

Survey, diagnosis and identification of resistant source of leaf curl virus infecting papaya (*Carica papaya* L.) in India

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Abstract

A survey conducted, at the orchards of papaya at different locations in India, revealed that the incidence of leaf curl disease ranged from 13.00–32.00 per cent and 12.00–28.00 per cent during 2006–07 and 2007–08 respectively. Maximum incidence of leaf curl (27.50%), during 2006–07, was recorded in District Etawah. Whereas, maximum leaf curl disease incidence (23.50%), during 2007–08, was recorded in Lucknow district. Symptoms of papaya leaf curl disease appeared in the form of severe distortion of leaves associated with curling and rolling of leaves, leathery leaf, vein zigzag and reduction in the size of petioles, internodes, and main shoot. As for as varietal response was concerned, maximum leaf curl incidence (80.00 and 86.67%) was observed in cultivar Co-4 followed by MF-1 (80.00 and 83.33%). While minimum leaf curl incidence (23.33 and 20.00 percent) was observed on Harichaap cultivar during 2006–07 and 2007–08, respectively. Variety Harichaap was found resistant against leaf curl disease during both the years. Six cultivars (varieties) viz., CO-2, CO-3, CO-6, Coorghoneydew, Pusa Delicious and Pusa Dwarf were rated as moderately resistant.

Introduction

Papaya (*Carica papaya* L.) is a popular and economically important fruit tree of tropical and subtropical countries in the World. Papaya provides economically important edible fruits and is considered to be one of the most important sources of vitamins A and C. In addition, papaya contains enzyme papain and chymopapain, both of which are widely used in the food industry and for medical purposes. It is consumed world-wide as fresh ripen fruit as well as vegetable besides, in the preparation of various value added products. This crop is badly affected by many biotic factors such as fungi, bacteria, viruses and nematodes. Among them viruses are the limiting factor for the cultivation of papaya in India, especially northern India. Large number of viruses have been reported time to time on papaya which belong to cucumo-, gemini-, ilar-, poty-, rhabdo-, tobra- and tospo- virus group [1]. In India, leaf curl virus is the second important virus infecting papaya, after papaya ring spot virus. It was first reported from Puerto Rico as Curly leaf [2,3]. In India, it was first reported from Coimbatore [4]. Subsequently this disease was reported from different states in India [5–7]. Leaf curl disease is characterized by severe curling, crinkling and distortion of leaves along with reduction of petiole and internodes and also the main shoot. Papaya leaf curl virus, of geminivirus group, is transmitted by whitefly (*Bemisia tabaci*) under natural conditions. Singh, *et al.* reported that whiteflies can transmit leaf curl virus to an extent of 70 % when they feed on *Ninnia elengans* plants infected with tobacco leaf curl virus [8]. Whiteflies require a latent period to become viruliferous. Verma [9] recorded 60 % incidence of this disease in Northern India. There is no much information available on the incidence of papaya leaf curl disease on different varieties of papaya and also about the characteristics of this virus. Therefore, keeping in view above fact, the present research work was carried out on survey, diagnosis and identification of resistance source of leaf curl virus infecting papaya (*Carica papaya* L.)^o in India.

Materials and methods

Survey for the incidence and symptomatology of papaya leaf curl virus

An experiment was conducted on the survey, diagnosis and characterization of leaf curl virus infecting papaya (*Carica papaya* L.)^o at the N. D. University of Agriculture and Technology, Kumarganj, Faizabad (Uttar Pradesh), India. Field survey for the incidence of viral diseases in papaya was carried out at four locations of Etawah, Faizabad, Lucknow and Varanasi districts of Uttar Pradesh. Each locality was surveyed on one year old papaya orchards only for the incidence of papaya leaf curl virus. At each location, 200 plants of papaya were tagged for recording of data on incidence and symptomatology. Observations for the incidence of leaf curl disease and type of symptoms were recorded in the field and the percent incidence of the disease was calculated by the following formula:

$$\text{Percent disease incidence} = \frac{\text{Number of infected plants in field}}{\text{Total number of plants (infected + healthy) in field}} \times 100$$

Response of different papaya varieties against artificial inoculation of papaya leaf curl virus through white flies under glass house

Seeds of 16 papaya cultivars were procured from N. D. University of Agriculture and Technology, Kumarganj, Faizabad, Uttar Pradesh,

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Indian Institute of Horticulture Research, Bangalore and Tamil Nadu Agriculture University, Coimbatore. Healthy seedlings of each variety were transplanted in the pots filled with sterilized soil. Ten pots, planted with one seedling in each, were kept as replications. The experiment was laid out under CRD with three replications. Pots were maintained in an insect free net house under natural conditions. Varietal Details are given below:

Varieties

1. CO-1
2. CO-5
3. Coorg honeydew
4. Pusa Dwarf
5. CO-2
6. CO-6
7. Wasington
8. Pusa Majesty
9. CO-3
10. CO-7
11. Pusa delicious
12. Hari Chaap
13. CO-4
14. MF-1
15. Pusa Nanha Pusa Gaint

The whiteflies (*Bemisia tabaci* Gen.), cultured on cotton plants in a separate net house were collected with the help of an aspirator and 1000 whiteflies were released on virus infected leaves under specially fabricated glass tubes for acquisition of the virus. These whiteflies were then allowed to feed on test plants (papaya seedlings) under controlled conditions for overnight. Ten whiteflies were used per test plant. After the inoculation feeding, next day seedlings were sprayed with Acephate @ 0.01% to kill the whiteflies. Observations were taken daily for the appearance of symptoms and data were recorded. Incidence of papaya leaf curl disease was recorded following 1, 2 and 3 months of transplanting. The types of symptoms appeared on the seedlings of different cultivars/varieties were also observed. Disease rating was done by using standard scale [10] as mentioned below (Table 1):

Results and Discussion

Survey for disease incidence and symptomatology of papaya leaf curl virus

Results presented in Table 2 clearly indicated that leaf curl disease incidence ranged from 13.00-32.00 per cent and 12.00-28.00 per cent during 2006-07 and 2007-08 at different locations of the Uttar Pradesh, India. Maximum disease incidence (27.50%) was recorded in District Etawah during 2006-07 whereas; during 2007-08 maximum leaf curl disease incidence (23.50%) was recorded in Lucknow district. Average disease incidence, in one year old orchards was found maximum (24.88%) at Etawah district followed by (24.00 per cent) Lucknow, (17.88 per cent) Faizabad and (17.25 per cent) Varanasi district. However, in one year papaya old orchards, maximum disease incidence recorded

Table 1. Disease rating done by using standard scale (Anonymous, 2004).

Grade	Description (average disease incidence in per cent)	Reaction/ category
I	0.00	Immune
II	0.1 – 25.0	Resistant
III	25.1 – 50.0	Moderately resistant
IV	50.1 – 75.0	Susceptible
V	75.1 – 100.00	Highly susceptible

Table 2. Survey of papaya fields in different districts for the incidence of papaya leaf curl virus disease.

S. No.	Districts/village	Papaya leaf curl virus disease incidence (%)		
		2006-07	2007-08	Mean
Etawah				
	Nagala Chhiddi	32.00	28.00	30.00
	Birari	24.00	19.00	21.50
	Jasvantnagar	26.00	16.00	21.00
	Bharathana	28.00	26.00	27.00
	Mean	27.50	22.25	24.88
Faizabad				
	Ayodhyaya	22.00	15.00	18.50
	Beekapur	20.00	18.00	19.00
	Kumarganj	19.00	20.00	19.50
	Sohawal	16.00	13.00	14.50
	Mean	19.25	16.50	17.88
Lucknow				
	Gosaiganj	24.00	28.00	26.00
	Neelmathah	26.00	25.00	25.50
	Rahamankhera	22.00	24.00	23.00
	Thakurganj	26.00	17.00	21.50
	Mean	24.50	23.50	24.00
Varanasi				
	Chirrai	13.00	16.00	14.50
	Ruhaniya	20.00	21.00	20.50
	Shivpur	23.00	18.00	20.50
	Sirkaraiya	15.00	12.00	13.50
	Mean	17.75	16.75	17.25
Over all mean		22.25	19.75	

was 22.5 per cent during 2006-07 and minimum 19.75 per cent during 2007-2008. Verma [9] reported 60.00 per cent leaf curl disease incidence in nursery and field plantations of papaya in Samastipur and Musafferpur districts of north Bihar and they reported that nurseries were apparently free from PRSV but mild to severe symptoms could be seen in one and two years old plantations. Papaya leaf curl disease was reported from different states of India [4,5,9,11]. Verma reported 60.00 per cent incidence of this disease in northern India [12].

Symptoms of papaya leaf curl disease were observed in the form of severe curling, crinkling and distortion of leaves along with reduction of petioles, internodes, and main shoot. The leaves were reduced in size and showed vein clearing. Leaf margins were rolled downwards and inwards forming the shape like inverted cups. In some cases, leaf margins rolled upwards. The leaves of infected plants turned dark-green and become leathery and brittle. The interveinal areas of affected leaves were much raised on upper surface due to uneven growth and twisting of veins. The petioles were twisted in a zigzag manner and bend towards the main trunk. Affected plants failed to flower and in case of occasional flowering, they bear a few small and abnormal fruits. In advanced stage of disease, defoliation takes place and growth of the plants was arrested (Figure 1). It has been reported that symptoms of leaf curl disease were exhibited in the form of severe curling, crinkling,



Figure 1. Symptoms caused by leaf curl virus on papaya plants.

Table 3. Response of different papaya varieties against artificial inoculation of papaya leaf curl virus through white flies under glass house.

Varieties	Papaya leaf curl disease incidence (%)					
	2006-07			2007-08		
	20 DAI	40 DAI	60 DAI	20 DAI	40 DAI	60 DAI
CO-1	20.00	43.33	56.67	23.33	46.67	63.33
CO-2	13.33	23.33	36.67	16.67	26.67	46.67
CO-3	10.00	23.33	36.67	13.33	20.00	43.33
CO-4	36.67	66.67	80.00	40.00	73.33	86.67
CO-5	30.00	53.33	66.67	26.67	60.00	73.33
CO-6	16.67	30.00	43.33	13.33	33.33	46.67
CO-7	33.33	63.33	76.67	26.67	60.00	83.33
MF-1	40.00	66.67	80.00	43.33	60.00	83.33
Coorghoneydew	16.67	30.00	43.33	20.00	36.67	50.00
Washington	26.67	50.00	63.33	23.33	53.33	66.67
Pusa Delicious	10.00	23.33	36.67	6.67	23.33	33.33
Pusa Nanha	23.33	40.00	53.33	26.67	36.67	60.00
Pusa Dwarf	16.67	30.00	43.33	20.00	36.67	50.00
Pusa Mejasty	30.00	53.33	66.67	33.33	63.33	63.33
Pusa Gaint	23.33	40.00	53.33	20.00	36.67	56.67
Harichaap	6.67	13.33	23.33	10.00	16.67	20.00
SEm ±	1.05	1.75	2.40	1.25	1.98	2.87
C.D. at 5 %	2.86	4.76	6.53	3.40	5.39	7.81

Table 4. Response of papaya varieties against papaya leaf curl diseases under field conditions during 2006-07 and 2007-08.

Category	Grade	Disease Incidence	Varieties	
			2006-07	2007-08
Immune	1	0.00	Nil	Nil
Resistant	2	0.1 – 25.0	Harichaap	Harichaap
Moderately resistant	3	25.1 – 50.0	CO-2, CO-3, CO-6, Coorghoneydew, Pusa Delicious and Pusa Dwarf	CO-2, CO-3, CO-6, Coorghoneydew, Pusa Delicious and Pusa Dwarf
Susceptible	4	50.1 – 75.0	CO-1, CO-5, Washington, Pusa Nanha, Pusa Mejasty and Pusa Gaint	CO-1, CO-5, Washington, Pusa Nanha, Pusa Mejasty and Pusa Gaint
Highly susceptible	5	75.1 – 100.00	CO-4, CO-7, MF-1	CO-4, CO-7, MF-1

distortion of leaves, reduction of petioles, internodes and main shoot, vein enation and stunting of plants [5,12-14].

Response of different papaya varieties against artificial inoculation of papaya leaf curl virus through white flies under glass house

Data pertaining to leaf curl incidence on different cultivars (Table 3) exhibited maximum leaf curl incidence (80.00 and 86.67%) in cultivar Co-4 followed by MF-1 (80.00 and 83.33%), Co-5 (66.67 and 73.33%), Washington (63.33 and 66.67%) at 60 days after inoculation during 2006-07 and 2007-08, respectively. While minimum leaf curl incidence of 23.33 and 20.00 per cent was observed on Harichaap cultivar during 2006-07 and 2007-08, respectively. Papaya varieties were categorized as immune to highly susceptible on the basis of disease incidence. Out of 16 varieties, none of the variety was found immune against leaf curl disease. Variety Harichaap was found resistant against leaf curl disease during both the years. While, six varieties viz., CO-2, CO-3, CO-6, Coorghoneydew, Pusa Delicious and Pusa Dwarf were rated as moderately resistant, six varieties viz., CO-1, CO-5, Washington, Pusa Nanha, Pusa Mejasty and Pusa Gaint as susceptible and three varieties viz., CO-4, CO-7 and MF-1 as highly susceptible during both the years (Table 4).

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