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RESEARCH PAPER

Survey for the severity of powdery mildew of mulberry in northern Karnataka

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Abstract: A fixed plot survey on severity of powdery mildew of mulberry was conducted in Bagalkot, Belagavi, Chitradurga, Dharwad, Gadag, Haveri, Vijayapura and Ramanagara districts of Karnataka during late *kharif* 2019-20. The results of survey revealed that, the disease severity varied across the locations surveyed.The maximum mean per cent disease index was recorded in Ramanagara district (42.77 PDI) followed by Dharwad district (40.20 PDI) and minimum mean per cent disease index was recorded in Chitradurga district (30.72 PDI) followed by Gadag district (31.72 PDI).Among the surveyed places the highest per cent disease index was noticed in Chikkamalligwad village (67.45 PDI) of Dharwad district followed by Ramanagara (66.32 PDI). Whereas, the lowest per cent disease index was noticed in J. N. Kote village (12.43 PDI) of Chitradurga district. The data from the survey revealed that, the disease severity was more in black soil (36.59 PDI) compare to red soil (35.78 PDI). The disease severity was more in rainfed (38.51 PDI) compare to irrigated (32.90 PDI) condition. Among the different varieties cultivated in the farmer's field V-1, S-34, Sahana, M-5, and DH had more per cent disease index compare to other varieties *viz*., Mysore Local, G-2 and DD. The maximum disease severity (43.91 PDI) was noticed in fields at 50-60 Days After Pruning (DAP).

Key words: Mulberry, Per cent disease index, Powdery mildew, Survey

Introduction

Mulberry (*Morus indica* L.) is a quick growing perennial woody plant and belongs to the family, *Moraceae.*The leaves of mulberry plant serves as the basic food material and a source of nutrition for the growth and development of silkworm (*Bombyx mori* L.). The silkworm larvae encloses itself inside a cocoon during the moulting stages and the silk which is a protein fibre is extracted from this cocoon which is used in the textile industries. India stands second in production of mulberry silk (35,468 Metric tonnes, MT) after China. Mulberry leaf serves the feeding material for silkworm, hence production of healthy mulberry forms a significant aspect. In India, the total area under mulberry cultivation is around 2.82 lakh hectares with a production of 10777.4 MT. In Karnataka, mulberry covers an area of 98,135 ha with 9,322 MT of total raw silk production (Anon, 2018).

The foliage of mulberry also is a host various diseases, which are caused by fungi, bacteria, nematode and viruses. Among the major fungal foliar diseases, powdery mildew caused by *Phyllactiniacorylea* (Pers.) Karst (syn. *P. moricola* and *P. guttata*) is one of the important disease that covers the leaf surface and in turn deteriorating the quality of leaves to feed the silkworms(Chattopadhyay *et al.*, 2010). It is essential that mulberry leaf should be disease free to increase the leaf yield, productivity and quality of cocoons. This disease alone causes the loss of leaf yield by defoliation of about 5-10 percent and an additional loss of 20-25 percent by destruction of leaf area (Teotia and Sen, 1992). The symptoms of the disease first appears as white or fluffy mycelial growth with small circular patches or spots on lower surface of the leaf and chlorotic lesions on its corresponding upper surface of the leaf. The severely affected matured mulberry leaves turn to yellowish, leathery and dried, leading to premature defoliation (Gupta, 2001).

The weather situations such as warm humid condition with susceptible host leads to a severe outbreak of powdery mildew disease that leads to 15 to 20 per cent mulberry crop losses (Manjunatha *et al.*, 2017). Powdery mildew thrives in moderate temperature (25 to 30 °C) and high humidity (90 %) without rainfall or overhead irrigation. Consequently, the dense plant growth and moderate temperature provide the optimal conditions for severe powdery mildew outbreaks (Chikkaswamy and Paramanik, 2014). In the northern Karnataka, presently weather conditions are favorable for the outbreak of powdery mildew disease and it is very problematic because of abrupt change in the climate conditions. In this background efforts were made to map the prevalence of the mulberry powdery mildew diseases in northern Karnataka along with seasonality and severity during 2019-20.

Material and methods

A fixed plot survey on severity of powdery mildew of mulberry was taken up in Bagalkot, Belagavi, Chitradurga, Dharwad, Gadag, Haveri, Vijayapura and Ramanagara districts of northern Karnataka during late *kharif* 2019-20. In each taluk of each district, three villages were selected for survey. In each village individual fields were surveyed and necessary information pertaining to disease severity was recorded. From each farmer’s field, five plants were randomly selected and powdery mildew severity was recorded as grade by following 0-9 scale through visual observations (Mayee and Datar, 1986) as given below. During the survey, observations on powdery mildew severity, stage of the crop and other details were also recorded.

Disease scoring scale for powdery mildew (0-9 scale)

Grade	Disease	Description
0	No symptoms of powdery mildew on leaves	Highly resistant
1	Small powdery specks covering 1 per cent or less	leaf area Resistant
3	Powdery lesions small (upto 5 mm in size) covering 1-10 per cent of leaf area.	Moderately resistant
5	Powdery lesions enlarging 11-25 per cent of leaf area	Moderately susceptible
7	Powdery lesions coalesce to form big patches covering 26-50 per cent of leaf area	Susceptible
9	Big powdery patches covering 51 per cent or more of leaf area and defoliation occurs.	Highly susceptible

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

$$PDI = \frac{\text{Sum of individual disease ratings}}{\text{Total number of leaves graded} \times \text{Maximum disease rating}} \times 100$$

Results and discussions

The survey results were recorded during the late *kharif* 2019 for mulberry powdery mildew disease are presented in Table 1, 2 and 3.The maximum mean per cent disease index was recorded in Ramanagara district (42.77 PDI) followed by Dharwad district (40.20 PDI) and minimum mean per cent disease index was recorded in Chitradurga district (30.72 PDI) followed by Gadag (31.72 PDI).In these months the temperature ranges from 24-28^{0}C with high relative humidity of 85-90 per cent, which was considered as favorable condition for conidial production, and development of powdery mildew disease in mulberry ecosystem. These results are in agreement with the findings of Chikkaswamy and Paramanik(2014) and stated that, the maximum disease severity of mulberry powdery mildew incidence was noticed in Kanakapura (12.40 PDI) of Ramanagara district from July to November and minimum from December to April.

In Bagalkot district, the survey was conducted in three taluks, *viz.*, Badami, Bagalkot and Mudhol. In Badami taluk, maximum disease severity was recorded in Chirlakoppa (44.24 PDI) followed by Badami (42.78 PDI). Whereas, least disease severity was recorded in Kulgeri (31.22PDI). Among the villages surveyed in Bagalkot taluk, the maximum disease severity was recorded in Bagalkot (43.44 PDI) and the least disease severity was recorded in Thimmapur (22.24 PDI). In Mudhol taluk, the maximum disease severity was recorded in Mudhol (56.76 PDI) and the minimum disease severity was recorded in Saumshi (19.77 PDI).

In Belagavi district, the survey was conducted in three taluks *viz.*, Bailhongal, Gokak and Savadatti. Among the surveyed villages in Bailhongal taluk, maximum disease severity was recorded in Bailhongal (54.42 PDI), followed by Anigol (46.66 PDI). Whereas the lowest disease severity was recorded in Belwadi (24.54 PDI). Among the surveyed villages of Gokak taluk, the maximum disease severity was recorded in Gokak (55.23 PDI), whereas minimum disease severity was recorded in Tukkanatti (21.44 PDI). In Savadattitaluk, the maximum disease severity was recorded in Yonagi (56.34 PDI) and the minimum disease severity was recorded in Yaragatti village (18.75 PDI).

In Chitradurga district, survey was conducted in two taluks *viz.,* Chitradurga and Hiriyur. In Chitradurga taluk, the maximum disease severity was recorded in Ajjapnahalli (42.14 PDI), followed by Chitradurga (32.12 PDI). Whereas, the minimum disease severity was recorded in J. N. Kote (12.43 PDI). In Hiriyur taluk, the maximum disease severity was recorded in Hiriyur (41.33 PDI) and the minimum disease severity was recorded in Shravanagere (25.36 PDI).

In Dharwad district, survey was conducted in different villages of three taluks *viz.*, Dharwad, Kalaghatgi and Navalgund. In Dharwad taluk, the maximum disease severity was recorded in Chikkamalligwad (67.45 PDI) followed by Narendra (45.32 PDI). Whereas, the least disease severity was recorded in Hiremalligwad (35.55 PDI). In Kalaghatgi taluk, the maximum disease severity was recorded in Kalaghatgi (40.76 PDI) and the minimum disease severity was recorded in Agadi (21.90 PDI). In Navalgunda taluk, the maximum disease severity was recorded in Navalgunda (52.33 PDI) followed by Morab (46.66 PDI) and the minimum disease severity was recorded in Konnur (35.33 PDI).

In Gadag district, survey was conducted in two taluks *viz.*, Gadag and Shirahatti. In Gadag taluk, the maximum disease severity was recorded in Bentur (36.12 PDI) followed by Gadag (31.12 PDI). Whereas, the minimum disease severity was recorded in Mallasamudra (14.26 PDI). In Shirahatti taluk, the maximum disease severity was recorded in Bannikoppa (41.33 PDI), followed by Balehosuru (38.65 PDI) and the minimum disease severity was recorded in Chebbi (25.36 PDI).

In Haveri district, survey was conducted in two taluks *viz.*, Haveri and Ranebennur. In Haveri taluk, the maximum disease severity was recorded in Motebennur (42.26 PDI) and the minimum disease severity was recorded in Kerimattihalli (24.26 PDI). In Ranebennur taluk, the maximum disease severity was recorded in Siddapur (42.30 PDI). Whereas, the minimum diseases severity was recorded in Halgeri (27.26 PDI).

In Vijayapura district, survey was conducted in three taluks *viz.*, Vijayapura, Basavanabagewadi and Muddebihal. In Vijayapura taluk, the maximum disease severity was recorded in Kumathe (43.55 PDI) followed by Hittinalli (43.54 PDI). Whereas, the minimum disease severity was recorded in Kannur (24.76 PDI). In Basavanabagewadi taluk, the maximum disease severity was recorded in Kalgurki (54.67 PDI) followed by Nidagundi (50.43 PDI) and the minimum disease severity was noticed in Talikote (24.00 PDI). In Muddebihala taluk, the maximum disease severity was recorded in Tangadagi (45.43 PDI) followed by Kandaganur (35.44 PDI). Whereas, the minimum disease severity was recorded in Muddebihal (28.33 PDI).

Table 1. PDI for powdery mildew of mulberry in different districts of northern Karnataka during late *kharif* 2019-20

Districts	Taluks	Villages	Variety	Age of the crop (DAP)	Soil type	Type of cultivation	Other diseases noticed	Insect noticed	PDI
Bagalkot	Bagalkot	Bagalkot	Sahana	50	Black	Irrigated	Leaf rust	Mealy bug	43.44
		Bevinamatti	V-1	45	Red	Irrigated	-	-	28.34
		Thimmapur	V-1	50	Black	Irrigated	-	Thrips	22.24
		Taluk mean	31.34						
	Badami	Badami	V-1	52	Black	Rainfed	Leaf rust	Mealy bug	42.78
		Kerur	Sahana	40	Black	Rainfed	-	Plant bugs	36.26
		Kulgeri	V-1	42	Black	Rainfed	Leaf rust	-	31.22
		Govanakoppa	V-1	44	Black	Rainfed	-	-	38.87
		Chirlakoppa	V-1	50	Black	Rainfed	-	Thrips	44.24
		Taluk mean	38.67						
	Mudhol	Malapur	V-1	45	Black	Rainfed	Leaf rust	-	30.33
		Mudhol	V-1	54	Black	Rainfed	-	-	56.76
		Muddapur	V-1	35	Black	Rainfed	-	Thrips	21.66
		Saumshi	V-1	28	Black	Rainfed	-	-	19.77
		Taluk mean	32.13						
		District mean	34.05						
Belagavi	Bailhongal	Anigol	V-1	56	Black	Irrigated	-	Thrips, Termites	46.66
		Bailhongal	V-1	46	Black	Rainfed	Leaf spot	Thrips	54.42
		Belawadi	V-1	36	Black	Rainfed	-	-	24.54
		Taluk mean	38.87						
	Gokak	Gokak	V-1	50	Black	Rainfed	-	-	55.23
		Kalloli	V-1	34	Black	Rainfed	Leaf rust	Mealy bug, Bihar hairy caterpillar	24.32
		Tukkanatti	V-1	32	Black	Rainfed	Leaf rust	Thrips, Mealy bug	21.44
		Taluk mean	33.66						
	Savadatti	Savadatti	V-1	40	Black	Rainfed	-	-	33.33
		Yonagi	V-1	55	Black	Rainfed	-	-	56.34
		Munuvalli	V-1	48	Black	Rainfed	Leaf spot	-	22.00
		Yaragatti	V-1	25	Black	Rainfed	Leaf rust	-	18.75
		Taluk mean	32.11						
		District mean	35.58						
Chitradurga	Chitradurga	Chitradurga	V-1	37	Red	Irrigated	-	Mealy bug	32.12
		Jodichikkenahalli	V-1	45	Red	Irrigated	Leaf spot	Thrips	14.27
		J. N. Kote	V-1	38	Red	Irrigated	-	-	12.43
		Ajjapanahalli	V-1	40	Red	Irrigated	-	Thrips	42.14
		Taluk mean	25.24						
	Hiriyur	Dharmapura	V-1	28	Red	Irrigated	Leaf spot	-	39.44
		Shravangere	Mysore local		52	Red	Irrigated	Leaf spot Mealy bug	25.36
		Hiriyur	S-34	39	Red	Irrigated	-	-	41.33
		Hoskere	V-1	44	Red	Irrigated	-	-	38.65
		Taluk mean	36.20						
		District mean	30.72						
Dharwad	Dharwad	Garag	V-1	48	Black	Rainfed	Leaf rust	Thrips	39.21
		Chikkamalligwad	V-1	50	Black	Rainfed	-	-	67.45
		Hire malligwad	V-1	40	Black	Rainfed	Leaf rust	Thrips, Mealybug	35.55
		Narendra	V-1	48	Black	Rainfed	Leaf rust	-	45.32
		Taluk mean	46.88						
	Kalaghatgi	Kalaghatgi	V-1	52	Black	Rainfed	Leaf rust	Thrips	40.76
		Mundagod	V-1	35	Black	Rainfed	-	-	27.89
		Agadi	V-1	22	Black	Rainfed	-	-	21.90
		Taluk mean	30.18						

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Districts	Taluks	Villages	Variety	Age of the crop (DAP)	Soil type	Type of cultivation	Other diseases noticed	Insect noticed	PDI
Dharwad	Navalgund	Navalgund	V-1	45	Black	Rainfed	Leaf rust	Thrips, Plant bugs	52.33
		Konnur	V-1	40	Black	Rainfed	-	Bihar hairy caterpillar	35.33
		Morab	V-1	47	Black	Rainfed	-	-	46.66
		Alagawadi	V-1	56	Black	Rainfed	-	-	39.87
		Taluk mean	43.55						
		District mean	40.20						
Gadag	Gadag	Gadag	DD	43	Black	Rainfed	-	Mealy bug, plant bugs	31.12
		Mallasamudra	V-1	25	Black	Rainfed	Leaf spot	-	14.26
		Asundi	V-1	41	Black	Irrigated	-	plant bugs	18.45
		Bentur	V-1	55	Black	Irrigated	-	-	36.12
		Taluk mean	24.99						
	Shirahatti	Shirahatti	S34	52	Black	Irrigated	Leaf rust	Leaf hopper	38.44
		Chebbi	S13	48	Black	Irrigated	-	Mealy bug	25.36
		Bannikoppa	V-1	46	Black	Rainfed	Leaf rust	-	41.33
		Balehosuru	V-1	42	Black	Rainfed	-	-	38.65
		Taluk mean	38.45						
		District mean	31.72						
Haveri	Haveri	Motebennur	V-1	42	Red	Rainfed	-	Thrips	42.26
		Haveri	V-1	46	Red	Rainfed	Leaf rust	-	28.23
		Kerimattihalli	V-1	45	Red	Irrigated	-	-	24.26
		Taluk mean	31.58						
	Ranebennur	Ranebennur	V-1	45	Red	Rainfed	-	-	39.63
		Siddapur	V-1	52	Red	Rainfed	-	Thrips	42.30
		Halgeri	V-1	35	Red	Rainfed	Leaf rust	-	27.26
		Chalageri	V-1	46	Red	Rainfed	-	-	38.87
		Taluk mean	37.28						
		District mean	34.43						
Ramanagara	Ramanagara	Ramanagara	V-1	60	Red	Rainfed	Leaf spot	-	66.32
		Kirangeri	M-5	45	Red	Rainfed	Leaf spot	Thrips	52.11
		Bannikuppe	G2	46	Red	Irrigated	Leaf spot	-	29.00
		Doddakuntanahalli	V-1	55	Red	Rainfed	Leaf rust	-	48.66
		Taluk mean	49.02						
	Kanakapura	Kanakapura	G2	30	Red	Irrigated	-	Mealy bug	33.25
		Kallahalli	M-5	28	Red	Irrigated	Leaf spot	-	23.00
		Ballageri	M-5	34	Red	Irrigated	Leaf rust	Mealy bug	32.23
		Belaguli	V-1	40	Red	Rainfed	Leaf spot	-	45.21
		Honnahalli	V-1	55	Red	Rainfed	-	-	48.89
		Taluk mean	36.52						
		District mean	42.77						
Vijayapura	Vijayapura	Vijayapura	V-1	45	Black	Irrigated	-	-	38.89
		Hittinalli	V-1	46	Black	Irrigated	Leaf spot	Mealy bug	43.54
		Kannur	DH	30	Black	Irrigated	-		24.76
		Kumathe	V-1	50	Black	Irrigated	-	Mealy bug	43.55
		Taluk mean	37.69						
	Basavana bagewadi	Basavana bagewadi	S-34	52	Black	Rainfed	Leaf rust	Thrips	37.32
		Kalgurki	DH	46	Black	Rainfed	-	Mealy bug	54.67
		Nidagundi	V-1	45	Black	Irrigated	Leaf rust	-	50.43
		Talikote	DH	28	Black	Irrigated	-	-	24.00
		Taluk mean	41.61						
Vijayapura	Muddebihal	Sarur	V-1	42	Black	Irrigated	-	Thrips	34.55
		Muddebihal	DH	38	Black	Rainfed	-	Mealy bug	28.33
		Kandaganur	DH	42	Black	Irrigated	Leaf spot	-	35.44
		Tangadagi	V-1	44	Black	Irrigated	-	-	45.43
		Taluk mean	35.94						
		District mean	38.41						

Note: DAP - Days after pruning

Table 2. District and taluk-wise severity of powdery mildew of mulberry in northern Karnataka during *kharif*2019-20

District	Taluk	Mean PDI
Bagalkot	Bagalkot	31.34
	Badami	38.67
	Mudhol	32.13
	Mean	34.05
Belagavi	Bailhongal	38.87
	Gokak	33.66
	Savadatti	32.11
	Mean	35.88
Chitradurga	Chitradurga	25.24
	Hiriyur	36.20
	Mean	30.72
Dharwad	Dharwad	46.88
	Kalaghatgi	30.18
	Navalgund	43.55
	Mean	40.20
Gadag	Gadag	24.99
	Shirahatti	38.45
	Mean	31.72
Haveri	Haveri	31.58
	Ranebennur	37.28
	Mean	34.43
Ramanagara	Ramanagara	49.02
	Kanakapura	36.52
	Mean	42.77
Vijayapura	Vijayapura	37.69
	Basavanabagewadi	41.61
	Muddebihal	35.94
	Mean	38.41

In Ramanagara district, survey was conducted in two taluks *viz.*, Ramanagara and Kanakapur. In Ramanagara taluk, the maximum disease severity was recorded in Ramanagara (66.32 PDI) followed by Kirangeri (52.11 PDI). Whereas, the minimum disease severity was noticed in Bannikuppe (29.00 PDI). In Kanakapura taluk, the maximum disease severity was recorded in Honnahalli (48.89 PDI) followed by Belaguli (45.21 PDI). Whereas, the minimum disease severity was recorded in Kallahalli (23.00 PDI).

During the survey the maximum mean per cent disease index was observed in Ramanagara district (42.77 PDI) of Karnataka. The minimum mean per cent disease index was observed in Chitradurga (30.72 PDI). Among all the districts surveyed, it was noticed that the maximum disease severity of powdery mildew was recorded in V-1 variety. These findings are also in agreement with Manjunatha (2017) who conducted survey for the disease severity of powdery mildew in mulberry growing areas of Mandya district of Karnataka and revealed that, among the five taluks of Mandya district, the highest per cent disease index was recorded in Malavallitaluk (22.06 PDI) and the lowest disease severity was recorded in Krishnarajapetetaluk (11.51 PDI).

Conclusion

The study reveals that, weather parameters, soil type, variety and stage of the crop influence the powdery mildew disease development. Thus, based on the above factors, the results of the survey during 2019-20 revealed that, the disease was noticed in different intensities in eight districts surveyed.

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