Current scenario of viral diseases of *Capsicum spp*. in Karnataka, India

ABSTRACT

The roving survey was conducted in major capsicum growing districts of Karnataka to know the incidence of viral disease in *Capsicu*m.The study revealed that the viral disease in capsicum was prevalent in all the surveyed districts of Karnataka. Among the districts surveyed, significantly highest disease incidence was recorded in Haveri (89%), followed by Belagavi (84%), Chikkaballapur (76%) and Kolar (60%) whereas the significantly least disease incidence was recorded in Bengaluru rural (43.33%). The average percent disease incidence in overall surveyed districts was 70.46%. Similarly, among the taluks, significantly highest disease incidence of 92% was recorded in Byadgi followed by Ramdurga (86.66%), whereas the significantly least disease incidence of 43.33% was recorded in Nelamangala. Similarly, among the villages, significantly highest disease incidence of 100% was recorded in Bannahatti village of Byadgi, whereas the significantly least disease incidence of 20% was recorded in Tadshigatta village of Nelamangala.Among the districts surveyed, significantly highest percent disease index was recorded in Haveri (60%), followed by Belagavi (37%), Kolar (30.50%) and Chikkaballapur (30.33%), whereas the significantly least percent disease index was recorded in Bengaluru rural (13.33%). Similarly, among the taluks, significantly highest percent disease index of 72.50% was recorded in Byadgi followed by Savanur (47.50%), whereas the significantly least percent disease index of 13.33% was recorded in Nelamangala. Similarly, among the villages surveyed, significantly highest percent disease index of 95% was recorded in Bannahatti village of Byadgi, whereas significantly least percent disease index of 5% was recorded in Tadshigatta village of Nelamangala.The average per cent disease index in overall surveyed districts was 34.23%.

Key words: *Capsicum*, virus disease, survey, Karnataka

INTRODUCTION

Capsicum(*Capsicum annuum* L.) is one of the important commercial crop grown in India mainly for its fruits. It is native to the Central and South America and is one of the most

important vegetables in the family *Solanaceae* (2n=24). Bell Pepper is good source of vitamin C. It has both nutritional and nutraceautical importance. The benefits resulting from the use of natural products rich in bioactive substances has promoted the growing interest of food industries.

Capsicum is one of the most popular and highly remunerative crops cultivated in most parts of the world, especially in temperate regions of Central and South America, European countries, tropical and subtropical regions of Asian continent mainly in India and China. Asia produces 65.8% of world green chillies and pepper and stands at the top; Europe stands 2nd contributing 12.1% and Africa stands 3rd with 9.5% of world production. Chillies produced in Asia are mainly of hot types, whereas African countries produce both hot and mild types (paprika) and European production is predominantly of mild type. China is first in the world in area and production of green chillies and peppers and Spain tops in terms of productivity (46.90 tons/ha). China, Turkey, Mexico, Spain, USA, Indonesia and Nigeria etc., are the major producers of green chilli and pepper (Anon. 2007).

In India, the total production of capsicum is 4,96,000 MT from an area of 34,000 ha with the productivity of 7109 kg per hectare. It is extensively cultivated in Karnataka, Madhya Pradesh, Andhra Pradesh, Maharashtra, Tamil Nadu, Himachal Pradesh, and hilly areas of Uttar Pradesh. In Karnataka, the total production is 65,270 MT from an area of 3,820 ha and major capsicum growing districts are Kolar, Mandya, Belgaum, Haveri, Chikballapur and Hassan (Anon. 2018).

Capsicum has been attacked by number of fungi, bacteria and viruses. Besides *Phytophthora* fruit rot, bacterial wilt and canker, viral diseases are most common cause of losses as they affect both quantity and quality of the produce and they are most difficult to control.

Viral diseases often cause extensive losses of peppers worldwide. Potyvirus, tobamovirus, tospovirus, begomovirus and *Cucumber mosaic virus* (CMV) are the most common viruses infecting *Solanaceae* crops (Green, 1991; Pernezny *et al.*, 2003). At least 67 viruses of 25 genera have been reported to infect peppers (Green & Kim, 1994; Pernezny *et al.*, 2003).

For epidemiological investigations, resistance breeding and plant virus collections, the determination of the species or even the strains are desirable. Reverse transcriptase PCR (RT–PCR) is used to identify RNA plant viruses. This procedure is rapid, specific and sensitive and PCR-based methods are useful in high-through put applications (Walsh *et al.*, 2001).

There was no much research work carried out on capsicum viral disease complex in Karnataka. Therefore, there was a need to study in detail about the different viruses involved in causing the disease. Hence, by considering the overall increase in the problem of virus disease complex in capsicum in the recent past with heavy economic losses, the present study was planned.

MATERIALS AND METHODS

The survey was conducted in the major capsicum growing areas *viz*., Haveri, Belgaum, Kolar, Chikkaballapur and Bengaluru rural districts for incidence of virus disease complex during the year 2019-20. In each district two important taluks and five plots for each taluk was surveyed for recording percent disease incidence and percent disease index. Observations *viz*., location, area, variety, stage of the crop, incidence (%) and severity (%) was recorded. And the different type of symptoms produced by capsicum virus disease were observed and recorded. The percent disease incidence and percent disease index was calculated by using the below mentioned formula.

$$\textbf{Per cent Disease Incidence} = \frac{\text{Number of diseased plants}}{\text{Total number of plants observed}} \times 100$$

$$\textbf{Per cent Disease Index} = \frac{\Sigma \text{ (Disease class x No. of plants in each class)}}{\text{Total no. of plants selected x maximum disease grade}} \text{ x } 100$$

Table 1: Disease rating scale given by Bashir and Zubair(2005).

Disease severity Index (disease grade)	Percentage of Infection
0	Free from infection
1	1-10% infection
2	11-20% infection
3	21-30% infection
4	31-50% infection
5	More than 50% infection

A **B** **C**

D **E** **F**

Plate 1: Disease rating scale for virus disease in capsicum

RESULTS AND DISCUSSION

A roving survey was carried out in major capsicum growing districts of Karnataka *viz*., Belgavi, Bengaluru rural, Chikkaballapur, Haveri and Kolar to determine the prevalence of virus disease complex in capsicum. Disease diagnosis in the field was based on symptoms expressed on plant parts *viz*., leaves, petioles, stems and fruits. The results revealed that the capsicum virus disease complex was prevalent in all the surveyed districts of Karnataka.

Percent disease incidence

The average percent disease incidence in overall surveyed districts was 70.46 percent. Among five districts surveyed, highest disease incidence was recorded in Haveri (89%), followed by Belagavi (84%), Chikkaballapur (76%) and Kolar (60%) whereas the least percent disease incidence was recorded in Bengaluru rural (43.33%). Similarly, among the 10 taluks, highest disease incidence of 92 per cent was observed in Byadgi followed by Ramdurga (86.66%), whereas the least incidence of 43.33 percent was recorded in Nelamangala. Similarly, among the 22 villages, highest incidence of 100 percent was recorded in Bannahatti village of Byadgi, whereas the least incidence of 20 percent was recorded in Tadshigatta village of Nelamangala.

In Haveri district ten capsicum plots from three villages of two taluks were surveyed and found to have average disease incidence of 89 per cent. The range of percent disease incidence among various villages of two taluks was 60-100%. The average maximum per cent disease incidence was recorded in Byadgi taluk (92%), followed by Savanur taluk (86%).

In Belagavi district ten capsicum plots from seven villages of three taluks were surveyed and found to have average per cent disease incidence of 84%. The range of per cent disease incidence among various villages of three taluks was 66.66-100%. The average maximum percent disease incidence was recorded in Ramdurga taluk (86.66%), followed by Hukkeri taluk (73.33%).

In Kolar district ten capsicum plots from seven villages of two taluks were surveyed and found to have average per cent disease incidence of 60%. The range of percent disease incidence among various villages of two taluks was 26.66-100%. The average maximum percent disease incidence was recorded in Mulubagilu taluk (66.66%), followed by Kolar taluk (53.33%).

In Bengaluru rural district ten capsicum plots from three villages of one taluk were surveyed and found to have average percent disease incidence of 43.33%. The range of percent disease incidence among various villages was 20-60%. The average maximum per cent disease incidence was recorded in Eswanahalli (60%). The average minimum percent disease incidence of Oblapura and Tadshigatta was 42.21%, and 41.11% respectively.

In Chikkaballapur district ten capsicum plots from four villages of two taluks were surveyed and found to have average per cent disease incidence of 76%. The range of per cent disease incidence among various villages of two taluks was 46.66-86.66%. The average maximum per cent disease incidence was in Chikkaballapur taluk (79.99%), followed by Gouribidanur (71.99%).

Percent disease index

The average percent disease index in overall surveyed districts was 34.23%. Among five districts surveyed, highest percent disease index was recorded in Haveri (60%), followed by Belagavi (37%), Kolar (30.50%) and Chikkaballapur (30.33%), whereas the least percent disease index was recorded in Bengaluru rural (13.33%). Similarly, among the 10 taluks, highest percent disease index of 72.50% was recorded in Byadgi followed by Savanur (47.50%), whereas the least percent disease index of 13.33% was recorded in Nelamangala. Similarly, among the 22 villages surveyed, highest percent disease index of 95% was recorded in Bannahatti village of Byadgi, whereas least percent disease index of 5% was recorded in Tadshigatta village of Nelamangala.

In Haveri district the average percent disease index recorded was 60%. The range of percent disease index among various villages of two taluks was 22.50-95%. The average maximum percent disease index was recorded in Byadgi taluk (72.50%) and average minimum percent disease index was recorded in Savanur taluk (47.50%).

In Belagavi district the average percent disease index recorded was 37%. The range of percent disease index among various villages of three taluks was from 21.66-70%. The average maximum percent disease index was recorded in Ramdurga taluk (46.66%) and average minimum percent disease index was recorded in Hukkeri taluk (21.66%).

In Kolar district the average percent disease index recorded was 30.50%. The range of percent disease index among various villages of two taluks was 8.33-58.33%. The average maximum per cent disease index was recorded in Mulubagilu taluk (35.99%) and average minimum percent disease index was recorded in Kolar taluk (24.99%).

In Bengaluru rural district the average percent disease index recorded was 13.33%. The range of percent disease index among the various villages was 5-23.33%. The average maximum percent disease index was recorded in Eswanahalli (23.33%) and average

minimum percent disease index was recorded in Oblapura and Tadshigatta (11.66% and 12.49% respectively).

In Chikkballapur district the average percent disease index recorded was 30.33%. The range of percent disease index among various villages of two taluks was 13.33-65%. The average maximum percent disease index was recorded in Gouribidanur taluk (30.99%) and average minimum percent disease index was recorded in Chikkaballapur (29.66%).

As capsicum is grown in areas with warm day temperature and cool nights, therefore, such climatic conditions also favour vector's activity and might have aggravated the situation further. Moreover, general phytosanitary conditions were very poor and a large number of weeds were often found in and around capsicum field, possibly providing rearing niches for vectors as well as these virus's foci. These infected fields might serve as a source of primary inoculum for capsicum viruses in the next growing season.

Leaf curl viruses infected capsicum plants exhibited yellowing and mosaic in younger leaves followed by blistering of leaves, upward curling of leaf lamina, leaf distortion and crumpling. The secondary symptoms such as stunted growth of plant and shorter internodes together with epidermal roughness were observed in early infected plants. The infected plants had small and lesser fruits compared to the healthy ones. The findings were confirmatory with the results of Vasudeva and Sam Raj (1948); Sastry and Singh (1973). Wherein they observed vein clearing, reduced leaf size, stunted growth, deformation of leaf let's, outward and inward curling and puckering of leaves.

The survey results of the present study on capsicum viral diseases are in accordance with the many research findings from different parts of the world. Wherein, an extensive survey was conducted by Sharma *et al.* (2016) in different capsicum grown polyhouses of Himachal Pradesh during 2011 to 2014.

Conclusion

The symptoms observed on diseased plants included upward and downward curling, mosaic and mottling, chlorosis, deformed leaves and fruits with stunted plant growth.Coinfection of different viruses, poses serious threat may be due to recombination and synergistic effect and its appearance in more devastated form is a constant threat under the prevailing cropping pattern and natural conditions.

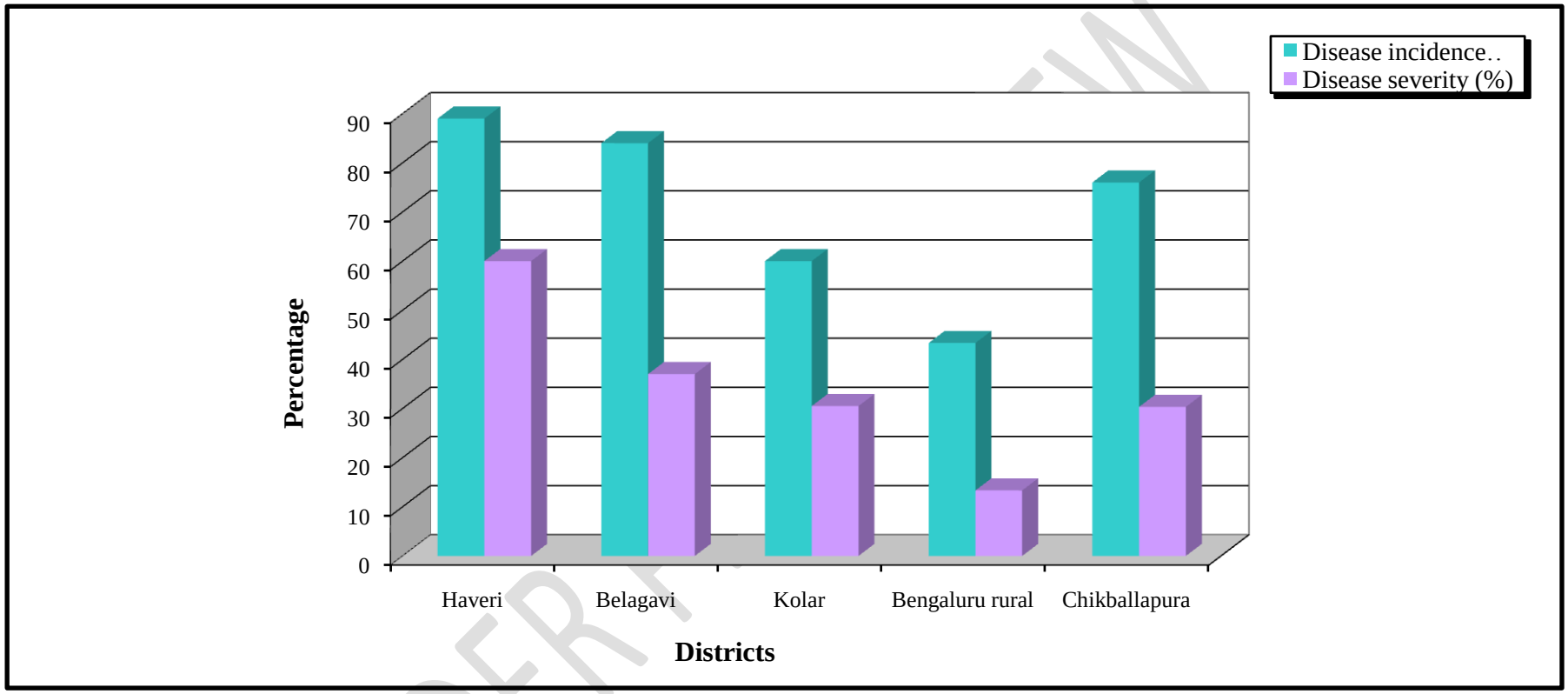

Fig. 1. Average per cent disease incidence and average per cent disease severity of surveyed districts for virus disease in capsicum

Table 2: Roving survey to know the incidence of virus disease in capsicum based on the symptoms.

Sl. No.	Taluk	Village	Variety/Hybrid	Open/protected cultivation	Area (acre)	Crop Stage	Previous Crop	Symptoms Observed	Disease Incidence (%)	Disease Severity (%)
District: Haveri										
1	Savanur	Allipura	Local	Open cultivation	1	Fruiting	Capsicum	M, Mo	80.00	43.75
		Allipura	Local	Open cultivation	2	Fruiting	Capsicum	VB, curling, chlorosis	90.00	47.50
		Yalavigi	Local	Open cultivation	2	Fruiting	Capsicum	Cupping of leaves with chlorosis.	85.00	48.75
		Yalavigi	Local	Open cultivation	1	Fruiting	Capsicum	Curling, Mo, VB	90.00	55.00
		Yalavigi	Local	Open cultivation	4	Fruiting	Capsicum	M, Mo	85.00	42.50
2	Byadagi	Bannahatti	Local	Open cultivation	1	Fruiting	Capsicum	M, VB, chlorosis	100.00	85.00
		Bannahatti	Local	Open cultivation	0.5	Fruiting	Soyabean	Severe curling, VB	60.00	22.50
		Bannahatti	Local	Open cultivation	1	Seedling	Capsicum	Chlorotic spots, M	100.00	83.75
		Bannahatti	Local	Open cultivation	0.5	Fruiting	Cotton	M, Interveinal chlorosis	100.00	95.00
		Bannahatti	Local	Open cultivation	1	Fruiting	Watermelon	Mo, VB	100.00	76.25
								Average	**89.00**	**60.00**
District: Belagavi										
3	Ramdurga	Halagatti	Local	Open cultivation	0.5	fruiting	Sugarcane	Chlorosis, Mo, M	86.66	46.66
4	Gokak	Badigavada	Indus	Open cultivation	1	fruiting	Tomato	VB, puckering, Mo	93.33	45.00
		Badigavada	Indus	Open cultivation	1	fruiting	Marigold	Chlorosis, M, Mo, curling	80.00	31.66
		Rajapura	Indus	Open cultivation	1.5	fruiting	Cabbage	M, Mo, VB	93.33	38.33
		Rajapura	Indus	Open cultivation	1	fiuiting	Cabbage	Stunting, curling, M	73.33	30.00
		Rajapura	Local	Open cultivation	1.8	fruiting	Sugarcane	M, Mo, Chlorosis, VB	86.66	31.66
		Dandapura	Indra	Open cultivation	2	fruiting	Marigold	M, Mo, Chlorosis, VB	100.00	70.00
		Sangankeri	Indus	Open cultivation	1	fruiting	Cabbage	Curling, VB, M	86.66	33.33
		Arabhavi	Indus	Open cultivation	0.5	fruiting	Tomato	M, Mo	66.66	21.66

5	Hukkeri	Shirigav	Local	Open cultivation	1	fruiting	Papaya	M	73.33	21.66
								Average	**84.00**	**37.00**
District: Kolar										
6	Kolar	Korogondhalli	Indra and venus	Shade net	1.5	fruiting	Capsicum	M, Chlorosis	66.66	25.00
		Korogondhalli	Indra	Shade net	2	fruiting	Tomato	M, Chlorosis, VB	40.00	20.00
		Korogondhalli	Indra	Shade net	3	fruiting	Tomato	VB, curling, M	53.33	30.00
		Dandiganahalli	Enza-zaden	Shade net	2	fruiting	Ragi	M, Chlorosis	60.00	26.66
		Dandiganahalli	Nemalite	Shade net	3	fruiting	Tomato	Curling, Mo	46.66	23.33
7	Mulubagilu	Balsandra	Indra	Shade net	3	fruiting	Capsicum	Interveinal chlorosis, M,	80.00	45.00
		Alangur	Rizkwan Red type	Poly house	1	fruiting	Tomato	M, Chlorosis, curling	100.00	58.33
		Gummakal	Indra	Poly house	1	fruiting	Tomato	M, Mo	86.66	53.33
		Gummakal	Rizkwan and Galaxy	Poly house	0.5	fruiting	Tomato	VB, Mo, M	26.66	8.33
		Gummakal	Rizkwan	Poly house	1.5	fruiting	Capsicum	M, VB	40.00	15.00
								Average	**60.00**	**30.5**
District: Bengaluru rural										
8	Nelamangala	Eswanahalli	Nemalite(emza)	Poly house	1	fruiting	Potato	M, chlorosis	60.00	23.33
		Oblapura	Rizkwan	Poly house	0.5	fruiting	Tomato	M, Mo	26.66	6.66
		Oblapura	Rizkwan	Poly house	1	fruiting	Cabbage	Chlorosis, M	53.33	15.00
		Oblapura	Rizkwan	Poly house	1.5	fruiting	Brinjal	Chlorosis, M	46.66	13.33
		Tadshigatta	Bachata	Poly house	1	fruiting	Ridgegourd	M	40.00	13.33
		Tadshigatta	Insperience	Poly house	0.5	fruiting	Beans	M	20.00	5.00
		Tadshigatta	Nemalite	Poly house	1	fruiting	Banana	Chlorosis, M	33.33	8.33
		Tadshigatta	Nemalite	Poly house	2	fruiting	Tomato	M, VB	40.00	13.33
		Tadshigatta	Rizkwan	Poly house	1.5	fruiting	Tomato	Chlorosis, M	60.00	21.66
		Tadshigatta	Rizkwan	Poly house	2	fruiting	Tomato	M	53.33	13.33
								Average	**43.33**	**13.33**
District: Chikballapura										
9	Gouribidanur	Goudagere	Rizkwan	Poly house	1.5	Fruiting	Capsicum	Curling, Mo, M, VB	46.66	13.33
		Goudagere	Bachato	Poly house	1	fruiting	Capsicum	Chlorosis, Curling, M, Mo	60.00	23.33
		Chilenahalli	Insperience	Poly house	1	fruiting	Tomato	M, Mo, VB	73.33	25.00
		Chilenahalli	Rizkwan	Shade net	0.5	fruiting	Capsicum	Curling, M	86.66	28.33
		Chilenahalli	Rizkwan	Shade net	1	fruiting	Tomato	Crinkling, Mo,	93.33	65.00

								VB		
10	Chikballapura	Nandi hobli	Rizkwan	Net house	0.5	fruiting	Tomato	Curling, VB, distortion of fruits, flower	80.00	31.66
		Nandi hobli	Rizkwan	Poly house	1	fruiting	Brinjal	Stunting, curling, crinkling, M	73.33	26.66
		Nallimaradhalli	Rizkwan	Poly house	1.5	fruiting	Tomato	Mo, M, curling, VB	86.66	31.66
		Nandi hobli	Nemalite	Poly house	2	fruiting	Tomato	M, VB, Mo	80.00	33.33
		Nandi hobli	Rizkwan	Poly house	1.5	fruiting	Tomato	Mo, curling, M	80.00	25.00
								Average	**76.00**	**30.33**

M – Mosaic, Mo – Mottling, VB – Vein banding

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