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Spatial Distribution of Chilli Leaf Curl Virus Disease in Northern Karnataka

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A B S T R A C T

Chilli (genus Capsicum, family Solanaceae) is an important food commodity used as vegetable, spice, medicinal herb and ornamental plant across the world. One of the main constrains hindering its cultivation is leaf curl disease caused by *Chilli leaf curl virus* (ChiLCV). This is the most devastating virus diseases of chilli in the world. Due to its continuing and rapid spread, leaf curl disease epidemics are observed across the agro climatic regions of India. Information of its distribution, severity, host cultivars and vector abundance helps in determining its management. In the present study, spatial distribution of chilli leaf virus disease in chilli growing North Karnataka is undertaken during 2019-20. Roving survey conducted revealed the incidence of ChiLCV across the region ranging from 2.5 % to 100%. Among the seven districts surveyed, highest average disease incidence of 42.53 per cent was noticed in Gadag district followed by Vijayapura (33.17%), Raichur (32.32%), Bagalkot (30.22%), Yadgir (30.16%), Koppal (29.79%) and lowest in Ballari district (16.74). Varying range of symptoms *viz*. upward curling, stunted growth, vein thickening and bushy appearance were predominantly recorded during the survey. Vector population was recorded in all the plots visited and was high in severely infested plots. Weeds around the infested chilli plots had virus symptoms, which may shelter the virus and vector during off season. Irrespective of soil types incidence of ChiLCV was found in all the cultivars grown. This information helps in identifying the virus and vector free areas for successful chilli cultivation and also develops suitable and effective chilli leaf curl disease management strategies.

Introduction

Chilli (*Capsicum annuum* L.) is one of the most valuable cash crops of India, widely cultivated as spice and vegetable crop and the country is leading the world in chilli production with 13.76 (36.57%) million tonnes per annum (Geetha and Selvarani, 2017). Andhra Pradesh is the largest producer of chilli contributing 26 per cent of national production followed by Maharashtra (15%), Karnataka (11%), Orissa (11%) and Madhya Pradesh (7%). Rest of the states contributes 22 per cent of the total area under chilli (Peer

et al., 2020). It is a richest source of vitamin C and A, has high iron, potassium and magnesium with the ability to boost immune system and lower the cholesterol levels (Grubben and Mohamed, 2004). With multiple benefits, the red chilli is gaining huge profit since three years, as a result more farmers are engaging in its cultivation across the Karnataka especially in Northern Karnataka. However, the threat of diseases, especially virus disease is hindering its potential productivity across many districts of the region.

The virus diseases are considered as major factors of yield limiting (Villalon, 1981) in chilli. So far 65 viruses have been reported to infect chilli of which, Chilli Leaf Curl Virus Disease (ChiLCVD) is infecting chilli throughout the world (Nigam *et al.*, 2015) and these viruses together cause huge economic losses of about 15billion US Dollar per annum worldwide (Van Fanbing, 1999).

Abundant vector populations, wide host range, emergence of new viral strains are contributing to increased incidence of chilli leaf curl disease. Prolonged dry spells, favourable weather conditions are favouring increased vector population build up during the chilli growing season (Raju, 2010; Manjesh, 2018 and Sudhapatil, 2018) and hence, the disease is exponentially spreading annually. Unless the disease spread across the regions is understood, it's difficult to formulate or develop suitable control measures as is vector borne.

The present study was aimed to identify spatial distribution of chilli leaf curl disease in chilli growing districts of Northern Karnataka. In order to support the studies of its epidemiology, collection of information related to cropping system, soil type and weather conditions which are pre-requisite to take final decision on sustainable disease management practices were also considered.

Materials and Methods

A roving survey on the incidence of *Chilli leaf curl virus* was conducted during ***rabi*** 2019-20 in major chilli growing districts of North Karnataka Region *viz.,* Gadag, Vijayapura, Raichur, Bagalkot, Yadgir, Koppal and Ballari district. Five villages from each taluk of respective district were chosen for survey (Figure 1).

Disease incidence at visit was recorded in each field visited by visual examination and counting number of plants infected out of total plant population from $5m^2$ area selected randomly in three spots of each plot visited. Minimum two plots from each village were visited covering five villages in each taluk. Later per cent disease incidence was calculated using the formula mentioned. During the survey, data on different types of symptoms observed on chilli, variety/hybrid grown, crop types (irrigated / rainfed), age of the crop, its surrounding crop / weeds, plant protection measures followed by grower, vector density and Global Positioning System (GPS) way points were also recorded. The data collected were imported to draw the spatial map of leaf curl disease distribution using the software.

$$\text{Disease incidence (\%)} = \frac{\text{Number of diseased plants}}{\text{Total number of diseases plant}} \times 100$$

Results and Discussion

Roving survey was conducted during ***rabi*** 2019-20 in major chilli growing regions of Northern Karnataka to assess the incidence of chilli leaf curl virus disease infecting chilli. The field survey conducted revealed invasive and exhaustive information on its current status and distribution across the plots visited and surveyed.

The survey data presented in Table 1 revealed

the prevalence of chilli leaf curl virus disease in all the districts surveyed. Disease incidence ranged from a minimum of 14.51 per cent to complete failure of crop. Maximum disease incidence of 53.54 per cent was recorded from Gadag taluk of Gadag District and minimum incidence of 14.51 per cent was recorded in Ballari taluk of Ballari district. The district wise data indicated that maximum incidence of disease was observed in Gadag (42.53%) followed by Vijayapura (33.17%), Raichur (32.32%), Bagalkot (30.22%), Yadgir (30.16%), Koppal (29.79%) and with minimum incidence in Ballari (16.74%) (Figure 1).

Table.1 Mean incidence of *Chilli leaf curl virus* disease in different talukas and their respective districts in North Karnataka region

District	Taluk	Mean	District mean
Bagalkot	Bagalkot	31.62	**30.22**
	Badami	34.59	
	Hungund	24.48	
	Mudhol	30.19	
Ballari	Ballari	14.51	**16.74**
	Sandur	19.84	
	Siruguppa	15.88	
Gadag	Nargund	42.47	**42.53**
	Mundargi	49.42	
	Gajendraghad	39.63	
	Rona	43.84	
	Laxmeshwar	46.99	
	Shirahatti	21.87	
	Gadag	53.54	
Koppal	Koppal	41.70	**29.79**
	Kustigi	16.15	
	Yelburga	31.51	
Raichur	Raichur	41.75	**32.32**
	Devadurga	40.26	
	Manvi	23.68	
	Lingasugur	27.75	
	Sindhanur	28.16	
Vijayapura	Vijayapura	36.93	**33.17**
	Indi	31.36	
	Sindgi	28.19	
	Basavana Bagevadi	36.90	
	Muddebihal	32.47	
Yadgir	Yadgir	20.74	**30.16**
	Shahapur	39.58	

Fig.1 GIS map of spatial distribution of *Chilli leaf curl virus* disease incidence in chilli during *rabi*-2019-20 at North Karnataka region

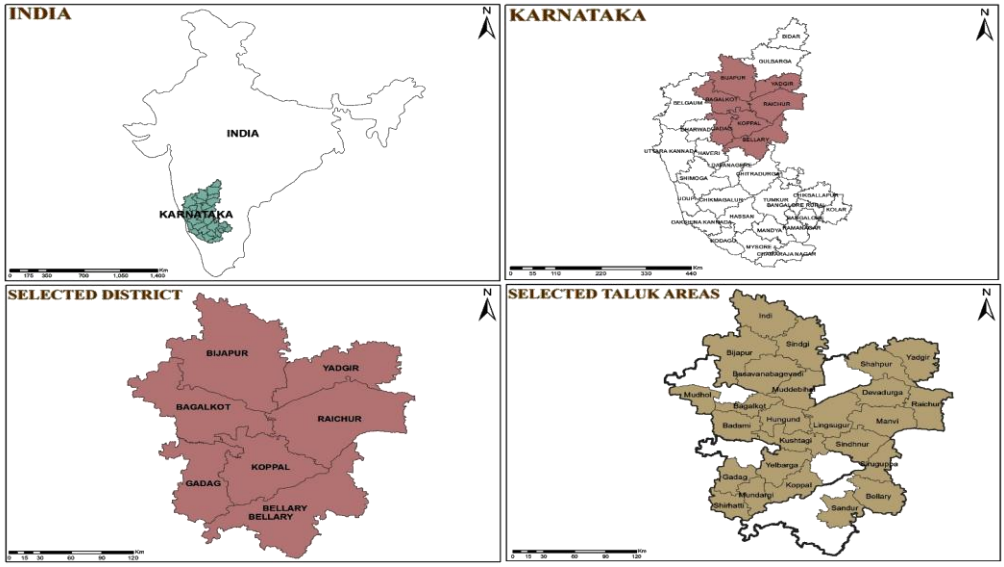

Fig.2 Different symptoms observed during survey of chilli leaf curl disease in North Karnataka region

Boat shaped leaves

Stunted growth

Vein thickening

Curling of leaves

Crowding of leaves

Yellowing of leaves

Observations made during the survey indicated that, majority of chilli plots visited showed severe curling of leaves in both upward and downward directions with puckering, crinkling of leaves, bushy appearance, stunted growth, reduced leaf size, leaf distortion, stunting and blistering, defoliation and, fewer and smaller fruits were the other characteristic symptoms observed (Figure 2). During survey, the major symptoms observed was severe leaf curling, stunting and vein thickening of the plants. Upward curling, puckering of leaves produced by thrips as reported by Reddy (1983) was also noticed along with mite infestation induced symptoms *viz*., downward curling, crinkling of leaves and elongation of leaf petiole.

The symptoms on infected plants varied from distortions to various types of colour deviations. Fruit distortions included surface roughness, twisting and malformation. The chilli fruits showed mottling of varying intensities. The fruits became reddish brown or dirty brown 1-2 days before ripening.

During the survey, in the field conditions the symptoms of leaf curl virus was observed on different kind of weed host *viz., Croton sp., Euphorbia sp., Cassia tora., Acalypha sp., Ageratum conyzoides., Amaranthus sp.,* and *Parthenium sp.,* were noticed adjacent to surveyed plots carrying symptoms such as mosaic, curling, crinkling, yellowing and vein clearing.

In addition to the chilli, the symptoms were also observed on other Crops like tomato, brinjal, Mesta, cucurbits occupying space either in main field as well as on bunds around surveyed plots which are considered to be a shelter for whitefly as well as virus.

The disease symptoms observed on chilli plants were similar to the findings made by Raju (2010), Sudhapatil (2018), Manjesh (2018) and Bhagavathidevi *et al.,* (2019) stated that growing of susceptible local cultivars prevailing in the districts as for multiplication and spread of virus and monocropping of chilli.

Variation in the disease incidence and symptoms *i.e.,* upward curling, malformation, reduction in leaf areas were observed due to differences in cultivars, time of infection and climatic conditions as reported by Abu-Kasim (1986). Previously, similar field symptoms on have been reported by Fujisawa *et al.,* (1986) in Japan, Cerkauskas *et al.,* (2004) in Taiwan, Hussain *et al.,* (1995) in Pakistan and uday *et al.,* (2017) in India

Individual plants showing severe leaf curl with typical cup-shaped, upward curling of leaves and yellowing and their association with sucking pest complex was not noticed in this study. Such symptoms are characteristic of begomoviruses in chilli as described by Chattopadhyay *et al.,* (2008) and Shafiq *et al.,* (2010).

Vector population with disease was noticed in all the plots visited but population was varying depending upon the cultivation practices followed. In some cases farmers found spraying insecticides intensively but, could not free the plants from virus. The crop was already infested either during seedling stage or early vegetative stage after transplanting. Weeds around the infested chilli plots had virus symptoms, which may shelter the virus and vector during off season. Irrespective of soil types incidence of ChiLCV was found in all the cultivars grown. This information helps in identifying the virus and vector free areas for successful chilli cultivation and also develops suitable and effective chilli leaf curl disease management strategies.

In conclusion the study on spatial variability of chilli leaf curl disease concludes that, the disease incidence varied across the study area, which was mainly due to presence of varied vector population density, alternate hosts of vector and virus for survival and spread during off season. Although farmers are following intensive management practices against the vector but efforts are adding to increased cost of cultivation. The information gathered could guide in formulating effective management strategies for Chilli leaf curl virus disease in chilli and its vector effectively. The observations gathered also guide on necessary practices to be followed especially sanitisation to free the alternate hosts of virus and vector. The areas with low virus and vector load could be helpful in growing disease-free crop also.

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