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Survey of Powdery Mildew in Major Cucumber Growing Areas of Northern Karnataka, India

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A B S T R A C T

Powdery mildew is very important foliar disease of cucumber among major cucurbits growing areas of Karnataka which results in huge economic loss. Disease first appear on the leaves thirty days after sowing and continue to produce white mycelial growth on various aerial plant parts up to the harvest. Survey results revealed that the disease severity of powdery mildew in all the cucumber growing areas of northern Karnataka is low to severe (10.25 to 63.08 %). The disease severity was varied among different stage of the crop and varieties grown but there was no significant difference among the cultivation practices. Maximum mean disease severity was recorded in Dharwad district 33.06 per cent, whereas minimum disease severity was recorded in Belagavi with 27.21 per cent.

Introduction

Cucumber (*Cucumis sativa* L.) is a popular fresh market vegetable preferred for several food stuffs and is cultivated throughout India. The total area under cucumber cultivation in India is 71000 hectare with a production of 1202000 tonnes with an average productivity of 16.92 tonnes (Anon, 2015-16). Powdery mildew is a serious disease and causes considerable yield loss to the number of cucurbitaceous crops grown in India. Its distribution and relative occurrence varies throughout the world. Most of the cucurbits are found susceptible to powdery mildew disease but few cucurbits are not much infected due to resistant cultivars. This disease reduces the yield by interfering with photosynthetic activity and biochemical imbalance. Till date across the world more than eight genera have been reported from order Erysiphales. Among them *Erysiphe cichoracearum, Sphaerotheca fuliginea* and *Levilulla taurica* are the major pathogens.

Cucumber powdery mildew caused by *Erysiphe cichoracearum and Sphaerotheca fuliginea* has worldwide importance and it is considered to be one of the most devastating diseases as its occurrence and incidence assumes greater significance resulting in reduction of fruit yield. Powdery mildew and downy mildew together causes up to 50-70 per cent a loss (Sitterly, 1972 and Awad, 2000). In

the present study survey was conducted to know the disease severity of powdery mildew of cucumber in major cucumber growing areas of northern Karnataka in open field as well as protected structures. Among the cucurbits, *Lagenaria siceraria* and *Cucurbita moschata* have recorded highest disease and also the wild cucurbit *Coccinia cardifolia* (Gangwar and Mishra, 2014).

Materials and Methods

A roving survey for severity of powdery mildew of cucumber was conducted in Belagavi, Haveri, Dharwad and Vijaypuraa districts of northern Karnataka during late *kharif* 2016-17. The information on cucumber growing areas was collected from respective districts of horticulture department. Details of individual fields visited and necessary information on disease severity was recorded. During the survey cucumber fields were observed for powdery mildew severity, stage of crop and other details were recorded. In open field conditions five plants were randomly selected and severity was recorded by following 0-9 scale through visual observation (Mayee and Datar, 1986) as given below.

Per cent disease index (PDI) was calculated by using formula given by Wheeler (1969).

$$PDI = \frac{\text{Sum of the all individual disease ratings}}{\text{Total number of plants observed} \times \text{Maximum grade}} \times 100$$

Results and Discussion

A roving survey was carried out in Dharwad, Haveri, Belagavi and Vijaypura districts of northern Karnataka during late *kharif* 2016 to find out the severity of powdery mildew of cucumber. Twenty seven locations in Belagavi, sixteen locations in Dharwad, thirty places in Haveri and eleven locations in Vijaypura (total eighty four cucumber fields) were surveyed as explained in Material and Methods. The results are presented in Table 1a, 1b, 1c, 1d, 1e, figure 1, 2, 3, 4, and plate 1.

Maximum mean percent disease severity (PDI) was observed in Dharwad district (33.06 PDI) followed by Haveri district (29.87 PDI) and minimum mean percent disease severity (PDI) was observed in Belagavi (27.21 PDI) district and it is on par with Vijaypuraa district (27.60 PDI).

In Dharwad district, two taluka's were surveyed, *Viz.,* Dharwad and Hubli. In Dharwad taluka the survey was conducted in sixteen villages. Among them, the maximum severity (59.66 %) was recorded at MARS, Dharwad followed by Tadakoda village with a severity of (40.86 %) whereas, least severity (12.25 %) was recorded in Mrutyunjay nagar. Similarly in Hubli taluka the maximum severity (43.29 %) was recorded in Saunshi followed by Adaragunchi with the severity of 42.78 per cent. The least severity (13.53 %) of powdery mildew was recorded in Ramanakoppa village.

In Haveri district, five taluka's were surveyed, *viz.,* Haveri, Ranebennur, Hirekerur, Shiggaon and Byadgi. In Haveri taluka the survey was conducted in five villages. Among them the maximum severity (29.66 %) was recorded in Vardi cross followed by Motebennur village with a severity of 26.36 per cent. Whereas least severity (20.15%) was recorded in Kerimathihalli village. Similarly in Ranebennur taluka the maximum severity (58.15 %) was recorded in Basirikatti village followed by Medleri with the severity of 40.19 per cent whereas, the least severity of 18.66 per cent was recorded in Chalageri.

Similarly in Shiggaon taluka the maximum severity (36.25 %) was recorded in Gotagodi

followed by Shiggaon with the severity of 30.78 % per cent, the least incidence (22.18 %) was recorded in Niralgi. In Byadgi taluka maximum severity (40.18 %) was recorded in Angargatti whereas the least severity (21.12 %) was recorded in Mallur. Similarly in Hirekurur taluka maximum severity (39.55 %) was recorded in Masur, least severity (20.48 %) was recorded in Bannihatti. Among the talukas surveyed in Haveri district the maximum severity (32.84 %) was recorded in Byadgi and least severity was recorded in Haveri taluka (24.49 %).

In Belagavi district, four taluka's were surveyed, *Viz.*, Belagavi, Bailhongal, Savadatti and Gokak. In Belagavi taluka the survey was conducted in five villages. Among them the maximum severity (29.18 %) was recorded in Sutagatti village followed by Hulikatti village with severity of 24.15 % per cent recorded, whereas least severity (10.25 %) was recorded in K. K Koppa village. Similarly in Bailhongal the survey was conducted in nine villages, among them maximum severity (63.08 %) was recorded in Bailwad cross followed by Kadrohalli village with the severity (36.17 %) whereas the least severity (20.79 %) was recorded in Badekollimath, Similarly in Gokak taluka the maximum severity of 38.12 per cent was recorded in Gokak followed by Yardal with the severity of 33.59 per cent the least disease incidence (29.45 %) was recorded in Murkibhavi. In Savadatti taluka maximum severity (29.15 %) was recorded in Inamhongal village followed by Yaragatti with a severity of 28.27 per cent was recorded and least disease severity was recorded in (18.19 %) Munavalli.

In Vijaypura district, three talukas were surveyed, *viz.*, Vijaypura, Basavana bagewadi and Indi. In Basavana Bagewadi taluka the survey was conducted in three villages. Among them, the maximum disease severity (40.15 %) was recorded in Managuli followed by Ronihal village (36.69 %) whereas least disease severity (28.66 %) was recorded in Agasbal village. Similarly in Vijaypura taluka the maximum severity (29.58 %) was recorded in Jumanal village followed by Vijaypura with the severity of 22.45 per cent and least severity (17.29 %) was recorded in Arakeri.

In Indi taluka maximum severity (27.69 %) was recorded in Tidagundi and minimum in (23.10 %) Horti village, respectively. Among the talukas surveyed in Vijaypura district the maximum severity (35.16 %) was recorded in Basavana Bagewadi taluka and least severity (22.35 %) was observed in Vijaypura taluka.

Disease scoring scale

Score	Description
0	No symptom of powdery mildew on leaves.
1	Small scattered powdery mildew specks covering 1 % or less leaf area.
3	Small powdery lesions covering 1-10 % of leaf area.
5	Powdery lesions enlarged covering 11-25 % of leaf area.
7	Powdery lesions coalesce to form big patches covering 26-50 % leaf area.
9	Big powdery patches covering 51 % or more of leaf area and defoliation occur

Table.1a Survey for severity of cucumber powdery mildew in different districts of northern Karnataka during *kharif* 2016

Districts	Taluks	Villages	Latitude (°N)	Longitude (°E)	Soil type	Stage of the crop	Type of cultivation	Variety/ Hybrid	PDI	Other diseases observed
Belagavi	Bailhongal	Bailhongal	15.81	74.86	Black	Flowering	Irrigated	Green long	22.16	Downy mildew
		Belavadi	15.76	74.75	Black	Flowering	Irrigated	Dharwad green	29.33	Downy mildew Anthracnose
		Bailawada cross	15.83	74.84	Black	Flowering	Rainfed	Dharwad green	63.08	Downy mildew
		Hire Bagevadi	15.77	74.64	Black	Flowering	Rainfed	Malini F1	31.18	-
		Badekollimath	-	-	Black	Harvesting	Irrigated	Malini F1	20.79	Downy mildew
		Ambadagatti	15.63	74.73	Black	Flowering	Rainfed	Malini F1	24.56	-
		Dasthikoppa	15.69	74.70	Black	Flowering	Rainfed	Malini F1	36.12	-
		Kadrolli	15.69	74.73	Black	Flowering	Irrigated	Malini F1	36.17	-
		M.K.hubli	15.72	74.69	Black	Flowering	Irrigated	Malini F1	30.15	-
								Taluk mean	**32.16**	
	Belagavi	Marihal	15.88	74.67	Black	Harvesting	Irrigated	Malini F1	16.12	Downy mildew
		Sulebhavi	15.89	74.65	Black	Flowering	Rainfed	Malini F1	17.88	Downy mildew
		K.K.Koppa	15.85	74.50	Black	Flowering	Rainfed	Malini F1	10.25	Downy mildew
		Hulikatti	15.78	74.62	Black	Flowering	Rainfed	Malini F1	24.15	Downy mildew
		Sutagatti	15.86	74.71	Black	Harvesting	Irrigated	Malini F1	29.18	Downy mildew anthracnose
								Taluk mean	**20.02**	
Belagavi	Gokak	Nesargi	15.90	74.77	Black	Flowering	Irrigated	Malini F1	30.12	-
		Yardal	15.77	74.79	Black	Flowering	Irrigated	Malini F1	33.59	-
		Murkibhavi	15.63	74.73	Black	Flowering	Irrigated	Malini F1	29.45	-
		Gokak	15.86	74.84	Black	Flowering	Irrigated	Malini F1	38.12	Anthracnose
								Taluk mean	**32.82**	
	Savadatti	Kurabetta	16.23	74.59	Black	Flowering	Rainfed	Gullakai	12.45	-
		Munavalli	15.63	74.51	Black	Flowering	Rainfed	Gullakai	18.19	-
		Yaragatti	16.23	74.50	Black	Flowering	Irrigated	Dharwad green	28.27	-
		Inamhongal	15.62	75.07	Black	Flowering	Irrigated	Dharwad green	29.15	-
		Hire ulligeri	15.66	75.09	Black	Harvesting	Irrigated	Greenlong	27.15	-
		Savadathi	15.75	75.12	Black	Harvesting	Irrigated	Dharwad green	26.15	-
							Taluk mean	**23.85**		
							District mean	**29.61**		

Districts	Taluks	Villages	Latitude (°N)	Longitude (°E)	Soil type	Stage of the crop	Type of cultivation	Variety/ Hybrid	PDI	Other diseases observed
Dharwad	Dharwad	MARS, Dharwad	15.45	75.00	Black	Harvesting	Rainfed	Dharwad green	59.66	Downy mildew, Anthracnose, Wilt.
		Garaga	15.34	74.55	Black	Harvesting	Irrigated	Greenlong	40.16	Downy mildew
		Tadakoda	15. 60	74.99	Black	Harvesting	Irrigated	Dharwad green	40.86	Anthracnose
		Lokur	15.72	74.79	Black	Flowering	Rainfed	Gullakai	35.12	Downy mildew
		Narendra	15.36	75.12	Black	Harvesting	Irrigated	Dharwad green	31.29	-
		Yethinagudda	15.48	74.98	Black	Harvesting	Irrigated	Gullakai	38.15	-
		Maalapur	15.46	75.00	Black	Harvesting	Irrigated	Dharwad green	46.66	-
		Mrityunjayanagar	15.46	75.01	Black	Harvesting	Irrigated	Sarpan seeds	12.25	Downy mildew
		Marewada	15.43	75.05	Black	Harvesting	Irrigated	Dharwad green	14.15	Downy mildew
		Kavalgeri	15.49	75.07	Black	Harvesting	Irrigated	Greenlong	29.16	-
								Taluk mean	**34.74**	
	Hubballi	Varur	15.1	74.97	Black	Harvesting	Irrigated	Dharwad green	28.16	Downy mildew
		Agadi	14.82	75.46	Black	Flowering	Irrigated	Dharwad green	36.66	-
		Adaragunchi	12.97	77.56	Black	Harvesting	Rainfed	Dharwad green	42.78	-
		Samshi	15.21	75.30	Black	Harvesting	Irrigated	Dharwad green	43.29	-
		Betadur	15.22	75.19	Black	Harvesting	Irrigated	Green long	15.17	Downy mildew
		Ramankoppa	15.16	75.14	Black	Harvesting	Irrigated	Gullakai	13.53	Downy mildew
								Taluk mean	**31.39**	
		District Mean							**33.06**	
Haveri	Byadgi	Mallur	14.69	75.44	Black	Harvesting	Rainfed	Dharwad green	29.66	Downy mildew
		Angaragtti	14.66	75.44	Red	Harvesting	Rainfed	Ranebennur local	40.18	-
		Kadaramandalgi	14.64	75.51	Red	Harvesting	Rainfed	Dharwad green	35.69	-
		Motebennur	14.71	75.48	Red	Harvesting	Rainfed	Ranebennur local	30.15	-
		Haleshidenur	14.63	75.44	Black	Harvesting	irrigated	Ranebennur local	39.28	-
								Taluk mean	**32.84**	
	Hirekerur	Bannihatti	14.37	75.41	Red	Floweing	Rainfed	Ranebennur local	20.48	Anthracnose
		Hullatti	14.48	75.48	Red	Harvesting	Rainfed	Ranebennur local	32.12	-
		Masur	14.25	75.01	Red	Floweing	Irrigated	Ranebennur local	39.55	-
		Rattihalli	14.42	75.51	Black	Floweing	Rainfed	Ranebennur local	30.36	Anthracnose
								Taluk mean	**30.62**	
	Haveri	Nelogal	14.69	75.40	Red	Harvesting	Rainfed	Ranebennur local	26.12	Downy mildew
		Haveri	14.66	75.43	Red	Harvesting	Irrigated	Ranebennur local	20.16	Downy mildew
		Motebennur	14.63	75.42	Red	Harvesting	Rainfed	Ranebennur local	26.36	Downy mildew
		Kerimattihalli	14.75	75.37	Red	Harvesting	Rainfed	Ranebennur local	20.15	Anthracnose

		Vardi cross	14.32	75.54	Red	Harvesting	Rainfed	Ranebennur local	29.66	Downy mildew
								Taluk mean	**24.49**	
Districts	**Taluks**	**Villages**	**Latitude (°N)**	**Longitude (°E)**	**Soil type**	**Stage of the crop**	**Type of cultivation**	**Variety/ Hybrid**	**PDI**	**Other diseases observed**
Haveri	Shiggaon	Bisalahalli	14.54	75.56	Black	Harvesting	Rainfed	Ranebennur local	23.20	Anthracnose
		Tadasa	13.90	75.70	Black	Harvesting	Irrigated	Ranebennur local	29.26	Anthracnose
		Niralagi	15.31	74.72	Red	Harvesting	Irrigated	Ranebennur local	22.18	Downy mildew
		Kamanhalli	15.01	75.19	Red	Harvesting	Rainfed	Ranebennur local	28.26	Downy mildew
		Gotagodi	15.02	75.18	Red	Harvesting	Rainfed	Ranebennur local	36.25	Downy mildew
		Shiggaon	14.51	75.41	Red	Harvesting	Rainfed	Ranebennur local	30.78	Downy mildew
		Taluk mean							**28.66**	
	Ranebennur	Gangajaltanda	-	-	Red	Harvesting	Rainfed	Ranebennur local	33.26	-
		Asundi	14.61	75.59	Red	Harvesting	Rainfed	Ranebennur local	30.15	-
		Guttal	14.62	75.62	Red	Harvesting	Rainfed	Ranebennur local	39.25	-
		Siddapur	14.34	75.89	Red	Harvesting	Rainfed	Ranebennur local	26.15	Anthracnose
		Halageri	14.61	75.63	Red	Harvesting	Rainfed	Ranebennur local	28.12	Downy mildew
		Ranebennur	14.61	75.62	Red	Harvesting	Rainfed	Ranebennur local	27.15	Downy mildew
		Chalageri	14.56	75.71	Red	Harvesting	Irrigated	Ranebennur local	18.66	-
		Medleri	14.66	75.73	Red	Harvesting	Irrigated	Ranebennur local	40.19	-
		Basirikatti	15.84	74.59	Red	Harvesting	Irrigated	Ranebennur local	58.15	-
		Chikkuruvathi	14.62	75.63	Red	Harvesting	Rainfed	Ranebennur local	26.77	Downy mildew
								Taluk mean	**32.78**	
						District mean			**29.87**	
Vijaypura	Basavana bagewadi	Agasabal	16.52	76.05	Black	Harvesting	Rainfed	Dharwad green	28.66	-
		Managuli	16.65	75.81	Black	Harvesting	Rainfed	Malini	40.15	-
		Ronihal	16.52	75.69	Black	Harvesting	Rainfed	Malini	36.69	-
								Taluk mean	**35.16**	
	Vijaypura	Jumanal	16.47	75.52	Black	Harvesting	Irrigated	Dharwad green	29.58	-
		Vijayapur	16.83	75.71	Black	Harvesting	Rainfed	Dharwad green	22.45	-
		Hittinalli	16.31	74.78	Black	Harvesting	Rainfed	Dharwad green	20.18	-
		Bhutanal thanda	16.89	75.71	Black	Harvesting	Irrigated	Dharwad green	22.26	-
		Arakeri	16.90	75.69	Black	Harvesting	Rainfed	Dharwad green	17.29	-
								Taluk mean	**22.35**	
	Indi	Tidagundi	17.21	75.80	Black	Harvesting	Rainfed	Dharwad green	27.69	-
		Horti	17.11	75.78	Black	Harvesting	Rainfed	Dharwad green	23.10	-
		Basanal	17.06	75.78	Black	Harvesting	Rainfed	Dharwad green	25.12	-
								Taluk mean	**25.30**	
						District mean			**27.60**	

Table.1b Districts and Talukawise incidence of powdery mildew in cucumber

Sl No.	District	Taluk	Mean PDI	District mean PDI
1	Belagavi	Bailhongal	32.16	**27.21**
		Belagavi	20.02	
		Gokak	32.82	
		Savadathi	23.85	
2	Dharwad	Dharwad	34.74	**33.06**
		Hubballi	31.39	
3	Haveri	Shiggaon	28.66	**29.87**
		Haveri	24.49	
		Byadgi	32.84	
		Ranebennur	32.78	
		Hirekerur	30.62	
4	Vijaypura	Vijaypura	22.35	**27.60**
		Indi	25.30	
		Basavanabagewadi	35.16	

Table.1c Influence of type of cultivation on severity of cucumber powdery mildew in northern Karnataka during *kharif* 2016

Sl No.	District	Taluk	Type cultivation		District mean PDI
			Rainfed (PDI)	Irrigated (PDI)	
1	Belagavi	Bailhongal	38.74	27.72	**27.21**
		Belagavi	17.43	22.65	
		Gokak	-	32.82	
		Savadathi	18.26	26.66	
2	Dharwad	Dharwad	47.39	28.61	**33.06**
		Hubballi	42.78	27.36	
3	Haveri	Shiggaon	29.62	25.72	**29.87**
		Haveri	25.57	20.16	
		Byadgi	34.99	39.28	
		Ranebennur	30.12	39.00	
		Hirekerur	27.65	39.55	
4	Vijaypura	Vijaypura	19.97	22.26	**27.60**
		Indi	25.30	-	
		Basavanabagewadi	35.17	-	
Mean per cent disease index			**30.23**	**29.32**	

Table.1d Influence of variety/hybrids on severity of cucumber powdery in northern Karnataka during *kharif* 2016

Sl No.	Variety/hybrid	Per cent disease index (PDI)				Mean PDI
		Belagavi	Dharwad	Haveri	Vijaypura	
1	Malini	27.19	-	-	38.42	**32.80**
2	Dharwad green	32.85	38.17	32.68	24.04	**31.95**
3	Greenlong	24.66	22.17	-	-	**23.41**
4	Gullakai	20.72	28.93	-	-	**24.82**
5	Ranebennur local	-	-	30.44	-	**30.44**
6	Sarpan hybrid	-	12.25	-	-	**12.25**

Table.1e Influence of stage of crop on severity of cucumber powdery on different varieties/hybrids in northern Karnataka during *kharif* 2016

Sl No.	Stage of the crop	Per cent disease index (PDI) in different variety						Mean PDI
		Malini	Dharwad green	Green long	Gullakai	Ranebennur local	Sarpan hybrid	
1.	Flowering stage	28.48	37.46	22.16	23.60	30.13	-	**28.36**
2.	Harvesting stage	18.455	36.075	33.655	32.65	31.705	12.25	**25.42**

The severity of powdery mildew ranged from 10.25 to 63.08 Per cent Disease Index (PDI) in northern Karnataka during late *kharif*, 2016. The highest mean disease severity was recorded in Dharwad district (33.06 PDI) followed by Haveri district (29.87 PDI) and least disease incidence was recorded in Belagavi district (27.21 PDI) and incidence in Vijaypura district was on par with Belagavi district (27.60). This clearly indicates that the disease severity and development depends on factor like location, stage of the crop, cultural practices adopted and susceptibility of the cultivars grown. Apart from this it also depends on congenial conditions prevailing in that area for disease development.

The highest severity of powdery mildew was attributed to the temperature, relative humidity, leaf wetness period, morning dew and sunshine hours prevailed during the crop period, which was favorable for the powdery mildew development and spread. Similar types of observations were made by Cheah *et al.*, (1996) while working with pea.

Prevalence of higher disease intensity in these areas may be due to congenial climatic conditions like relative humidity, cool temperature and susceptible genotypes which might have influenced inoculum multiplication, varied temperature regimes and water content of conidia supported spore germination and infection process of the fungus *Erysiphe cichoracearum.*

The results are in confirmation with observation of several investigators (Sharmila *et al.*, 2005; Raghavendra, 2005 and Ashtaputre, 2006). Results are also in line with Chaudhary *et al.*, 2014 who reported that capsicum powdery mildew disease severity was differ among the various locations of Himachal Pradesh.

If the age of the crop coincides with favourable weather parameters development of the disease with very fast and cause a severe loss. Minimum rainfall, cooler nights and high day temperatures were enough for disease development. Wide variation (13-15^0 C) in the maximum and minimum temperature and day and night relative humidity (39.9-51.7 %) enhances the development of powdery mildew and it was very much noticed in black gram (Anand Singh and Anil Sirohi, 2003).

The highest severity of powdery mildew was attributed to the temperature and relative humidity prevailed during the crop periods which were favourable for the powdery mildew development and spread. Similar types of observations were made in chilli powdery mildew by Ashtaputre *et al.,* (2006).

Among the varieties/hybrids cultivated Malini a hybrid from Seminis Company has covered more area in Belagvi district. Because of heavy plant population and higher doses of fertilizer application by farmers resulting in succulency in plant and favourable microclimate for disease development and host susceptibility similar observation were also made by Koren (1978) and Palti (1971). Intensive cultivation coupled with continuous cropping, where in proximity of infected crops and amount of inoculum present undoubtedly affected the incidence of disease besides creating the favourable environmental conditions (Giladi, 1983, Palti, 1971, Friedrich *et al.,* 1998, Reuveni and Rotem, 1973, Clerk and Ayesu offei, 1967).

From the survey during 2016-17 it was very clear that, the disease incidence was varying in four different districts. The mean disease severity was more in Dharwad district (33.06 PDI) followed by Haveri district (29.87 PDI) and average mean percent disease severity (PDI) was observed in Belagavi (27.21 PDI) district followed by Vijaypuraa (27.60 PDI). The maximum disease severity of 63.08 per cent was observed in Bailwad cross village of Bailhongal taluka, Belagavi district where prevailing fertile black soils resulted in luxurious growth of the crop and prevailing dry condition has helped the pathogen to build up the inoculum hence, the disease intensity was more severe there.

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