote taluk (53.3%) (Table 1). In Ramanagar district the incidence of disease on ridge gourd varied from 37.5 to 72%. Among the 4 different taluks surveyed, the incidence of disease recorded highest in Bidadi taluk (61%) and lowest in Channapattana taluk (43.5%) (Table 1). The incidence of

disease in Kolar district on ridge gourd varied from 55.2 to 68.5%. Among the 5 different taluks of Kolar surveyed, the incidence of yellow mosaic on ridge gourd was highest in Kolar taluk (63%) and lowest in Bangarpet taluk (58.86%) (Table 1). In Chikkaballapur district, the incidence of disease on ridge gourd varied from 55.3 to 86%. Chikkaballapur taluk recorded highest disease incidence of 69.2 % and Chintamani taluk recorded lowest incidence of 62.2% (Table 1).

TABLE 2. Average incidence of yellow mosaic virus disease on ridge gourd in 4 districts of southern dry zone of Karnataka

District	Taluk	Average incidence (%)	Average disease incidence of a district (%)
Bengaluru rural	Devanahalli	57.60	57.09
	Doddaballapur	57.93	
	Hoskote	53.33	
	Nelamangala	59.50	
Ramanagar	Ramanagar	46.70	49.88
	Magadi	48.33	
	Channapattana	43.50	
	Bidadi	61.00	
	Bangarpet	58.86	
Kolar	Malur	59.40	60.28
	Kolar	63.00	
	Srinivasapura	60.10	
	Mulbagal	60.03	
	Chintamani	62.26	
Chikkaballapur	Chikkaballapur	69.20	67.09
	Sidlaghatta	68.90	
	Bagepalli	66.90	
	Gowribidanur	68.23	

Survey carried out from 2013-2014 in southern dry tract of Karnataka comprising of 4 districts for the assessment of disease status. Survey revealed that occurrence of the disease on ridge gourd range between 37.5 to 86.0 %. Chikkaballapur and Kolar districts have the larger area

under vegetable crops recorded highest incidence of the disease. There are many reports on begomviruses infecting wide range of cucurbits from different parts of the country. The YMV infected ridge gourd samples were collected; DNA was isolated using CTAB method and subjected to

PCR using specific primers. The virus was cloned and sequenced. The sequence analysis shown that YMV is strain of Tomato leaf curl New delhi virus (ToLCNDV). They are likely to be a major threat to the cucurbits production in the future. The present study confirmed with the occurrence of begomovirus on bottle gourd in Delhi and Haryana varied from 4.7 to 36% (Sohrab *et al.*, 2003), on bitter gourd in Gorakhpur up to 20% (Tiwari *et al.*, 2010). Nagaraja (2005) conducted a survey to identify yellow mosaic disease in bhendi, transmitted by *B. tabaci*, in different districts of Southern Karnataka. BYVMV incidence ranged from 19.1 to 95.4 %, the highest disease incidence was recorded in Mandya district (36.80 to 95.4 per cent), followed by Mysore (43.3 to 85.5 per cent), Bangalore (21.62 to 37.5 per cent) and Kolar (19.1 to 24.3 per cent). The differences in incidence of disease in areas surveyed might be due to variation in the source of inoculum, vector population, crop and weather condition. High level of incidence at certain locations might be due to the abundant source of inoculum. Results of this study have epidemiological significance for monitoring and management of the disease.

Host range of yellow mosaic virus infecting ridge gourd

Twenty one crop plants and three weed species belonging to six different families were inoculated with YMV by using viruliferous vector (whiteflies) by giving 24 h AAP and 24 h IAP under insect proof glass house. Hundred per cent infection was observed on cucumber, ridge gourd, bottle gourd, pumpkin, ash gourd and squash after 8-12 days of inoculation. Yellow mosaic virus inoculated ridge gourd plants developed initial symptom of yellow mosaic disease as small chlorotic specks after eight days of inoculation with mild mosaic symptoms. As the disease progresses, yellow mosaic with puckering was observed 12 days after inoculation. After 20 days, the diseased plant was stunted with complete chlorosis of leaves. Upward leaf curling in cucumber, yellow vein mosaic, chlorosis and mottling on bottle gourd, yellow vein mosaic on pumpkin, yellow mosaic and reduced leaf size on ash gourd and yellow vein mosaic and stunted growth on squash (Table. 3 and Fig. 2). The virus could not infect the plants of *Solanaceae*, *Fabaceae*, *Asteraceae* and weed plants. The results of host range studies are presented in table 3.

TABLE 3. Host range of yellow mosaic virus -ridge gourd assessed by symptom expression after virus transmission by *B. tabaci*.

Plant species inoculated ^a	Common name	Family	% Infection	Symptoms ^b	No of Days taken for Symptom development
<i>Luffa cylindrica</i>	Sponge gourd	Cucurbitaceae	0 (0/10)	-	-
<i>Cucumis sativus</i> L.	Cucumber	Cucurbitaceae	100 (10/10)	Yellow mosaic, mottling and leaf curling	12-15
<i>Cucurbita moschata</i>	Pumpkin	Cucurbitaceae	100 (10/10)	Yellow vein mosaic	12-15
<i>Cucurbita pepo</i> L.	Squash	Cucurbitaceae	100 (10/10)	Yellow mosaic	10-15
<i>Cucumis melo</i> L.	Musk melon	Cucurbitaceae	0 (0/10)	-	-
<i>Citrullus vulgaris</i>	Watermelon	Cucurbitaceae	0 (0/10)	-	-
<i>Lagenaria siceraria</i>	Bottle gourd	Cucurbitaceae	100 (10/10)	Yellow mosaic, chlorosis and reduced leaf size	10-12
<i>Luffa acutangula</i> (L.)	Ridge gourd	Cucurbitaceae	0 (0/10)	Yellow mosaic	8-10
<i>Momordica charantia</i> L.	Bitter gourd	Cucurbitaceae	0 (0/10)	-	-
<i>Trichosanthes charantia</i>	Snake gourd	Cucurbitaceae	0 (0/10)	-	-
<i>Benincasa hispida</i>	Ash gourd	Cucurbitaceae	100 (10/10)	Yellow mosaic and reduced leaf size	10-15
<i>Lycopersicon esculentum</i> Mill.	Tomato	Solanaceae	0 (0/10)	-	-
<i>Nicotiana tabacum</i> L.	Tobacco	Solanaceae	0 (0/10)	-	-
<i>Solanum melongena</i> L.	Eggplant	Solanaceae	0 (0/10)	-	-
<i>Capsicum annuum</i> L.	Bell pepper	Solanaceae	0 (0/10)	-	-
<i>Nicotiana glutinosa</i> L.	Tobacco	Solanaceae	0 (0/10)	-	-
<i>Phaseolus lunatus</i> L.	Lima bean	Fabaceae	0 (0/10)	-	-
<i>Macrotyloma uniflorum</i>	Horse gram	Fabaceae	0 (0/10)	-	-
<i>Vigna radiata</i> (L.)	Greengram	Fabaceae	0 (0/10)	-	-
<i>Vigna unguiculata</i> (L.)	Cowpea	Fabaceae	0 (0/10)	-	-
<i>Vigna mungo</i> (L.)	Blackgram	Fabaceae	0 (0/10)	-	-
Weeds					
<i>Parthenium hysterophorus</i> L.		Asteraceae	0 (0/10)	-	-
<i>Chenopodium amaranticolor</i>		Chenopodiaceae	0 (0/10)	-	-
<i>Euphorbia geniculata</i> Orteg.		Euphorbiaceae	0 (0/10)	-	-

a Two . Three-week-old plants were inoculated using 15-20 *B. tabaci* per plant provided with 24 h AAP and 24 h IAP.

b Expression of symptoms was recorded weekly for 3 months after virus inoculation.

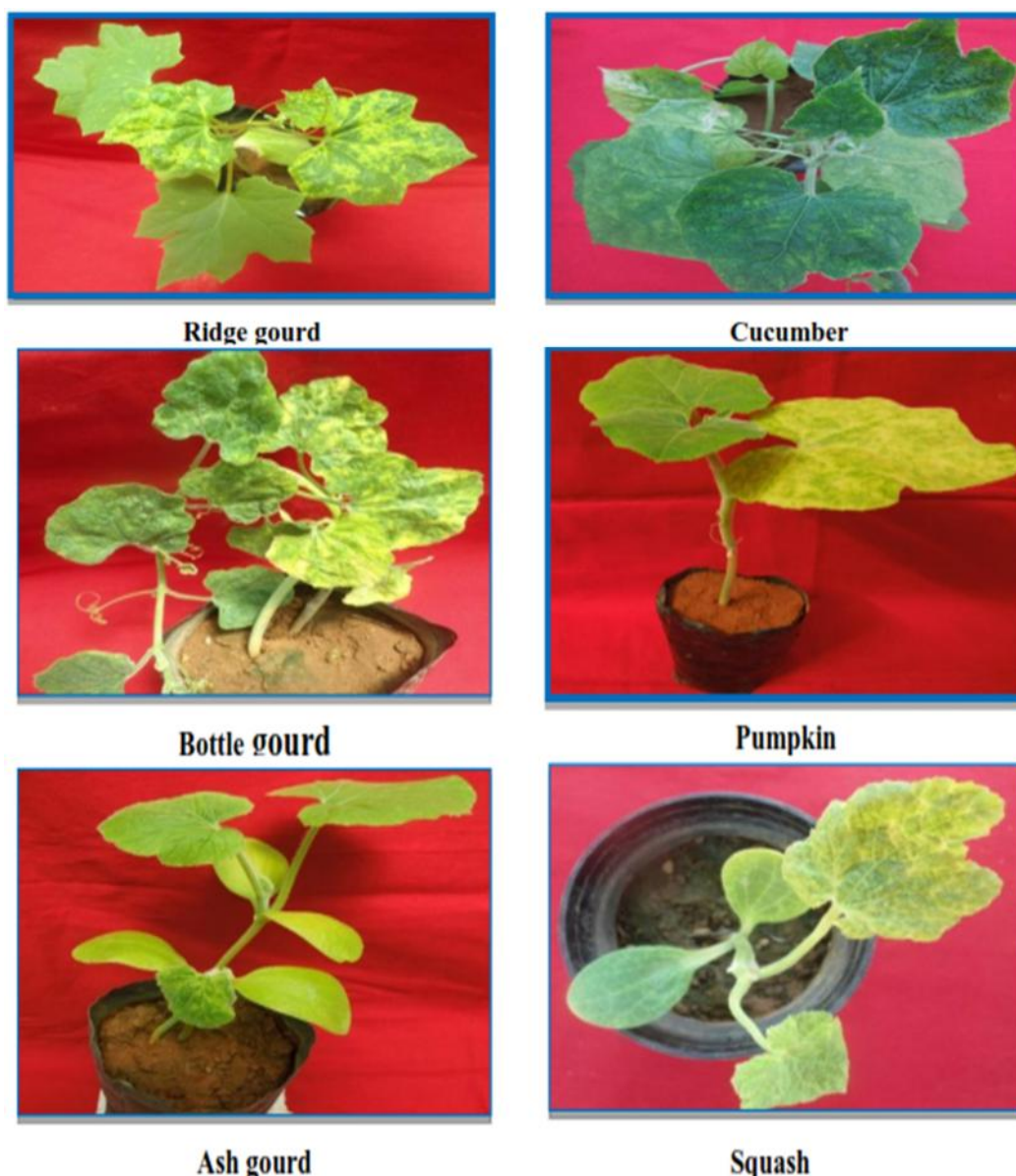


FIGURE 2: Cucurbits showing symptoms of mild mosaic to yellow mosaic upon inoculation with YMV using White fly, *B. tabaci*

The results of studies on identification of susceptible hosts to the virus indicated that YMV successfully transmitted to ridge gourd, bottle gourd, cucumber, pumpkin, ash gourd and squash. Plant species such as Bitter gourd, snake gourd, musk melon, watermelon, tomato, tobacco, legume crops and weed hosts did not take infection upon inoculation experimentally. The ToLCNDV associated with yellow mosaic disease of Chayote was experimentally transmitted to *Luffa acutangula* by using *B. tabaci* (Mandal *et al.*, 2004). But it was interesting note that the virus could not be transmitted to tomato though it is a distinct species of Tomato leaf curl virus in India. Sohrab *et al.* (2003) studied the host range of Tomato leaf curl New Delhi virus infecting *Luffa cylindrica*. The virus was transmitted to *Cucumis sativus*, *Luffa acutangula*, *L. cylindrica*, *Lycopersicon esculentum*, *Nicotiana tabacum* and *Praecitrullus fistulosus* but not to *Citrullus lunatus*, *Cucumis melo*, *Cucurbita moschata* and *Vigna unguiculata*. The yellow mosaic virus from ridge gourd was successfully transmitted by whiteflies to cucurbitaceous crops such as cucumber, bottle gourd, ash

gourd, pumpkin and squash suggesting that the insect vector plays a major role in determining the natural host range of these viruses. This also shows that these crops grown in and around ridge gourd fields may act as reservoir for virus and *B. tabaci* would help in spread and severity of the disease in ridge gourd.

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