Asian Journal of Soil Science and Plant Nutrition

Volume 10, Issue 3, Page 144-152, 2024; Article no.AJSSPN.118661
ISSN: 2456-9682

Screening of Chilli Genotypes for Resistance to Leaf Curl Virus

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/ajsspn/2024/v10i3326

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/118661

Original Research Article

Received: 07/04/2024
Accepted: 11/06/2024
Published: 15/06/2024

ABSTRACT

Leaf curl virus disease is a most destructive threat to chilli production. In the present investigation 54 chilli genotypes were screened for leaf curl virus resistance in the natural epiphytotic field conditions and artificial inoculation using viruliferous white flies at Horticulture Research and

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Cite as: Palled , Apoorva, Raveendra Jawadagi, Shashikanth Evoor, Satish D, Ravi Kumar, and Vinaykumar M Mudenur. 2024. "Screening of Chilli Genotypes for Resistance to Leaf Curl Virus". Asian Journal of Soil Science and Plant Nutrition 10 (3):144-52. https://doi.org/10.9734/ajsspn/2024/v10i3326.

Extension Centre (University of horticulture science, Bagalkot) during 2020-2023. The genotypes DCA-262, Khandhari and Bhoot Jolokia were found to be immune and genotypes EC 391087 (9%), IC 342426 (5%), Punjab Lal (7%), Punjab Surkh (9%) were found to be highly resistant to leaf curl virus under natural conditions. Screening with artificial inoculation confirmed that the genotypes Khandhari and Bhoot Jolokia were found to be immune and genotypes EC 391087 (11%), Punjab Lal (10%), Punjab Surkh (10%) were highly resistant to leaf curl virus. The checks Byadgi Dabbi (100%) and Byadgi Kaddi (98%) were found to be highly susceptible in both natural and artificial conditions.

Keywords: Chilli leaf curl virus; resistance; screening; genotypes; white fly; host plant resistance.

1. INTRODUCTION

The chilli crop yield is adversely affected due to leaf curl disease, caused by Chilli leaf curl virus [1] belonging to genus Begomovirus and family Geminiviridae [2]. It causes the greatest damage regarding disease incidence and yield loss. There have been reports of 100% losses of marketable fruit in extreme circumstances [3,4]. White fly (*Bemisia tabaci*) acts as a vector for the transmission of virus into the host plant. Common symptoms include leaf puckering, curling, and rolling; blistering of the veinous regions; vein thickening and swelling; internode and petiole shortening; leaf crowding; and overall plant stunting [5,6,7,8]. Evasive techniques have been attempted with varying degrees of success, including agronomic treatments, sick plant removal, and pesticide applications to suppress vectors. Managing the disease with pesticides is great challenging because of recurrent development of resistance against pesticides by whitefly [9,10,11,12]. Utilizing host plant resistance is a long-term, cost-effective, environmentally secure, and reliable method of managing diseases, particularly those brought on by viruses. Wild relatives or accessions of the cultivated species are renowned for their wealth of useful genes including those of disease resistant [13]. Therefore, the goal of the current study was to screen chilli genotypes under natural epiphytotic and artificial conditions using viruliferous whiteflies to identify the source of resistance to the chilli leaf curl virus.

2. MATERIALS AND METHODS

The present investigation on screening and identification of chilli leaf curl virus resistant genotype in chilli was carried out at Horticulture Research and Extension Centre, (University of Horticulture Science, Bagalkot) during 2020-2023. The experimental material consisting of 54 genotypes during 2020-21. The experiment was laid out in Randomised Block Design with two replications and two checks. Seedlings of chilli genotypes were raised in protrays and 35 days old seedlings were transplanted at a distance of 60 x 45 cm in the month of January during the summer season. The experimental site and season were found to be favourable for white fly build up in the past years [14]. Susceptible check genotypes were planted at every 6th row after 5 rows of chilli genotypes under investigation. All the recommended cultural practices were followed. The virus scoring was carried out at an experimental plot during early and grand growth stages. For artificial screening under mass inoculation conditions, chilli genotypes were raised and challenged by viruliferous white fly population maintained on susceptible symptomatic chilli plants in the wooden cage covered with nylon net. Adult virulent whiteflies collected from the symptomatic plants were given an acquisition access period (AAP) of 48 hrs on the genotypes under investigation. Seedlings were inoculated at the three-leaf stage, using 10–12 viruliferous whiteflies per seedling for an inoculation access period (IAP) of 48 hrs. Seedlings were then transplanted in an open field condition and disease incidences were scored.

Observation recorded: Ten plants in each genotype in each replication were randomly selected, tagged and the disease index observations were recorded from the tagged plants in both natural screening as well as artificial screening. The leaf curl index was calculated for each chilli genotypes based on the ratings using the scale followed by Kumar et al. [15]. From the recorded observation percent disease incidence (PDI) and disease severity were calculated. Based on the genotype performance against leaf curl virus reaction, they were categorized into six categories by adopting the method of Reddy et al. [16].

Percent disease incidence (PDI): The incidence of leaf curl virus was calculated by

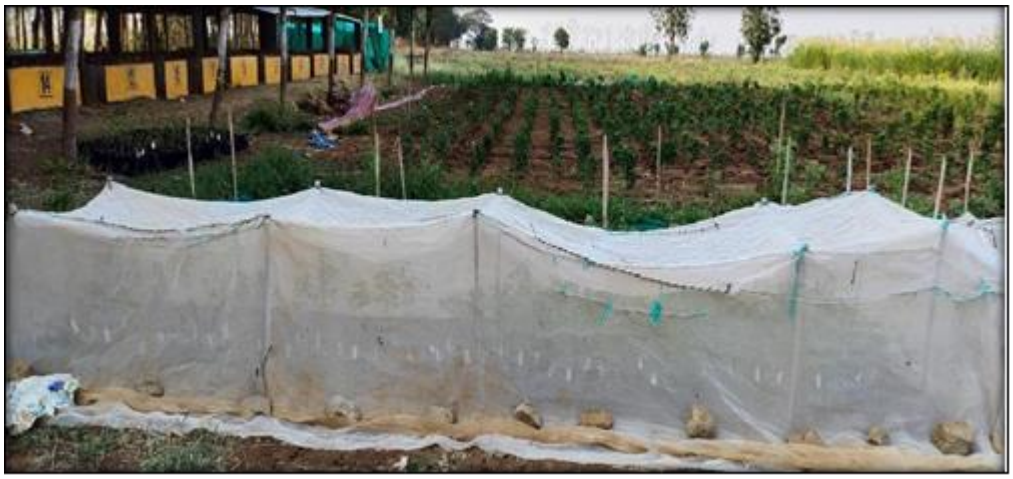

Fig. 1. Screening the genotypes under artificial inoculation method

Table 1. Indexing of leaf curl virus in chilli

Symptom severity grade	Symptoms	Reaction (%)	Category
0	No symptom	0	Immune
1	0-5% Curling and clearing of upper leaves	1 – 10	Highly Resistant
2	6-25% Curling, clearing of leaves and swelling of veins	11 – 25	Resistant
3	26-50% Curling, puckering and yellowing of leaves and swelling of veins	26 – 40	Moderately Resistant
4	51-75% leaf curling and stunted plant growth and blistering of internodes	41 – 60	Susceptible
5	>75% curling and deformed small leaves, stunted plant growth with small flowers and no or small fruit set	>60	Highly Susceptible

using the following formula developed by [15] and statistically analysed.

Percent disease incidence (%) =(Number of diseased plants/ Total number of plants observed) × 100

Disease severity: The severity of chilli leaf curl virus was calculated by using the following formula developed by [17] and statistically analysed.

Diversity severity =(∑ (Disease class × No. of plants in each class)/ Total No. of plants selected × Maximum disease grade) × 100

3. RESULTS AND DISCUSSION

There was high phenotypic variation for leaf curl virus disease incidence and severity among chilli genotypes studied. It ranged from 0 to 100 per cent within the evaluated genotypes. No disease incidence and severity were observed in Bhoot Jolokia (*Capsicum chinense*), Khandhari, DCA-262 (*Capsicum frutescence*). In species *Capsicum annuum* EC 391087 (9%), IC 342426 (5%), Punjab Lal (7%), Punjab Surkh (9%) were found to be highly resistant having least disease incidence and severity.

Under artificial screening, a significant variance was observed in the leaf curl virus incidence and severity among the genotypes investigated. The disease severity ranged from 0 to 100 per cent, lowest was observed in Khandhari (*Capsicum frutescence*) and Bhoot Jolokia (*Capsicum chinense*) with 0 per cent disease incidence showing immunity to virus. Genotypes DCA-262 (6%), Punjab Lal (10%) and Punjab Surkh (10%)

were found to be highly resistant to leaf curl virus. The highest per cent of disease incidence was observed in Byadgi Kaddi, Byadgi Dabbi and followed by Shankershwar with disease severity of 100%, 98% and 97% respectively and were found to be highly susceptible.

Based on the observed data and calculated disease incidence and severity it was obtained that Bhoot Jolokia, Khandhari and DCA-262 were immune to leaf curl virus disease. Similar results were observed by [18,19]. Genotypes EC 391087, IC 342426, Punjab Lal and Punjab Surkh were found highly resistant to virus. Similar results were observed by several workers [20,21,15,19]. The native resistance of these genotypes to the virus was further confirmed with the artificial inoculation in the presence studies. Hence, the resistance observed was not due to any kind of escape or non-preference of whitefly during screening but due to resistance mechanism present in these genotypes that either hinder virus replication or its movement throughout the plant [22]. The resistance gene or allele that prevails in these genotypes is the most appropriate reason for observed resistance and immunity to leaf curl virus. Identification of new and stable chilli genotypes that are immune to leaf curl virus infection through different methods of screening is quite crucial for adopting them in chilli crop improvement program.

Fig. 2. Susceptibility of chilli genotypes to chilli leaf curl virus

Fig. 3. Resistance of chilli genotypes to chilli leaf curl virus

Table 2. Reaction of chilli genotypes screened against leaf curl virus

Sl No	Genotypes	Natural screening			Artificial screening		
		Per cent disease index (%)	Disease severity (%)	Disease reaction	Per cent disease index (%)	Disease severity (%)	Disease reaction
1	EC 378633	86.67	80	HS	91.67	83	HS
2	EC 378688	73.33	54	S	78.33	61	HS
3	EC 391082	23.33	17	R	28.33	23	R
4	EC 391083	30.00	20	R	30.00	24	R
5	EC 391087	10.00	9	HR	20.00	11	R
6	EC 596952	76.67	51	S	81.67	58	S
7	EC 599993	70.00	69	HS	75.00	74	HS
8	IC 214965	36.67	36	MR	45.00	39	MR
9	IC 214966	26.67	17	R	31.67	23	R
10	IC 284628	20.00	12	R	23.33	21	R
11	IC 342426	10.00	5	HR	18.33	14	R
12	IC 342464	23.33	12	R	33.33	19	R
13	IC 537595	76.67	54	S	86.67	64	HS
14	IC 537657	46.67	36	MR	56.67	43	S
15	IC 537658	36.67	29	MR	45.00	37	MR
16	IC 537659	43.33	32	MR	50.00	40	MR
17	IC 537661	40.00	36	MR	48.33	45	S
18	IC 570388	60.00	45	S	66.67	60	S
19	IC 572454	66.67	52	S	78.33	65	HS
20	IC 572465	63.33	50	S	73.33	58	S
21	IC 572466	56.67	39	MR	65.00	50	S
22	IC 572475	90.00	80	HS	95.00	88	HS
23	IC 572477	93.33	84	HS	96.67	90	HS
24	Nic 23897	83.33	73	HS	91.67	77	HS
25	Nic 23906	90.00	80	HS	93.33	83	HS
26	DCA-111	33.33	26	MR	38.33	34	MR
27	DCA-245	90.00	80	HS	93.33	87	HS
28	DCA-299	80.00	57	S	88.33	65	HS
29	DCA-226	36.67	21	MR	45.00	31	MR
30	DCA-255	43.33	25	R	53.33	33	MR

Sl No	Genotypes	Natural screening			Artificial screening		
		Per cent disease index (%)	Disease severity (%)	Disease reaction	Per cent disease index (%)	Disease severity (%)	Disease reaction
31	DCA-92	83.33	59	S	90.00	68	HS
32	DCA-86	86.67	82	HS	95.00	90	HS
33	DCA-195	86.67	79	HS	91.67	88	HS
34	DCA-257	76.67	58	S	85.00	70	HS
35	DCA-107	73.33	55	S	80.00	66	HS
36	DCA-131	83.33	60	S	91.67	68	HS
37	LCA 305	30.00	20	R	43.33	28	MR
38	LCA 324	36.67	27	MR	46.67	32	MR
39	KDSC 210-10	46.67	31	MR	53.33	34	MR
40	Hissar Vijay	30.00	21	MR	35.00	25	R
41	Pant C1	26.67	19	R	35.00	25	R
42	Pusa Jwala	33.33	17	R	35.00	23	R
43	G-4	93.33	87	HS	96.67	90	HS
44	DCA-262 (Capsicum frutescence)	0.00	0	I	13.33	6	HR
45	Khandhari	0.00	0	I	0.00	0	I
46	Bhoot Jolokia	0.00	0	I	0.00	0	I
47	Punjab Lal	6.67	7	HR	13.33	10	HR
48	Punjab Tej	23.33	13	R	28.33	20	R
49	Punjab Sindhuri	20.00	12	R	25.00	19	R
50	Punjab Surkh	16.67	9	HR	20.00	10	HR
51	Suraj Mukhi	36.67	23	R	46.67	30	MR
52	Byadgi Kaddi	100.00	98	HS	100.00	98	HS
53	Byadgi Dabbi	100.00	100	HS	98.33	100	HS
54	Shankeshwar	96.67	97	HS	93.33	95	HS
	S.Em±	1.50	1.50		3.38	3.38	
	C.D. at 5%	4.24	4.24		9.58	9.58	
	C.D. at 1%	5.65	5.65		12.76	12.76	

Table 3. Categorization of chilli genotypes for resistance to leaf curl virus based on virus symptoms under natural condition

Disease reaction	No. of genotypes	Genotypes
Immune	3	DCA-262 (*Capsicum frutescence*), Khandhari, Bhoot Jolokia
Highly resistant	4	EC 391087, IC 342426, Punjab Lal, Punjab Surkh
Resistant	12	EC 391082, EC 391083, IC 214966, IC 284628, IC342464, LCA 305, Pant C1, Pusa Jwala, Punjab Tej, Punjab Sindhuri, DCA-255, Suraj Mukhi
Moderately resistant	11	IC 214965, IC 537657, IC537658, IC537659, IC537661, IC572466, DCA-111, DCA-226, LCA 324, KDSC 210-10, Hissar Vijay
Susceptible	11	EC378688, EC596952, IC537595, IC570388, IC572454, IC572465, DCA-299, DCA-92, DCA- 257, DCA-107, DCA-131
Highly susceptible	13	EC378633, EC599993, IC572475, IC572477, Nic-23897,Nic-23906,DCA-245,DCA-86, DCA-195, G-4, Byadgi Kaddi, Byadgi Dabbi, Shankeshwar

Table 4. Categorization of chilli genotypes for resistance to leaf curl virus based on virus symptoms under artificial condition

Disease reaction	No. of genotypes	Genotypes
Immune	2	Khandhari (*Capsicum frutescence*), Bhoot Jolokia
Highly resistant	3	DCA-262, Punjab Lal, Punjab Surkh
Resistant	12	EC 391087, IC 342426, EC 391082, EC 391083, IC 214966, IC 284628, IC342464, Hissar Vijay, Pant C1, Pusa Jwala, Punjab Tej, Punjab Sindhuri
Moderately resistant	10	IC 214965, IC537658, IC537659, DCA-111, DCA- 226, LCA 324, KDSC 210-10, LCA 305, DCA-255, Suraj Mukhi
Susceptible	6	EC 596952, IC 537657, IC 537661, IC 572466, IC 570388, IC 572465,
Highly susceptible	21	EC 378688, EC 378633, IC 537595, EC 599993, IC 572475, IC 572454, IC 572477, Nic-23897, Nic-23906, DCA-299, DCA-92, DCA-257, DCA-107, DCA-131, DCA-245, DCA-86, DCA-195, G-4, Byadgi Kaddi, Byadgi Dabbi, Shankeshwar

The genotypes were categorized into 6 groups based on their reaction to leaf curl virus. From disease severity per cent, it is evident that 3 genotypes were found to be immune to virus, 4 genotypes were highly resistant, 12 were resistant, 11 were moderately resistant, 11 were susceptible and 13 were found to be highly susceptible to leaf curl virus during natural screening. In case of artificial screening by mass inoculation of virulent white flies, it was observed that 2 genotypes were found to be immune, 3 genotypes were highly resistant, 12 genotypes were resistant, 10 genotypes were moderately resistant, 6 genotypes were susceptible and 21 genotypes exhibited highly susceptible reaction to leaf curl virus. Total 18 genotypes exhibited different reaction to leaf curl virus in natural and artificial screening, this is because of forced inoculation to viruses into the plant system through vectors in artificial screening. In case of

natural screening there may be chances of escapism of virus infestation by vectors [23]. Total of 36 chilli genotypes exhibited similar reaction to virus in both natural and artificial screening imparting the resistance is due to the genetic make up of these genotypes against virus. The standard susceptible check Byadgi Dabbi and Byadgi Kaddi exhibited complete susceptibility to leaf curl virus which confirms the effective screening program [24,25].

4. CONCLUSION

Identification of new and stable chilli genotypes that are immune to leaf curl virus infection through different methods of screening and adopting in breeding program is crucial for chilli crop improvement.The investigation on chilli genotypic reaction for leaf curl virus infection, sources of resistance, were conducted for effective resistance breeding program. The promising genotypes identified that are resistant to leaf curl virus include EC 391087, IC-342426, Punjab Lal, Punjab Surkh, IC-284628, IC-342464, Punjab Tej and Punjab Sindhuri. These genotypes can be further utilised for effective breeding and development of multiple disease resistant chilli varieties.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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