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Research Paper

Status of major foliar diseases of mulberry under temperate climatic conditions of Kashmir, India

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ABSTRACT

Mulberry (*Morus* species) the sole food of silkworm (*Bombyx mori*) is prone to several fungal foliar diseases. An extensive survey of two major foliar diseases of mulberry, leaf spot (*Phloeospora maculans*) and powdery mildew (*Phyllactinia corylea*) was carried in three districts of Kashmir valley *viz.* Baramulla, Kupwara and Bandipora during the year 2020 and 2021. The survey indicates that both the diseases are frequent in all the districts investigated. Overall disease incidence of leaf spot was 36.98 and 31.72 per cent and intensity of 17.76 and 14.52 per cent was observed in two consecutive years, respectively, in all the districts surveyed. The maximum disease incidence of 41.74 per cent and intensity of 23.50 per cent was recorded in district Baramulla and minimum disease incidence of 24.48 per cent and intensity of 10.68 per cent was observed in district Bandipora. In case of powdery mildew, overall disease incidence of 48.69 and 45.30 per cent and intensity of 25.78 and 22.76 per cent was observed during the year 2020 and 2021, respectively. Among the various districts surveyed, disease incidence and intensity based on the mean of two years was the highest in district Baramulla (59.78 and 31.74 %, respectively) and the least in district Bandipora (32.14 and 12.41 %). Survey conducted in three districts of Kashmir valley has indicated that both the diseases are more or less prevalent in all districts surveyed during 2020 and 2021.

Key words: Disease survey, leaf spot, mulberry, powdery mildew

Mulberry (*Morus* species), the only food of silkworm (*Bombyx mori* L.) belongs to family Moraceae and genus *Morus*. It is a woody perennial plant which has been under cultivation since long and exclusively grown for its foliage which is the principal economic product of plant (Anusha and Bhaskar, 2015). In India, different *Morus* species which grow naturally include *Morus alba, M. indica, M. serrata* and *M. laevigata* grow widely in the Himalayas (Bindroo *et al*., 2012). There are more than 58 countries in the world practising sericulture (Tikadar, 2011). In Indian sub-continent, the traditional sericulture is practiced in Karnataka, Tamil Nadu, Andhra Pradesh etc. enjoying tropical climate, whereas under temperate to sub-tropical conditions, the commercial sericulture is being practiced in Himachal Pradesh, West Bengal and Jammu & Kashmir. The largest producer of silk is Karnataka (8276 MT) followed by Andhra Pradesh (5735 MT), West Bengal (1587 MT), Tamil Nadu (1548 MT) and Jammu & Kashmir (16 MT) (Anonymous, 2020b). In Jammu and Kashmir, an area of 4,717 hectares is under mulberry cultivation in addition to thousands of scattered mulberry trees growing on hill and road sides and river banks etc (Anonymous, 2020a). The foliage of these trees is mainly utilized for silkworm rearing and silk production (Kumar *et al* .2021).

In view of cosmopolitan distribution of mulberry under varied climatic conditions it is vulnerable to different kinds of biotic and abiotic stress. Among the biotic stresses, plant diseases play an important role in reducing the foliage to a considerable extent and as such result in economic losses to the farmers. Besides reducing leaf yield and impairing its nutritional value by reducing moisture, protein and carbohydrates, diseased leaves also adversely affect the silkworm larval growth, cocoon and silk characters (Kumar *et al.,* 1993). Among the various diseases on mulberry, leaf spot (*Phloeospora maculans*) and powdery mildew (*Phyllactinia corylea*)

are the most serious fungal foliar diseases which result in 15-20 per cent loss in leaf yield firstly due to destruction of leaf area and secondly an additional loss of 5-10 per cent by defoliation (Sukumar and Ramalingam, 1990; Reddy *et al.*, 2009; Monir *et al*., 2017). Both the diseases are serious threat to the sericulture industry in Kashmir valley, where the environmental conditions including temperature and humidity are predominantly favourable for the disease development (Qadri *et al*., 1999; Illahi *et al*., 2012).

Leaf spot is one of the destructive disease on mulberry and appears in the month of May with maximum intensity in July-September (Kausar, 2001). The disease spreads primarily with the rain droplets and wind. In the initial stages, the disease appears as circular or irregular brownish spots of varying size with ash grey centre. As the disease advances, the spots enlarge, coalesce and result in the formation of shot holes. Severely affected leaves become yellowish and fall off prematurely (Hong *et al*., 2011). The disease directly affects leaf yield of about 5 per cent due to defoliation, which may however, reach upto 35 per cent in the most severe conditions resulting in severe economic loss to the farmers (Baiyewu *et al*., 2005). Powdery mildew of mulberry appears in the last week of July with maximum intensity in August –October (Munshi *et al*., 1999). Initially, white powdery patches on lower surface of leaves are seen which later cover the entire leaf surface. Later turn black to brown in colour. Infected leaves turn yellow and fall off. The incidence and severity of diseases is governed by availability and virulence of the fungal propagules, environmental factors like temperature, rainfall, humidity and management practices. The disease results in the yield loss of 10-15 per cent besides the deterioration in the quantity (Monir and Mandal, 2016). In this background efforts were made to study the prevalence of these two foliar diseases of mulberry in Kashmir valley during 2020 and 2021.

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MATERIALS AND METHODS

Periodic surveys were carried out during two consecutive years in three districts of Kashmir valley *viz*., Baramulla, Bandipora and Kupwara. Three locations per district and five plants per locality were selected randomly and marked to record the incidence and intensity of disease. The selected plants were kept unsprayed and surveyed during two consecutive years.

Disease incidence: The disease incidence was calculated by counting the total number of diseased units to the total number of units on three randomly selected branches in each direction by using the following formula:

$$\text{Disease Incidence (\%)} = \frac{\text{Number of infected leaves}}{\text{Total number of leaves assessed}} \times 100$$

Disease Intensity: Disease intensity was recorded by visual observations using 0-5 scale (Singh *et al.*, 1996). Five disease categories were made on the basis of per cent leaf area diseased. Category I,II,II,IV,V with numerical value of 0,1,2,3,4, showing healthy foliage, upto 10 per cent leaf area covered, 10.1-25 per cent leaf area covered, 25.1-50 per cent leaf area covered, 50.1-75 per cent leaf area covered, above 75 per cent leaf area covered, respectively against each category.

The Per cent Disease Intensity (PDI) was calculated as per the formula:

$$PDI = \frac{€ (n \times v)}{N \times S} \times 100$$

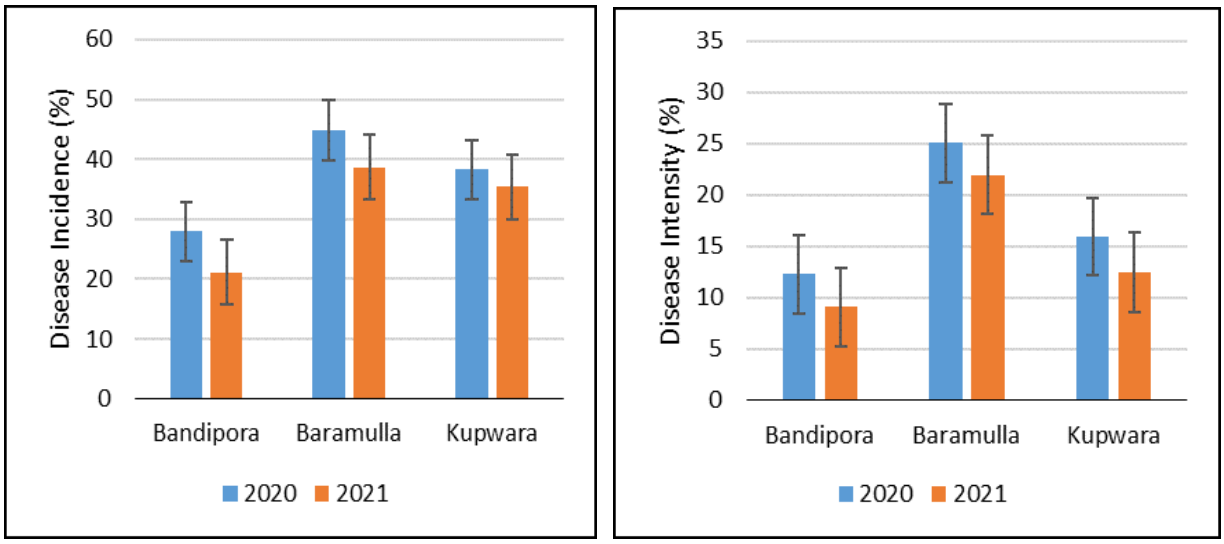
Where,

€ = Summation
n = Number of leaves in each category
v = Numerical value of each category
N = Number of leaves examined, and
S = the maximum numerical value.

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RESULTS AND DISCUSSION

Disease incidence and intensity of leaf spot on mulberry: The overall mean disease incidence recorded in 2020 and 2021 varied significantly from each other. A disease incidence of 36.98 per cent was recorded in the year 2020 in comparison to 31.72 in 2021 (Fig. 1a). The disease incidence over the years recorded was the highest in district Baramulla (41.74%) followed by district Kupwara (36.84%). However, the least disease incidence of 24.48 per cent was recorded in district Bandipora. The overall disease intensity (Fig 1b) of 17.76 per cent was recorded in the year 2020 in comparison to 14.52 per cent in 2021. The disease intensity over the years recorded was the highest in district Baramulla (23.50%) followed by district Kupwara (16.79%). However, the least disease incidence of 10.68 per cent was recorded in district Bandipora.



(a) (b)

Fig.1: Incidence and intensity of Leaf spot (*Phloeospora maculans*)on mulberry leaves in various districts of Kashmir valley

The results (Table 1) revealed that the disease incidence ranged from 22.36 to 62.30 per cent during the year 2020 and 17.50 to 55.32 per cent in 2021. On overall comparison amongst different locations surveyed, the highest disease incidence of 58.84 per cent, 47.61 per cent and 39.26 per cent was recorded in villages Pattan, Unisoo and Sheeri of district Baramulla and Kupwara, respectively. The least disease incidence of 19.93 per cent was recorded in Panzigamarea of district Bandipora.

Table 1. Disease Incidence of leaf spot (*Phloeospora maculans*) of mulberry in various districts of Kashmir valley

District	Location	Disease incidence (%)		Pooled
		2020	2021	
Kupwara	Chogal	43.06	35.14	39.10
	Kulangam	39.48	33.08	36.28
	Unisoo	43.56	38.08	47.61
	Mean	**38.25**	**35.44**	**36.84**
Baramulla	Pattan	62.30	55.32	58.84
	Dhobiwan	30.38	23.84	18.07
	Sheeri	41.78	36.75	39.26
	Mean	**44.84**	**38.64**	**41.74**
Bandipora	Chetibanday	32.30	24.04	28.17
	Arin	29.04	21.62	25.33
	Panzigam	22.36	17.50	19.93
	Mean	**27.90**	**21.05**	**24.48**
Overall mean		**36.98**	**31.72**	**34.36**

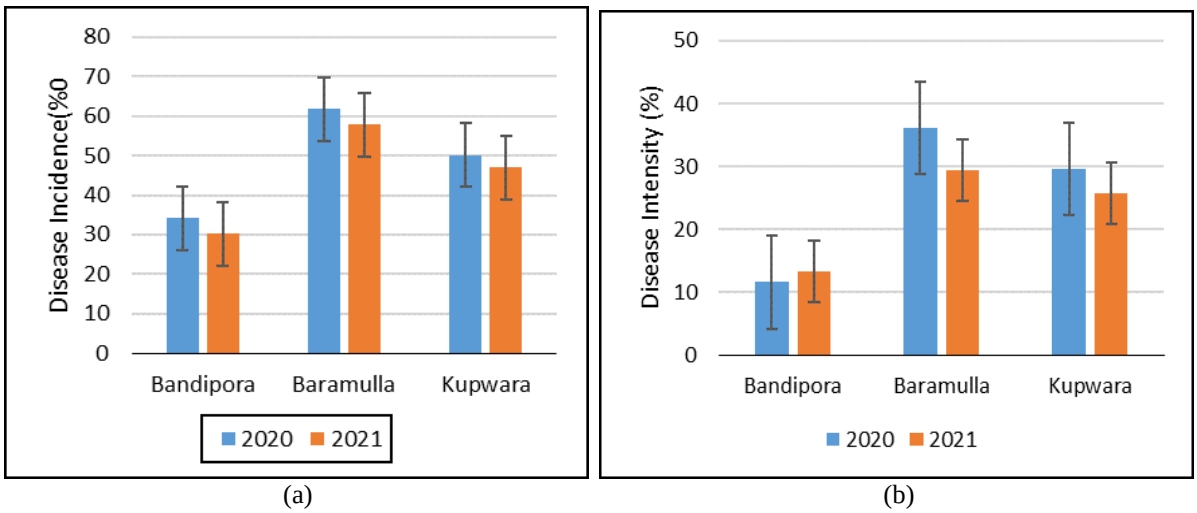
However, disease intensity (Table 2) over years varied among most of the locations. The highest (36.70%) disease intensity was recorded in Pattan of district Baramulla followed by Sheeri (21.48%) of same district. Disease intensity of 21.12 per cent and 18.72 per cent was recorded in Kulangam and Chogal of district Kupwara. In district Bandipora, disease intensity of 12.31 per cent and 10.40 per cent was recorded in Panzigam and Chetibanday, respectively. The least disease intensity of 9.33 per cent was recorded in village Arin of district Bandipora.

Table 2. Disease intensity of leaf spot (*Phloeospora maculans*) of mulberry in various districts of Kashmir valley

District	Location	Disease Intensity (%)		Pooled
		2020	2021	
Kupwara	Chogal	20.42	17.02	18.72
	Kulangam	15.38	11.48	21.12
	Unisoo	12.08	8.98	10.53
	Mean	**15.96**	**12.49**	**16.79**
Baramulla	Pattan	39.02	34.38	36.70
	Dhobiwan	14.04	10.64	12.34
	Sheeri	22.08	20.88	21.48
	Mean	**25.05**	**21.96**	**23.50**
Bandipora	Chetibanday	11.36	9.45	10.40
	Arin	11.08	7.58	9.33
	Panzigam	14.38	10.24	12.31
	Mean	**12.28**	**908**	**10.68**
Overall mean		**17.76**	**14.52**	**16.99**

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Disease incidence and intensity of powdery mildew on mulberry: The overall mean disease incidence, recorded in 2020 and 2021 varied from each other. A disease incidence of 48.69 per cent was recorded in the year 2020 in comparison to 45.30 in 2021 (Fig. 2a). The disease incidence over the years recorded was the highest in district Baramulla (59.78%) followed by district Kupwara (48.61%). However, the least disease incidence of 32.14 per cent was recorded in district Bandipora. Disease intensity of 25.78 per cent and 22.76 per cent was recorded during two consecutive years, respectively (Fig. 2b). The disease intensity over the years recorded was the highest in district Baramulla (31.74%) followed by district Kupwara (27.65 %), whereas, the least disease intensity of 12.41 per cent was recorded in district Bandipora.



(a) (b)

Fig.2. Incidence and intensity of Powdery *mildew* (*Phylactina corelea*) on mulberry leaves in various districts of Kashmir valley

The results (Table 3) revealed that the disease incidence ranged from 29.02 to 70.84 per cent during the year 2020 and 24.34 to 68.04 per cent in 2021 with an average incidence of 48.69 and 45.30 per cent, respectively. On overall comparison, amongst different locations surveyed, the highest disease incidence of 69.44 per cent followed by 57.88 per cent was recorded in villages Pattan and Chogal of district Baramullaand Kupwara, respectively.

Table 3. Disease incidence of powdery mildew (*Phylactina corelea*) of mulberry in various districts of Kashmir valley

District	Location	Disease incidence (%)		Pooled
		2020	2021	
Kupwara	Chogal	60.08	55.68	57.88
	Kulangam	41.82	40.38	41.10
	Unisoo	48.63	45.10	46.86
	Mean	**50.18**	**47.05**	**48.61**
Baramulla	Pattan	70.84	68.04	69.44
	Dhobiwan	60.02	55.32	57.67
	Sheeri	54.38	50.10	52.24
	Mean	**61.75**	**57.82**	**59.78**
Bandipora	Chetibanday	39.02	35.54	37.28
	Arin	34.36	30.82	32.59
	Panzigam	29.02	24.34	26.53
	Mean	**34.14**	**30.14**	**32.14**
	Overall mean	**48.69**	**45.30**	**46.84**

The least disease incidence of 26.53 per cent was recorded in Panzigam area of district Bandipora. An insight into the data (Table 4), revealed that the disease intensity ranged from 16.08 per cent to 39.30 per cent during the year 2020 and 10.34 to 32.06 per cent during 2021 with an average intensity of 28.87 and 22.76 per cent, respectively. The disease intensity over years varied among most of the locations. Data reveals that the highest disease intensity of 35.68 per cent was recorded in Pattan of district Baramulla followed by Dhobiwan (32.14%) of the same district. Disease intensity of 31.20 per cent and 29.00 per cent was recorded in Chogal and Unisoo of district Kupwara. In district Bandipora, disease intensity of 18.50 per cent and 15.67 per cent was recorded in Panzigam and Arin, respectively, whereas, the least disease intensity of 13.21 per cent was recorded in village Chetibanday of district Bandipora.

Table 4. Disease intensity of powdery mildew (*Phylactina corelea*) of mulberry in various districts of Kashmir valley

District	Location	Disease Intensity (%)		Pooled
		2020	2021	
Kupwara	Chogal	32.38	30.02	31.20
	Kulangam	25.36	20.14	22.75
	Unisoo	31.02	26.98	29.00
	Mean	**29.58**	**25.72**	**27.65**
Baramulla	Pattan	39.30	32.06	35.68
	Dhobiwan	37.02	30.26	32.14
	Sheeri	32.33	25.66	27.49
	Mean	**36.21**	**29.32**	**31.74**
Bandipora	Chetibanday	16.08	10.34	13.21
	Arin	18.36	12.98	15.67
	Panzigam	20.84	16.46	18.50
	Mean	**11.57**	**13.26**	**12.41**
	Overall mean	**25.78**	**22.76**	**24.27**

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Survey conducted in three districts of Kashmir valley on mulberry leaves has indicated that both the diseases were more or less prevalent in all the mulberry growing areas of the valley during 2020 and 2021. However, the diseases were more severe during the crop season 2020 in comparison to 2021. The high disease severity during the year 2020 could be attributed to high rainfall, more number of rainy days and high relative humidity as compared to 2021.Similar results have been reported by Munshi *et al*. (1999), Illahi *et al*. (2012), Chikkaswmy and Paramanik (2014). The highest disease in various villages surveyed could probably be attributed to the higher plant density and improper pruning leading to high relative humidity in the microclimate of the plants, besides non-disposal of fallen diseased leaves. The least disease incidence could be attributed to lesser planting density and better orchard management (Maji *et al*., 2013).

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