



# Distribution and Prevalence of Downy Mildew Disease on Cucurbits in Punjab

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**Abstract:** Cucurbit downy mildew caused by *Pseudoperonospora cubensis* is a major destructive disease affecting wide range of cucurbits which causes significant losses to the growers in terms of yield and fruit quality. The present study was conducted with an objective to assess the disease incidence and severity in Punjab under different agro-climatic zones. The survey conducted in various cucurbit growing regions of Punjab revealed that highest disease incidence was observed in Western Zone (36.41%) followed by Central Plain Zone (26.92%). The disease severity was highest in Western Zone (20.42%) succeeded by Central Plain Zone (15.62%), sub-mountain Undulating Zone (14.30%) and Western Plain Zone (12.79%). The overall mean disease incidence in Punjab state was 31.21 and 36.06 per cent during the year 2018-19 and 2019-20, whereas disease severity was 16.78 and 21.65 per cent in the respective years. Ludhiana and Sangrur emerged as the hot spot areas for the occurrence of downy mildew with disease incidence of 43.88 and 34.69 per cent, respectively. Among the different crops surveyed, the disease prevalence was maximum in cucumber (37.61%) and least in watermelon (22.00%). The hybrids cultivated in each cucurbit host reported to be more affected by the downy mildew as compared to the composites and land races.

**Keywords:** *Pseudoperonospora cubensis*, Disease incidence, Disease severity, Cucurbits, Survey

Vegetables are grown extensively all around the world and India holds second position in vegetable production while it ranked 25<sup>th</sup> in the production of cucumber and gherkins (1.96 lac tonnes) in the world during 2018 (Anonymous 2018). Punjab is the leading producer of vegetables with an area of 2.73 lac ha under vegetable cultivation, producing 54.42 lac tonnes and average productivity of 19.91 tonne per ha. Among vegetables, cucurbits are among the economically important vegetable crops. The family *Cucurbitaceae* includes more than 118 genera and 825 species grown worldwide in various temperate and tropical regions (Lebeda and Cohen 2011). During 2018-19, the cucurbits covered an area of 17.01 thousand ha having productivity of 159.00 q/ha and a total production of 270.45 thousand tonnes in Punjab (Anonymous 2019). Cucurbits are important crops in terms of its use in both culinary as well as non-culinary items. Among diseases, downy mildew of cucurbits caused by *Pseudoperonospora cubensis* poses a continuous threat to the cultivation of cucurbits worldwide and is known to occur annually under Punjab conditions. It was first reported by Butler in Punjab (Butler 1918) and thereafter several reports have indicated the prevalence of disease in state. The loss due to downy mildew is directly proportional to disease intensity and adversely affects the yield and quality of produce. The survey and sampling of the pathogen help in studying the occurrence and distribution of the pathogen in a

particular region. It also helps in timely forecasting the disease epidemic depending upon the presence of inoculum. Samples collected from the infected fields can be further used for the identification, characterization and virulence studies, etc. Therefore, the current investigation was aimed at assessing the disease incidence and its severity of downy mildew of cucurbits under Punjab conditions.

## MATERIAL AND METHODS

Extensive surveys were conducted in different cucurbit growing regions of Punjab such as Amritsar (31.6340°N, 74.8723°E), Faridkot (30.6774°N, 74.7539°E), Hoshiarpur (31.5123°N, 75.9115°E), Jalandhar (31.3260°N, 75.5762°E), Kapurthala (31.3723°N, 75.4018°E), Ludhiana (30.9010°N, 75.8573°E) and Sangrur (30.2458°N, 75.8421°E) during April-October for 2018-19 and 2019-20. In order to assess the disease incidence and disease severity of downy mildew among various cucurbit hosts, different fields were inspected and the diseased samples were collected. Random plot sampling was done to record the percent disease incidence and disease severity. The diseased leaf samples were properly labelled inscribing the information of name of district, village/location and cultivar on the collection bags and these bags were brought to the laboratory for the further studies. Fifty plants were assessed randomly across the field and the percent disease incidence was calculated using formula used by Shrestha et al (2019):

$$\text{Percent Disease Incidence (PDI)} = \frac{\text{Number of diseased plants}}{\text{Total number of plants assessed}} \times 100$$

Grade	Description
0	No symptoms/ damage
1	1-10% area chlorotic and/or necrotic
2	11-20% area chlorotic and/or necrotic
3	21-30% area chlorotic and/or necrotic
4	31-40% area chlorotic and/or necrotic
5	41-50% area chlorotic and/or necrotic
6	51-60% area chlorotic and/or necrotic
7	61-70% area chlorotic and/or necrotic
8	71-80% area chlorotic and/or necrotic
9	81-100% area chlorotic and/or necrotic or dead

Based on the percentage of leaf area affected, per cent disease severity was calculated using the following formula (Ketta et al 2016):

$$\text{Percent Disease Severity (PDS)} = \left[ \frac{\sum(a \times b)}{N \times K} \right] \times 100$$

Where a= number of infected leaves rated; b= numerical value of each grade; N= total number of examined plants; K= highest degree of infection on scale.

## RESULTS AND DISCUSSION

The prevalence of cucurbit downy mildew varied to different extents in various areas surveyed in the different agroclimatic zones of Punjab. Among the different districts surveyed during 2018-19, the highest mean disease incidence was from Ludhiana (43.88%) followed by Sangrur, Kapurthala, Faridkot whereas minimum disease incidence was observed in Jalandhar (10.00%). Dehlon region of Ludhiana and Sunam tehsil of Sangrur recorded the maximum incidence of the disease *i.e.*, 66.00 and 76.00 percent in the respective districts with minimum disease incidence in village Dalelgarh, Sangrur (9.25%). Similarly, the highest per cent disease severity was recorded in districts Ludhiana and Sangrur which was 24.15 and 17.95 per cent, respectively. The lowest disease severity (3.36%) was recorded from Phillaur in district Jalandhar. The close scrutiny of the disease condition in the following year of 2019-20 expressed the similar trend as of the previous year with maximum disease incidence from district Ludhiana (50.02%) followed by district Sangrur and minimum in district Jalandhar (12.00%). District-wise maximum disease incidence was at Dehlon (74.35%) in Ludhiana and Sunam tehsil of Sangrur (84.00%). The per cent disease severity during this period was highest in district Ludhiana (29.26%) followed by Sangrur and the minimum was in district Jalandhar (7.86%) followed by Amritsar. The overall mean

disease incidence in Punjab was 31.21 and 36.06 per cent during the year 2018-19 and 2019-20, respectively where the disease severity was recorded to be 16.78 and 21.65 per cent respectively for both the years. The pooled data for overall mean disease incidence and disease severity across the state was 33.62 and 19.22 per cent, respectively for the same duration under consideration. Similar studies done by Sharma et al (2003) revealed that the downy mildew disease was prevalent in Solan, Sirmour, Shimla and Bilaspur districts of Himachal Pradesh in moderate to severe form on cucumber crop. The disease incidence and severity were ranged from 50-100 per cent and 20-78 per cent, respectively. The average disease severity was comparatively lesser in Shimla and Bilaspur than in Solan and Sirmour. Similarly, Paul and Thakur (2003) surveyed Indore area of Kangra district in Himachal Pradesh and reported the disease incidence due to downy mildew was 15-20 per cent. Earlier, during March-April 2007-08, an extensive survey was conducted in cucumber and muskmelon fields in various districts of Punjab and collected 31 isolates of *P. cubensis* in the form of infected leaves with sporulating lesions (Thind et al 2010). Thereafter, Gupta et al (2014) reported the disease incidence and intensity of downy mildew as 70% and 56%, respectively, in cucumber. Haveri et al (2019) observed disease severity up to 27.43 per cent in Karnataka during 2018-19.

Among the different agro-climatic zones surveyed during both the years, disease incidence was highest in Western Zone (36.41%) followed by Central Plain Zone and Western Plain Zone. The data for disease severity was highest in Western Zone (20.42%) succeeded by Central Plain Zone, sub-mountain Undulating Zone and Western Plain Zone (Table 1).

In terms of disease incidence and disease severity among different cucurbit crops, disease incidence was more in cucumber (37.61%) followed by summer squash, muskmelon, pumpkin, and watermelon (Table 2). Lebeda et al (2011) reporting disease prevalence of 60-100% and cucumber being most frequently affected host. Different varieties of cucumber and muskmelon cultivated in the state get infected by downy mildew to different extents. Among the cucumber cultivars, highest mean disease incidence over the period of two years was on hybrids *i.e.*, Hybrid Ziya (80.00%) followed by Radhika and Multistar. Among the summer squash incidence of downy mildew was more in cultivar PCK1 (52.62%) than the Local Landrace (19.33%). In muskmelon incidence was much higher in MH27 (56.87%) as compared to HB Raseela (41.00%) and Bobby (26.00%). In pumpkin, highest disease incidence was found in hybrid Nirvana (45.00%) followed by PPH1 (42.00%). The least disease was observed in watermelon with incidence of

**Table 1.** Prevalence of downy mildew disease in different cucurbit growing areas of Punjab during 2018-19 and 2019-20

Agroclimatic zone	District	Location/Village	Crop	Variety	Disease incidence (%)			Disease severity (%)			
					2018-19	2019-20	Mean	2018-19	2019-20	Mean	
Sub-mountain Undulating Zone	Hoshiarpur	Mahalpur	Cucumber	Punjab Naveen	36.00	40.00	38.00	16.46	26.68	21.57	
		Sikri	Cucumber	Punjab Hybrid	20.00	28.00	24.00	15.24	20.34	17.79	
		Hariana	Cucumber	Local Landrace	16.00	24.00	20.00	12.34	18.67	15.51	
		Khanpur	Cucumber	Multistar	12.00	16.00	14.00	5.01	8.28	6.65	
		Hariana	Muskmelon	Hara Madhu	14.00	18.00	16.00	8.69	11.25	9.97	
	Mean				19.60	25.20	22.40	11.55	17.04	14.30	
Central Plain Zone	Amritsar	Gheri Mandi	Cucumber	Punjab Naveen	12.25	20.55	16.40	7.85	12.32	10.09	
		Hamja	Cucumber	Local Landrace	17.25	21.35	19.30	10.20	10.86	10.53	
		Dashmesh Nagar	Cucumber	Local Landrace	15.00	20.00	17.50	9.34	15.28	12.31	
		Mean				13.63	18.48	16.05	7.69	11.58	9.63
	Jalandhar	Phillaur	Pumpkin	Hybrid Bheema	10.00	12.00	11.00	3.36	7.86	5.61	
Kapurthala	Phagwara	Cucumber	Local Landrace	40.00	42.00	41.00	28.64	30.86	29.75		
	Mustafabad	Cucumber	Radhika	42.00	48.00	45.00	16.32	28.64	22.48		
	Barindpur	Muskmelon	Bobby	12.00	18.00	15.00	8.20	10.46	9.33		
	Mean				31.33	36.00	33.67	17.72	23.32	20.52	
Central Plain Zone	Ludhiana	Dehlon	Cucumber	Multistar	66.00	74.35	70.18	46.35	52.22	49.29	
		Ladhowal	Pumpkin	Nirvana	42.00	48.00	45.00	18.43	22.58	20.51	
		Research farm, Dept. of Plant Pathology, PAU	Cucumber	Punjab Naveen	55.00	62.00	58.50	23.62	35.46	29.54	
		Muskmelon	MH 27	65.20	72.25	68.73	42.35	45.29	43.82		
		Pumpkin	PPH 1	40.00	44.00	42.00	22.50	26.56	24.53		
		Summer Squash	PCK 1	48.65	56.59	52.62	20.25	22.56	21.41		
		Watermelon	Sugar 6	20.00	24.00	22.00	10.46	14.44	12.45		
		Research farm, Dept. of Vegetable Science, PAU	Cucumber	Punjab Naveen	30.00	37.00	33.50	12.36	14.68	13.52	
		Muskmelon	MH 27	42.00	48.00	45.00	25.06	32.64	28.85		
		Pumpkin	Punjab Samrat	30.00	34.00	32.00	20.13	26.16	23.15		
	Mean				43.88	50.02	46.95	24.15	29.26	26.71	
Western Zone	Sangrur	Malerkotla	Cucumber	Nazia F1	70.00	74.00	72.00	36.86	44.28	40.57	
		Mandiala	Cucumber	Multistar	46.00	50.00	48.00	31.28	40.34	35.81	
		Badshahpur	Cucumber	Local Landrace	22.00	24.00	23.00	10.36	14.76	12.56	
		Ubhawal	Cucumber	Hybrid Bella	10.00	14.00	12.00	6.34	9.69	8.02	
		Sangrur	Cucumber	Local Landrace	20.00	24.00	22.00	4.60	10.26	7.43	
		Sunam	Cucumber	Hybrid Ziya	76.00	84.00	80.00	38.96	42.12	40.54	
		Dalelgarh	Cucumber	Pooja 20	9.25	12.50	10.88	5.55	8.66	7.11	
		Bhasaur	Cucumber	NCH 840	44.00	38.00	41.00	23.46	26.82	25.14	
		Madevi	Cucumber	NCH 840	15.00	18.00	16.50	7.35	10.25	8.80	
		Dugni	Muskmelon	Bobby	32.00	42.00	37.00	19.36	25.04	22.20	
Amargarh	Muskmelon	HB Raseela	40.00	42.00	41.00	15.03	18.26	16.65			
	Badrukhan	Pumpkin	Hybrid Bheema	32.00	35.00	33.50	16.25	24.31	20.28		
		Mean				34.69	38.13	36.41	17.95	22.90	20.42
Western Plain Zone	Faridkot	Pipli	Cucumber	Punjab Naveen	29.00	34.00	31.50	9.38	11.76	10.57	
		Sarawan	Pumpkin	Local Landrace	26.00	32.00	29.00	12.45	16.42	14.44	
		Bargari	Summer Squash	Local Landrace	17.85	22.00	19.33	11.25	15.46	13.35	
	Mean				24.28	29.33	26.81	11.02	14.55	12.79	
Overall Mean					31.21	36.06	33.62	16.78	21.65	19.22	

\*Observations were recorded between April to October in the year 2018-19 and 2019-20

**Table 2.** Prevalence of downy mildew disease on different cucurbits

Crop	Variety	Disease incidence (%)			Disease severity (%)		
		2018-19	2019-20	Mean	2018-19	2019-20	Mean
Cucumber	Punjab Naveen	32.45	38.71	35.58	13.934	20.18	17.058
	Punjab Hybrid	20.00	28.00	24.00	15.24	20.34	17.79
	Multistar	41.33	46.78	44.06	27.55	33.61	30.58
	Radhika	42.00	48.00	45.00	16.32	28.64	22.48
	Nazia F1	70.00	74.00	72.00	36.86	44.28	40.57
	Hybrid Bella	10.00	14.00	12.00	6.34	9.69	8.02
	Pooja 20	9.25	12.50	10.88	5.55	8.66	7.11
	Hybrid Ziya	76.00	84.00	80.00	38.96	42.12	40.54
	NCH 840	29.50	28.00	28.75	15.41	18.54	16.97
	Local Landrace	21.71	25.89	23.80	12.58	16.78	14.68
Mean		35.22	39.98	37.61	18.87	24.28	21.58
Muskmelon	Hara Madhu	14.00	18.00	16.00	8.69	11.25	9.97
	MH27	53.6	60.13	56.87	33.71	38.97	36.34
	Bobby	22.00	30.00	26.00	13.78	17.75	15.77
	HB Raseela	40.00	42.00	41.00	15.03	18.26	16.65
Mean		32.40	37.53	34.97	17.80	21.56	19.68
Pumpkin	Hybrid Bheema	21.00	23.50	22.25	9.81	16.09	12.95
	PPH1	40.00	44.00	42.00	22.50	26.56	24.53
	Nirvana	42.00	48.00	45.00	18.43	22.58	20.51
	Punjab Samrat	30.00	34.00	32.00	20.13	26.16	23.15
	Local Landrace	26.00	32.00	29.00	12.45	16.42	14.44
Mean		31.80	36.30	34.05	16.66	21.56	19.12
Summer Squash	PCK 1	48.65	56.59	52.62	20.25	22.56	21.41
	Local Landrace	17.85	22.00	19.33	11.25	15.46	13.35
Mean		33.25	39.29	35.97	15.75	19.01	17.38
Watermelon	Sugar 6	20.00	24.00	22.00	10.46	14.44	12.45

\*Observations were recorded between April to October in the year 2018-19 and 2019-20

22.00%. Hence, cucumber was most frequently affected host followed by muskmelon and the hybrids in each crop were observed to be more susceptible to the disease.

### CONCLUSION

Ludhiana and Sangrur districts are the hotspot areas for downy mildew of cucurbits and was maximum on cucumber and minimum on watermelon. The hybrids cultivated in each cucurbit host were more affected by the downy mildew as compared to the composites and land races. Overall, the disease was more prevalent in major cucurbit growing pockets of Western zone in Punjab. Therefore, can be inferred that downy mildew disease occurs annually in all cucurbit growing areas in varying extents and on all the different types of cucurbit host cultivated in the state. Downy mildew is one of the main reasons of major crop and yield

losses in cucurbits so, there is need to devise a careful management practice in order to discourage the increasing threat of this disease. Therefore, survey and monitoring of the prevailing condition of the disease act as a guiding step for further action to be taken.

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Received 23 August, 2022; Accepted 02 December, 2022