



## Viral diseases incidence and symptomatology spectrum associated with Capsicum under protected cultivation in Himachal Pradesh

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### Abstract

**Capsicum (*Capsicum annuum* L. var. *grossum* Sendt.) is popularly grown vegetable crop in the world. Diseases caused by viruses in capsicum crop affect quality and quantity of produce significantly. To know the prevalence and incidence of viral diseases in capsicum, surveys were undertaken during 2022-23 in three districts of Himachal Pradesh viz., Kangra, Hamirpur and Mandi. Results revealed that the highest viral mean disease incidence i.e. 32.77% was in district Kangra followed by district Hamirpur (18.75%) and district Mandi (15.74%). Varied symptomatology associated with viral diseases was observed in all surveyed the districts. Symptoms viz., mosaic, mottling, vein-thickening, vein-banding, yellowing and stunting were the most prominent and common symptoms associated with viral diseases.**

**Keywords:** Capsicum, disease incidence, symptomatology

*Capsicum annuum* L. var. *grossum* Sendt. belongs to the Nightshade family *Solanaceae* and is originated from tropical South America (Shoemaker and Teskey 1995). It is one of the most economical and agriculturally important crop all over the world (Macneish 1964). Sweet Pepper or Bell Pepper is also popularly known as Shimla Mirch. It is high value low volume crop cultivated under natural and protected conditions in India (Nikki *et al.* 2017). In the year 2022, total annual production of capsicum in Himachal Pradesh was 48.86 thousand tonnes from an area of 2.85 thousand ha (Anonymous 2023). Himachal Pradesh is a leading supplier of capsicum to the plains during summer and rainy season. The produce becomes off-season to the plains and fetches higher price to the vegetable growers (Sreedhara *et al.* 2013).

Capsicum is attacked by numerous fungal, bacterial and viral pathogens but viral diseases are the most serious threat under protected cultivation as they affect both quantity and quality of the produce (Singh *et al.* 2020). More than 68 viruses are known to attack capsicum (Waweru *et al.* 2019). In Himachal Pradesh, viruses that are of great significance to capsicum cultivation are Cucumber mosaic

virus (CMV), Pepper mild mottle virus (PMMoV), Tomato mosaic virus (TMV), Tomato spotted wilt virus (TSWV), Potato virus Y (PVY), Pepper veinal mottle virus (PVMV) and Capsicum chlorosis virus (CaCV) (Rialch *et al.* 2015, Sharma and Kulshrestha 2016).

### Materials and Methods

To record the prevalence and incidence of viral diseases, surveys of major districts of Himachal Pradesh viz., Kangra, Mandi and Hamirpur were conducted during 2022-2023. The plants were observed for the presence of virus like symptoms viz., puckering, mottling, mosaic, vein-banding, vein-clearing, stunting, and yellowing etc. Data on per cent disease incidence of symptom variability was recorded during the survey. Per cent disease incidence was calculated using the following formula:

$$\text{Disease incidence (\%)} = \frac{\text{No. of infected plants}}{\text{No. of plants observed}} \times 100$$

### Results and Discussion

During 2022-23, roving surveys were undertaken in twenty (20) locations of three (3) districts viz., Kangra, Hamirpur and Mandi to assess the prevalence

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of diseases caused by virus (es) affecting capsicum under protected cultivation (Figure 1). Surveys in three districts revealed that the presence of virus like symptoms was present in all the locations. During the survey, it was found that Kangra district had highest mean viral disease incidence *i.e.* 32.77% followed by Hamirpur and Mandi district having 18.75% and 15.74% mean viral disease incidence respectively (Figure 2). Amongst the locations surveyed in Kangra district, Dadhamb had the highest disease incidence *i.e.* 60%. Likewise, in Hamirpur and Mandi district, Choru (45%) and Siyanji (35%) had the highest disease incidence respectively. Bharmoti in the district

Hamirpur, Jajraut and Dhangu in district Mandi were concluded to have least *i.e.* 5% viral disease incidence. In Kangra district, Dadhamb had the highest per cent disease incidence *i.e.* 60% followed by Vegetable farm Palampur (55%) and Rajol (50%) and least disease incidence was found in Uparla Dohbh, Bhatu Palam and Dehan *i.e.* 15%. In Hamirpur district, highest disease incidence was recorded in Choru *i.e.* 45% and the least disease incidence *i.e.* 5% was in Bharmoti. In district Mandi, Siyanji had the highest per cent disease incidence *i.e.* 35% followed by Chauntra (25%) and Palahota (20%).

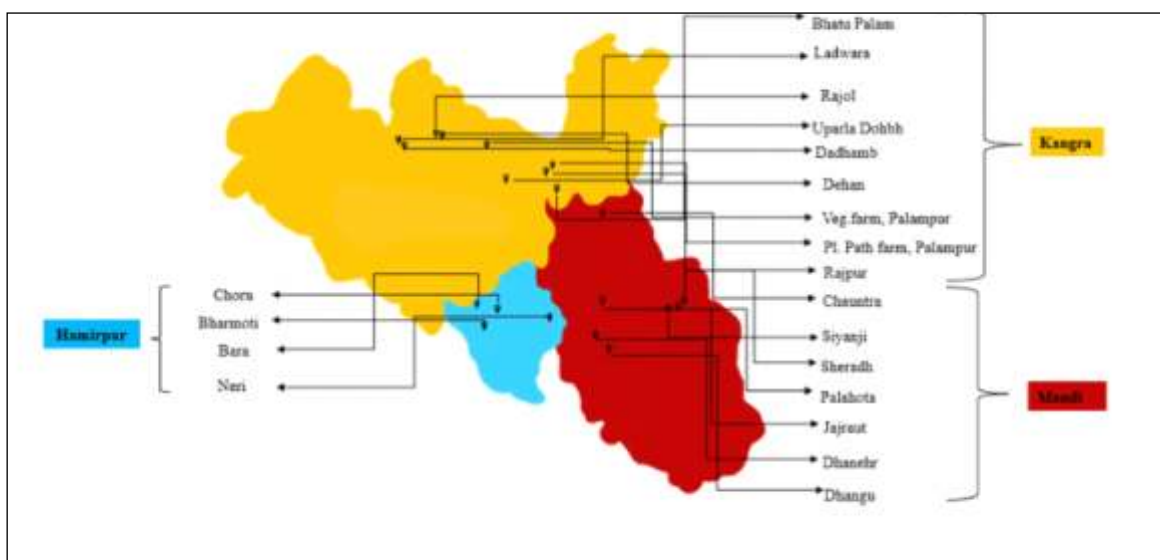


Figure 1: Map depicting different surveyed locations in Himachal Pradesh

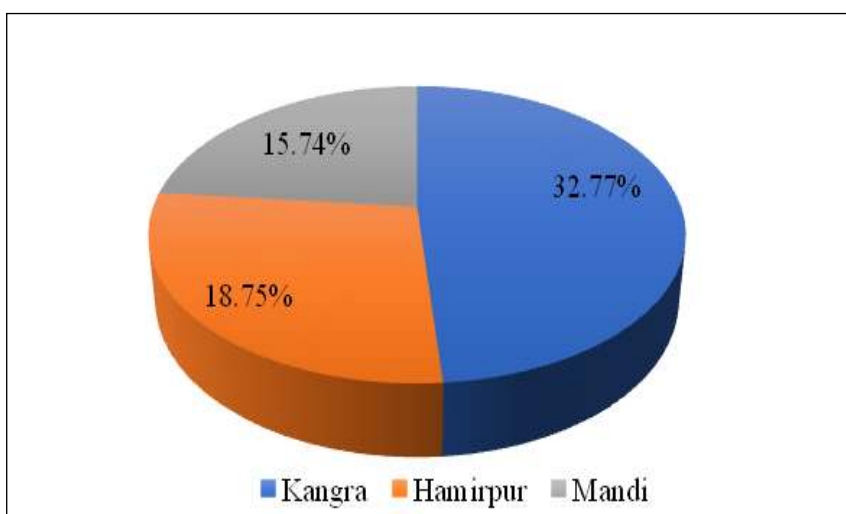


Figure 2: Average incidence of viral diseases incidence on capsicum crop in different districts of Himachal Pradesh

Varied symptomatology in capsicum was observed at different locations during the survey (Table1). The diseased plant expressed an array of symptoms like mosaic, mottling, puckering, vein-banding, vein-clearing, yellowing, stunting, chlorosis, upward or downward curling and deformation of leaves etc (Figure 3). Mottling, puckering, mosaic, leaf deformation, vein-thickening, vein-banding, upward cupping and phyllody were observed in plants suspected to be infected with virus (es).

In Kangra district, the prevalence of vein-thickening/greening disease symptoms was 17.64% followed by second highest prevalence of mosaic disease symptoms *i.e.* 16.17%. In Hamirpur district mottling/puckering were the most prevalent symptoms *i.e.* 23.68% followed by mosaic (21.05%) and leaf curling (15.78%). Likewise in Mandi district, most prevalent symptom was mosaic *i.e.* 21.21% followed by stunting/wilting and yellowing/chlorosis

*i.e.* 18.88% (Table 2). Further it can be concluded that overall mean prevalence of mosaic diseases was highest *i.e.* 19.47%, followed by mottling/puckering *i.e.* 16.83% and yellowing/chlorosis diseases *i.e.* 15.57% in Himachal Pradesh. The least prevalent symptoms were necrotic spots/ chlorotic ringspots *i.e.* 2.02% followed by vein-clearing/vein-banding *i.e.* 10.83% (Figure 4).

Present experiments results are in accordance with earlier workers, who also found variable incidence of virus diseases in chilli and bell pepper in different areas of Himachal Pradesh. Rialch *et al.* (2015) conducted survey to record viral disease incidence on capsicum in seven (7) districts of Himachal Pradesh. They observed that the disease incidence ranged from 12.5-40 % in surveyed districts. Highest incidence of viral diseases was observed in Bilaspur district (Berthin) with about 60% average incidence followed by Kullu and then Kangra with

**Table 1: Per cent disease incidence of viral diseases in different Capsicum growing areas of Himachal Pradesh**

Location (district-wise)	Samples collected (No.)	Disease incidence (%)	Geographical location		Major symptomatology observed
			Latitude	Longitude	
<b>District Kangra</b>					
1. Rajpur	4	35.00	32°04'34.6"N	76°32'00.1"E	Vein-thickening, shortening of internodes, lustrous greening, mosaic, mottling puckering, yellowing, wilting, stunting, vein-banding, vein-clearing, chlorotic ringspots, apical necrosis, phyllody, curling and silvering of midrib
2. Ladwara	2	20.00	32°10'39.9"N	76°13'13.4"E	
3. UparlaDohbh	3	15.00	32°11'42.1"N	76°19'28.8"E	
4. Rajol	4	50.00	32°10'10.8"N	76°14'36.7"E	
5. Dadhamb	3	60.00	32°12'57.5"N	76°10'25.8"E	
6. Bhatu Palam	4	15.00	32°04'59.2"N	76°29'26.4"E	
7. Vegetable farm, Palampur	16	55.00	32°05'38.0"N	76°32'14.4"E	
8. Pl. Path. farm, Palampur	6	30.00	32°05'54.6"N	76°32'46.1"E	
9. Dehan	3	15.00	32°04'02.9"N	76°31'01.6"E	
<b>District Hamirpur</b>					
10. Choru	5	45.00	32°46'47.9"N	76°25'24.0"E	Mosaic, mottling, leaf curling, necrotic lesions, vein-clearing, vein-banding and chlorosis
11. Bara	5	10.00	31°46'19.2"N	76°24'32.2"E	
12. Bharmoti	4	5.00	31°46'08.1"N	76°20'31.5"E	
13. Neri	4	7.5	31°40'41.5"N	76°29'20.0"E	
<b>District Mandi</b>					
14. Siyanji	6	35.00	31°29'00.8"N	76°58'41.8"E	Yellowing, wilting, vein-vclearing, mosaic, crinkling, curling, mottling, puckering and vein-thickening
15. Chauntra	2	25.00	31°00'45.7"N	76°44'56.9"E	
16. Dhanehr	3	10.00	31°34'15.4"N	76°50'59.8"E	
17. Jajruat	3	05.00	31°34'26.2"N	76°52'07.6"E	
18. Palahota	4	20.00	31°32'12.9"N	76°55'54.6"E	
19. Seradh	2	15.00	31°29'56.6"N	76°57'58.5"E	
20. Dhangu	2	5.00	31°35'44.4"N	76°55'43.0"E	

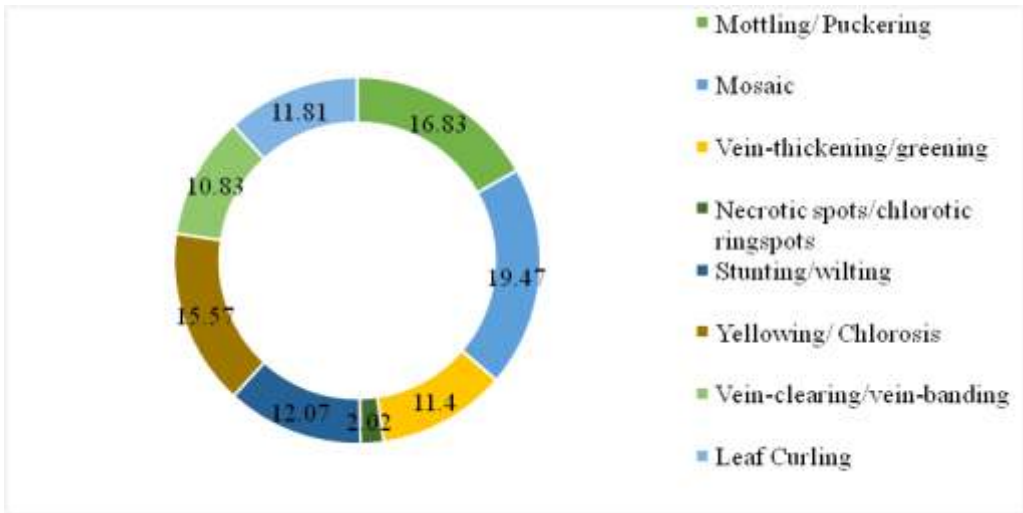


**Figure 3: Symptom variability observed in Himachal Pradesh (A: Mottling and Mild puckering; B: Mosaic; C: Puckering; D: Vein-banding; E: Vein-thickening; F: Upward cupping and mosaic)**



**Table 2: Average prevalence of symptomatology on capsicum under protected cultivation in different districts**

Districts	Symptoms prevalence (%)							
	Mottling/ puckering	Mosaic	Vein- thickening/ greening	Necrotic spots/ chlorotic ringspots	Stunting/ wilting	Yellowing/ chlorosis	Vein- clearing/ vein-banding	Leaf curling
Kangra	14.70	16.17	17.64	04.42	14.70	14.71	11.78	05.88
Mandi	23.68	21.05	10.52	00.00	02.63	13.16	13.12	15.78
Hamirpur	12.12	21.21	06.06	03.05	18.88	18.88	09.01	15.16



**Figure 4: Pie diagram of overall mean prevalence (%) of viral symptomatology in Himachal Pradesh**

24% and 20% average viral incidence, respectively. These results are in accordance with Sivaprasad *et al.* (2015) and Vinodini *et al.* (2021), who reported that viruses generally induce symptoms viz., leaf mosaic, curling, puckering, vein-banding, mottling, apical necrosis, chlorosis, yellowing and deformed fruits. Tsedaley (2015) recorded the data on viral disease incidence in capsicum crop from different locations in Nigeria, further reported that it ranged from 20-60%. Channakeshava (2019) reported that in protected cultivation of capsicum mean viral disease incidence was 27.92% in Karnataka. They also deciphered that the most prevalent disease symptom was mottling i.e 19.16% followed by leaf curling (16.83%) and mosaic

(13.55%). In the face of climate change, updated information on prevalence of viral diseases under protected cultivation in Himachal Pradesh should be generated regularly. Further, characterization of variants resulting in varied symptomatology and yield losses is necessary to devise effective management strategies.

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**Conflict of interest:** The authors declare that there is no conflict of interest in this research paper.

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