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Survey and mapping of powdery mildew in cucumber growing belts of Western Maharashtra

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Abstract
Cucumber (*Cucumis sativus* L.) is belonging to family Cucurbitaceae one of the most popular and favorite vegetable crops in different parts of the world. Powdery mildew of cucumber caused by *Erysiphe cichoraciarum* DC, is one of the most important fungal diseases and is responsible for substantial yield losses. The present investigation was undertaken to study the epidemiology of the disease and to develop suitable management practices under field conditions during *Kharif* 2018-19 and 2019-20. In the present study, systematic survey was carried out to know the severity and distribution of cucumber powdery mildew in cucumber growing areas of Western Maharashtra and also to study the symptomatology to get status of the disease. The severity of cucumber powdery mildew in Western Maharashtra was noticed variation from locality to locality, because of type of varieties grown, different environmental conditions, cropping pattern and buildup of inoculum due to ideal microclimatic condition at different localities. Two villages varying Arangaon percent disease index (PDI) 30.88 percent of Jamkhed tahsil and Mirajgaon percent disease index (PDI) 36.44 percent of Karjat tahsil of Ahmednagar district were identified as hot spots for cucumber powdery mildew disease in Western Maharashtra.

Keywords: Cucumber, powdery mildew, survey, Western Maharashtra, *Erysiphe cichoracearum*

Introduction
Cucumber (*Cucumis sativus* L.) is belonging to family Cucurbitaceae one of the most popular and favorite vegetable crops in different parts of the world. It is used either as fresh fruits or in pickling industry. Cucumber contains 0.4 percent protein, 2.5 percent carbohydrates, 15 mg iron and 2 mg of vitamin C in 100 mg of fresh weight. Fruits are good for people suffering from constipation, jaundice and indigestion (Anonymous, 2014) [1]. Cucurbit powdery mildew is particularly prevalent in tropical and some temperate climate where it frequently causes significant reduction in product quality and yield. The disease has been reported to be most common, wide spread and easily recognized disease of both field and greenhouse grown cucurbit crops. Due to prevalence of powdery mildew on cucumber it is highly susceptible to this disease and suffers heavy losses in all localities of Maharashtra State, wherever it is grown. Cucumber is found wild in Himalaya in Northern India (Molen, 2007/2008). Cucumbers have been grown in India for more than 3000 years and around 2000 B.C. was brought to the area around the Mediterranean Sea and Egypt (Bjelland, 1988) [3]. Powdery mildew can appear in most parts of the cucumber plant, but is most common in young tissues on the upper side of the leaves (Agrios, 2005) [4]. The root is not infected and fruits are free of visible infection (Sitterly, 1978) [5]. The first signs of infection are circular white spots, in both the upper and lower surface of the leaf (Robinson and Decker-Walters, 1997). The white lesions increase in number, until they cover both leaf surface and stems (Sitterly, 1978) [5]. Leaves that are seriously affected will become brown and shrunken. When young leaves are infected, it can result in chlorosis. When conditions are ideal the powdery mildew can cover the whole leaf, cause leaves to die, which results in premanture defoliation. Powdery mildew may also cause reduced yields with failed maturity and small and deformed fruits (Sitterly, 1978) [5]. Powdery mildew and downy mildew together cause up to 50 -70 percent loss (Sitterly, 1978 and Awad, 2000) [5]. There is a need for evaluation of disease development in various geographical situation in western Maharashtra by counducting roving survey for disease to get information on distribution, stage of severity, volume of spread and to locate hot spot in cucumber growing areas of western Maharashtra.

Materials and Methods
Cucumber is mostly cultivated in *Kharif* season under both rainfed and irrigated conditions in

Maharashtra. A roving survey was carried out in the major cucumber growing belts of Western Maharashtra during *kharif*, 2018-19 and 2019-20. Farmers field in different villages of Ahmednagar, Pune and Satara, Sangli, Kolhapur districts were covered under survey programme. In each village five cucumber fields were selected randomly on both sides of the road and 60 days old cucumber crops were assayed for powdery mildew when powdery mildew pustules will be visible. In each field ten cucumber plants were randomly selected and for measuring disease incidence and disease severity lower, middle and upper crop canopy observed and evaluated individually using 0-9 rating scale based on leaf area covered by pustules as mentioned below in Rating scale used for disease severity (Mayee and Datar, 1986) [6].

Rating scale	Description
0	No symptoms on leaf
1	Powdery mildew pustules small, scattered covering 1% or less of leaf area
3	Powdery mildew pustules more in number covering 1-10% of leaf area
5	Typical powdery mildew pustules covering 11-25% of leaf area
7	Typical powdery mildew pustules covering 26-50% of leaf area
9	Typical powdery mildew pustules covering 51% or more of leaf area

Further these scales were converted to percent disease index using formula given by Wheeler (1969) [8].

$$PDI = \frac{\text{Sum of observed numerical rating}}{\text{Number of leaves/plants observed x Maximum grade}} \times 100$$

The percent disease incidence was calculated by using the following formula

$$\text{Percent disease incidence} = \frac{\text{Number of plants affected}}{\text{Total number of plants observed}} \times 100$$

Results and Discussion

A systematic survey of powdery mildew of cucumber was carried out in 5 districts of Western Maharashtra during *Kharif* 2018-19 and 2019-20 to find out the appearance, prevalence, distribution and severity of disease powdery mildew on cucumber as explained in material and methods. The data on severity and incidence of powdery mildew of cucumber 55 localities of Western Maharashtra the results are presented in Table 1. The data revealed that, powdery mildew of cucumber caused by *Erysiphe cichoraciarum* DC was predominant in regions but their severity was varied from in cucumber growing belts of Western Maharashtra during *Kharif* 2018-19 and 2019-20. In Western Maharashtra, the average severe disease incidence and severity was recroded in Ahmednagar district PDI and severity (36.94 and 29.10%) followed by Pune (33.50 and 26.93) and low in Kolhapur district (32.32 and 25.77%). Among the tahsil of Ahmednagar district, the average disease severity was more severe in Karjat tahsil (38.90 and 29.16%). The low severity of was also recorded in Gaganbavada (31.64 and 25.31%) followed by Karveer (33.0 and 26.23%) *Kharif season* 2018-19 and 2019-20.

Among the tahsil of Pune district, the average severity was moderate in Bhore (33.96 and 27.52%) followed by Purandar tahsil (33.13 and 26.34%) during *Kharif* season of 2018-19 and 2019-20. Among the tahsils of Satara district severity was more severe in Koregaon (34.72 and 26.91%) followed by moderate in Satara (31.92 and 24.91%). In Satara tahsil severity was more severe PDI in Degaon village (41.99 and 32.88%) and in Koregaon tahsil Chilewadi was more severiety PDI in village. In Koregaon tahsil Chilewadi village had severe disease severity and PDI (36.23 and 29.93%). Among Sangli districts, Sangli tahsil Tasgaon the average severity was more in Tasgaon (34.17 and 27.7%) followed by moderate in Kavahemhankal (34.91 and 27.36%). In Tasgaon tahsil Julewadi village was more disease severity (35.65 and 29.50%). In Kavathemahankal Tahsil Irali village was more disease severity and PDI (42.15 and 31.54%).

Among the Kolhapur district the average severity was more severe in Karveer (33.00 and 26.23%) followed by moderate in Gaganbavada tahsil (31.64 and 25.31%) in Karveer tahsil, severity was moderate in Shiroli Dumala village (39.51 and 33.60%) in Gaganbavada tahsil, Gaganbavada village has more severity (44.33 and 32.45%). The disease severity was more in irrigated area than rainfed. All varieties sown by farmer was infected by *E. cichoraciana* DC but more severe in case variety Saini and Jypsy lowest in Swati cultivar.

This systematic survey was confirmed by random survey of cucumber growing are systemic survey was confirmed by random survey of cucumber growing area powdery mildew and downy mildew together causes upto 50-70 percent a loss (Sitterly, 1978) [5]. The severity of powdery mildew was attributed to the temperature and relative humidity prevailed during crop periods which were favourable for the powdery mildew development and spread. Similar types of observation were made in chilli powdery mildew by Ashtaputre *et al.* (2007) [1]. The data revealed that on severity and incidence that villages of Ahmednagar district like Mirajgaon and Arangaon were identified as hot spot for cucumber powdery mildew disease in major cucumber growing areas of Western Maharashtra during *Kharif* season 2018-19 and 2019-20.

Table 1: Survey on severity of cucumber powdery mildew in major cucumber growing areas of Western Maharashtra

Taluka/ Village	Variety sown	Longitude	Latitude	Disease incidence (%)			Disease Severity (%)		
				2018-19	2019-20	Mean	2018-19	2019-20	Mean
Ahmednagar district									
Jamkhed									
Borle	Rijkzwaaan	18°34'08.0"	75°18'22.1"	35.10	37.11	36.10	27.87	31.12	29.50
Arangaon	Gypsy	19°01'34.9"	74°42'51.7"	46.88	49.66	48.27	28.66	33.10	30.88
Jawala	Gypsy	18°32'49.8"	75°16'22.0"	23.88	27.98	25.93	26.33	32.45	29.39
Jategaon	Saini	19°55'22.9"	73°38'50.9"	39.66	41.10	40.38	21.59	25.87	23.73
Halgaon	Rijkzwaan	18°35'35.6"	75°13'54.8"	30.42	34.40	32.41	20.20	23.20	21.70
Average of Taluka	-	-	-	35.19	38.05	36.62	24.93	29.15	27.04
Karjat									
Mirajgaon	Saini	18°43'46.6"	75°01'16.1"	43.26	47.10	45.18	32.33	35.89	36.44
Pategaon	Gypsy	18°37'10.1"	75°03'57.1"	42.44	38.88	40.66	30.25	31.12	30.88
Walvad	Rijkwzaan	18°37'43.7"	74°57'31.7"	32.88	36.78	34.83	16.55	19.88	29.39
Nimbe	Saini	18°28'28.8"	75°02'55.4"	36.55	40.46	38.505	27.87	34.13	30.73
Khandvi	Gypsy	18°44'28.1"	74°52'36.5"	33.55	37.10	35.325	24.21	28.33	26.27
Average of Taluka	-	-	-	37.74	40.06	38.9	28.44	29.87	29.16
Rahuri									
Desavandi	Jypsy	19°24'09.0"	74°40'03.5"	42.10	44.13	43.115	35.89	33.55	34.72
Digras	Shiny	19°22'03.7"	74°37'10.2"	37.33	35.24	36.285	27.88	31.12	29.5
Taklimiya	Local	19°27'07.9"	74°40'06.7"	23.66	25.88	24.77	15.66	17.10	16.38
Valan	Local	19°16'32.7"	74°37'13.7"	32.88	34.89	33.885	26.33	30.11	28.22
Warwandi	Local	19°19'48.8"	74°37'34.3"	37.10	39.88	38.49	31.25	35.22	33.235
Average of Taluka	-	-	-	34.61	36.00	35.31	27.40	29.42	28.41
Average of District	-	-	-	35.85	38.03	36.94	28.23	29.48	29.10
Pune District									
Bhor Tahsil									
Khopi	Himangi	18°18'58.6"	73°50'34.6"	36.56	38.34	37.45	29.10	31.98	30.54
Shivre	Chitra	18°18'23.8"	73°50'34.6"	26.98	29.88	28.43	18.10	20.11	19.11
Degaon	Malika	18°16'45.0"	73°53'48.9"	34.98	35.77	35.38	26.35	30.10	28.23
Vavare BK	saini	18°18'12.3"	73°52'02.4"	36.98	39.60	38.29	29.28	31.29	30.29
Kamthadi	Swati	18°14'44.2"	73°53'17.6"	28.66	31.86	30.26	28.44	30.45	29.45
Average of Taluka	-	-	-	32.83	35.09	33.96	26.25	28.79	27.52
Taluka/ Village	**Variety sown**	**Longitude**	**Latitude**	**Disease incidence (%)**			**Disease Severity (%)**		
				2018-19	**2019-20**	**Mean**	**2018-19**	**2019-20**	**Mean**
Purandar									
Tekewadi	Himangi	18°24'00.8"	74°11'46.8"	40.15	42.66	41.405	31.46	33.50	32.48
Kothale	Swati	18°19'02.6"	74°09'31.8"	32.10	36.45	34.275	26.55	30.45	28.5
Hatave BK	Shubhangi	18°14'11.5"	73°51'16.8"	31.66	34.10	32.88	28.50	30.65	29.58
Naygaon	Rajeshwari	18°21'52.4"	74°14'11.6"	25.66	28.10	26.88	15.98	19.10	17.54
Rajuri	Chitra	19°08'59.5"	74°08'23.8"	28.10	32.35	30.225	22.56	24.63	23.60
Average of Taluka	-	-	-	31.53	34.73	33.13	25.01	27.67	26.34
Average of District	-	-	-	32.18	34.81	33.50	25.63	28.23	26.93
Satara district									
Satara tahsil									
Nagthane	Kolhapur kakdi	17°33'45.3"	74°02'58.0"	31.66	35.30	33.48	21.55	24.66	23.10
Anavale	Kolhapur kakdi	17°42'07.7"	73°54'14.0"	35.20	37.55	36.375	28.30	30.36	29.33
Chikhali	Chitra	17°52'10.1"	73°40'58.6"	24.66	26.33	25.495	17.66	19.99	18.83
Degaon	Shiny/Gypsy	17°37'55.0"	74°03'19.8"	41.10	42.88	41.99	31.78	33.98	32.88
Kari	Shiny	17°37'59.7"	73°54'35.0"	31.33	33.20	32.265	18.20	22.65	20.43
Average of Taluka	-	-	-	32.79	29.99	31.92	23.50	26.33	24.91
Koregaon									
Chilewadi	Jypsy	17°52'24.9"	74°15'15.0"	37.13	35.33	36.23	28.98	30.87	29.93
Nandiwal	Jypsy	17°57'34.3"	74°04'22.3"	30.11	34.12	32.115	20.88	22.40	21.64
Naygaon	Shiny/Himangi	17°59'07.0"	74°03'53.9"	28.55	32.88	30.715	19.55	21.89	20.72
Karanjkhop	Kolhapur Kakadi	17°56'34.1"	74°03'06.3"	23.66	25.87	24.765	14.98	16.99	15.99
Solashi	Shiny/Himangi	17°59'06.6"	74°02'33.2"	33.66	35.27	34.765	27.65	29.88	28.765
Average of Taluka	-	-	-	35.62	33.81	34.72	29.41	24.41	26.91
Average of District	-	-	-	34.21	31.43	33.32	27.96	25.37	26.67
Sangli district									
Kavathemahankal									
Irali	Hemangi	17°03'23.0"	74°58'43.5"	40.15	44.10	42.125	29.88	33.20	31.54
Haruli	Saini	16.971982	74.795694	38.10	43.20	40.65	29.10	31.24	30.17
Shirdone	Gypsy	17°01'05.9"	74°48'24.2"	31.55	33.66	32.605	26.10	28.78	27.44
Lonarwadi	Saini	16°56'08.4"	74°57'08.1"	34.87	36.68	35.775	25.66	31.10	28.38

Zurewadi	Kolhapur Kakdi	17°01'45.4"	74°51'21.6"	21.36	25.42	23.39	16.36	22.14	19.25
Average of Taluka	-	-	-	33.21	36.61	34.91	25.42	29.29	27.36
Taluka/ Village	Variety sown	Longitude	Latitude	Disease incidence (%)			Disease Severity (%)		
				2018-19	2019-20	Mean	2018-19	2019-20	Mean
Tasgaon tahsil									
Alte	Himangi	17°10'08.8"	74°32'42.6"	31.10	33.45	32.275	27.45	31.21	29.33
Anjani	Kolhapur kakdi	17°05'01.9"	74°46'40.2"	38.10	39.22	38.66	28.79	32.20	30.50
Dorli	Saini	17°07'05.8"	74°35'20.7"	26.98	28.97	27.98	24.56	28.45	26.51
Limb	Kolhapur kakdi	17°10'02.3"	74°34'00.9"	30.56	34.45	32.51	23.55	26.33	24.94
Julewadi	Saini	17°01'18.3"	74°30'39.0"	33.65	37.65	35.65	27.89	31.10	29.50
Average of Taluka	-	-	-	32.08	34.75	33.41	26.45	29.86	28.15
Average of District	-	-	-	32.65	35.68	34.17	25.94	29.58	27.76
Kolhapur district									
Karveer tahsil									
Shiroli dumala	Us800F1 hybrid)	16°36'27.3"	74°06'51.4"	36.66	42.36	39.51	30.66	36.55	33.605
Kasba Beed	Trust seed	16°38'56.2"	74°07'53.1"	23.56	27.33	25.445	18.65	22.33	20.49
Sadoli Dumala	F1 Saloni hybrid)	16°35'53.1"	74°06'17.0"	35.89	43.22	38.55	29.30	33.25	31.28
Savarde	Local/Himangi	16°36'19.9"	74°05'11.6“	19.66	24.33	21.995	17.66	19.88	18.77
Bahireshwar	Kolhapur kakdi	16°39'19.0"	74°06'29.1"	34.66	42.33	38.495	19.33	24.66	22.0
Average of Taluka	-	-	-	30.09	35.91	33	24.12	27.33	26.23
Gaganbavda tahsil									
Wetavde	F1Saloni hybrid)	16°39'15.3"	73°59'42.4"	23.55	26.98	25.27	14.89	18.98	16.94
Salwan	Local/Himangi	16°41'43.5"	73°59'09.2"	33.56	37.69	35.63	27.56	31.66	29.61
Gaganbavda	Kolhapur kakdi	16°59'09.2"	73°50'00.3"	40.33	44.33	42.33	30.33	34.56	32.45
Asandoli	Us 800F hybrid)	16°39'09.4"	73°57'07.8"	36.56	41.10	38.83	28.56	32.33	30.45
Tisangi	Trust seed	16°40'22.4"	74°00'25.1"	27.56	31.22	29.39	20.56	24.56	22.56
Average of Taluka	-	-	-	32.31	36.26	31.64	24.25	28.42	25.31
Average of District	-	-	-	30.20	35.09	32.32	24.18	26.87	25.77

Conclusion

The authors concluded that the severity of Cucumber powdery mildew in Western Maharashtra was found varied from locality to locality because the type of variety grown, different environmental conditions, cropping pattern and buildup of inoculum due to ideal microclimate of different localities villages data indicate that viz., Arangaon in Jamkhed tahsil and Mirajgaon in karjat tahsil of Ahmednagar district identified as a hot spot for cucumber powdery mildew disease in Western Maharashtra**.**

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