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Status of Alternaria Leaf Blotch on Apple under Kashmir Conditions

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Alternarialeaf blotch (*Alternaria mali*Roberts) of apple is one of the major fungal diseases in all the apple growing regions of the world. Although the disease was previously of minor economic importance in Kashmir valley, it has now attained the status of one of the major diseases of apple.The frequent epidemics of Alternaria leaf blotch have been witnessed in Kashmir, inflicting heavy losses. As most of the commercial apple cultivars are susceptible to this disease, orchardists

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mainly rely on frequent fungicide applications for its management. Four districts of the valley viz., Pulwama, Kulgam, Shopian and Srinagar were surveyed to record the status of Alternaria leaf blotch disease of apple. The disease was prevalent in all the districts surveyed with an overall disease incidence and intensity of 55.59 and 33.16, respectively. The highest disease incidence and intensity were recorded in district Kulgam and least in district Shopian. What is the significance of your research (our significance is to record the disease incidence and intensity of major apple growing belts of jammu and Kashmir because maximum apple growers are unnable to manage the disease from last six years moreover in this study we observed were growers are lacking to controll disease ? Did you try to suggest a means of solving this problem (yes sir in this study we observed that why most of the apple growers are unable to manage this major foliar disease? What is the contribution of your research to knowledge in Science? (our contribution of research in science is to provide the management capsule for controlling Alternaria leaf blotch of apple.

Keywords: Disease incidence; intensity; Alternaria leaf blotch; survey.

1. INTRODUCTION

Apple is a rosaceous fruit tree, belonging to the genus *Malus*, holds a preeminent position as the most extensively cultivated fruit tree globally [1] citation needed). Thriving primarily in temperate regions across the northern and southern hemispheres, its economic significance is profound. China emerges as the foremost cultivator of apples, boasting the largest area under cultivation at 2.4 million hectares and the highest fruit production, reaching 44.5 million metric tons as of 2019 (citation needed)(Directorate of Horticulture 2019). Alongside China, countries such as the USA, Poland, and Turkey are prominent contributors to global apple production [2]. In India, although the apple cultivation area stands at a significant 0.305 million hectares, the country ranks fifth in terms of apple production, yielding approximately 2.3 million tons (citation NHB 2019[b] needed). The commercial cultivation of apple fruit in India is confined to North Himalayan hill region comprising the states of Jammu & Kashmir, Himachal Pradesh and Uttaranchal and to a limited extent to the states of Arunachal Pradesh, Sikkim, Nagaland, Meghalaya and Manipur covering a total area of 3 .08 lakh ha with production of 23.16 lakh tons, productivity of 7.52 tons per hectare and which collectively contribute to 99 percent of the country's total production (Sharma, 2021). In Jammu & Kashmir, the area under apple is 1.65 lakh ha and 18.82 lakh tons and productivity are around 11.40 tons per hectare, followed by Himachal Pradesh with 11.3 metric tonnes per hectare and Uttarakhand with 5.03 metric tonnes per hectare, showcasing the diverse regional contributions to India's apple industry [3].

A number of diseases like scab, Alternaria leaf blotch, Marsonena, Sooty blotch, Fly-speck and a number of post-harvest diseases have been reported to cause losses in apple (Sharma [4] citation needed). Among the foliar diseases, Alternaria leaf blotch caused by *Alternariamali* is one of the most serious disease-causing premature leaf fall in apple (Bulajic 1996citation needed). The occurrence of Alternaria leaf blotch in Jammu and Kashmir (J&K) was reported by Shahzad et al*.* [5] and the disease is prevalent in almost all the apple growing districts of Kashmir valley. Alternaria leaf blotch was considered a disease of minor importance in comparison to apple scab (Rotondo 2012citation needed). However, the disease resulted in epidemic during summer and about 40-60 percent yield loss was reported (Sofi et al*.,* 2013). Alternarialeaf blotch (*Alternaria mali*Roberts) of apple is one of the major fungaldiseases in all the apple growing regions of the world (Harteveld [6] citation needed). Although the disease was previously of minor economic importance in Kashmir valley, it has now attained the status of one of the major diseases of apple (Shahzad [7], …this citation is unacceptable. Kindly find a suitable citation for this or expunge the text completely.). The frequent epidemics of Alternaria leaf blotch have been witnessed in Kashmir, inflicting heavy losses.

2. MATERIALS AND METHODS

2.1 Survey for the Incidence Andintensity of the Disease…where are the Materials?

Disease incidence and intensity: A brief survey of important apple growing belts of various districts of Kashmir valley viz., Srinagar,

Table 1. Checklist for six different categories based on the intensity of the disease

Category	Numerical Value	Criteria
I	0	Disease free
II	1	>0- ≤ 3 % leaf area covered with disease lesions
III	2	>3-≤6% leaf area covered with disease lesions
IV	3	>6-≤12% leaf area covered with disease lesions
V	4	>12-≤25% leaf area covered with disease lesions
VI	5	>25% leaf area covered with disease lesions or chlorotic leaf with petiole infection

Pulwama, kulgamand Shopian was conducted during 2021 -2022 to assess the disease incidence and intensity of Alternaria leaf blotch of apple. Twenty villages were selected randomly from these districts and from each village three orchards were selected randomly. A random sample of five apple trees was drawn to represent each orchard. Four branches from the four directions of the tree were randomly selected and tagged. The number of leaves bearing Alternaria leaf blotch symptoms on apple were picked up, one hundred leaves were examined randomly from each tree for recording the incidence and intensity of Alternaria leaf blotch.

$$\text{Percent Disease Incidence (PDI)} = \frac{\text{Number of leaves infected}}{\text{otal number of leaves observed}} \times 100$$

The Alternaria leaf blotch intensity was recorded as per the slightly modified 0-5 scale adopted by Filajdic and Sutton [8].

The percent Alternaria leaf blotch intensity was calculated as per the following formula:

$$\text{Percent Disease Intensity} = \sum \frac{n \times v}{\text{N. G}} \times 100$$

Where;

∑ = Summation
N = no of diseased units
V = numerical value of each category
N = total no of units examined
G = highest category value

3.RESULTS

3.1 Status of the Disease

The disease survey was conducted in seven districts of Kashmir valley namely, Pulwama, Shopian, Kulgam and Srinagar during late August in 2021 and 2022 2007 and 2008 and disease incidence and intensity was recorded.

3.1.1 Disease incidence

The overall mean disease incidence recorded in 2021 was 41.83% as compared to 36.81% in 2022 (Table 2). Alternaria leaf blotch disease was prevalent in all the four districts surveyed with highest disease incidence of 79.22 percent in district kulgam village khee followed by 70.44% in district pulwama village kachipora. In Srinagar,the disease incidence was recorded at 60.22%. The lowest disease incidence of 41.83% was recorded in district Shopian. During 2021, the disease incidence varied from 41.83% in district Shopian to 71.80% in kulgam and during 2022 it varied from 36 .81% in Shopian to 61.61% in kulgam.

The site-wise polled data revealed the highest disease incidence of 79.22% in Khee village of district Kulgam (Table 2). This was followed by 76.22 % in Chowlgam of district kulgam, 70.44% in kachiporaof district Pulwama and 59.89 % in Drubgam of district Pulwama. The least disease incidence of 32.11% was recorded in Kachdoora (Distt. Shopian) followed by 34.11% in Trenz (Shopian). The data in Table 2 indicates that Alternaria leaf blotch was present in all the four districts of the Apple growing areas of Kashmir valley. The maximum average disease incidence of 71.80% was recorded in district kulgam (2021). Moreover, maximum pooled disease incidence of 68.11% was recorded in kulgam district. The least pooled disease incidence of 39.32% was recorded in shopian district.During both the years (2021& 2022) lowest disease incidence was recorded in Kachdoora (Shopian) and highest disease incidence in Khee (kulgam). In district Pulwama, kachipora recorded the highest disease incidence of 70.44.63% while Drubgamrecorded the lowest of 64.78%. In district Srinagar,highest disease incidence of 60.22% was recorded in Shalimar and lowest incidence of 43.00% was recorded in Baspora. In district Kulgam, kheerecorded the highest disease incidence of 79.22% while Ashmungi

recorded the lowest disease incidence of 58.67%.

3.1.2 Disease intensity

The data presented in Table 3 revealed that overall disease intensity of 44.14% recorded in 2021 was higher than 40.17% recorded in 2022.The pooled data showed that highest disease intensity of 42.15% was recorded in kulgamfollowed by 36.78 % in Pulwama. The lowest disease intensity of 22.21% was recorded in Shopian district.

Disease intensity in different sites varied from 20.55 to 50.78% in 2021 and 18.91 to 46.21% in 2008 (Table 3). The pooleddata revealed that the disease intensity varied from 19.73 to 48.49% the highest disease incidence in (Kulgam) followed by 45.78% in Kachipora (Pulwama) and 38.63% Murran (Pulwama). The lowest disease intensity of 15.55% was recorded in Kachdoora (Shopian). In Pulwama,highest disease intensity of 45.78% was recorded in Kachipora followed by 43.23% in Rajporaand 38.63 % in Murran. In srinagar, shalimarrecorded the disease intensity of 34.89% followed by 32.65% Habak and Mulfaq 27.89%. Out of the five sites surveyed in shopian, trenz village recorded the highest disease intensity of 26.52%, while pinjooraand kachdoorarecorded 25.66% and 20.55%, respectively. In Kulgamhighest disease intensity of 50.78% was recorded in Khee and the lowest of 38.66 .98% was recorded in Ashmunji.

Table 2. Incidence of Alternaria leaf blotch of apple at different districts of Kashmir valley during 2021 &2022

District	Sites	Per cent Disease Incidence(%) 2021	Per cent Disease(%) Incidence 2022	Pooled Per cent Disease Incidence
Pulwama	Pulwama L-1	69.44	63.22	66.33
	Pulwama L-2	70.44	64.00	67.22
	Pulwama L-3	63.78	58.00	60.89
	Pulwama L-4	59.89	54.56	57.22
	Pulwama L-5	64.78	58.89	61.83
Overall mean ± SE.(m)		**64.69±2.17**	**58.87±1.97**	**61.77±2.07**
C.I 95% Limits		**57.80-71.58**	**52.59-65.14**	**55.20-68.36**
Srinagar	Srinagar L-1	56.89	50.89	53.89
	Srinagar L-2	55.89	49.11	52.50
	Srinagar L-3	48.89	43.00	45.94
	Srinagar L-4	52.78	46.44	49.61
	Srinagar L-5	60.22	53.67	56.94
Overall mean± SE.(m)		**54.42±2.39**	**48.04± 2.23**	**51.23±2.31**
C.I 95% Limits		**48.81-62.04**	**40.95-55.14**	**43.88-58.51**
Kulgam	Kulgam L-1	79.22	71.33	75.28
	Kulgam L-2	70.44	63.33	66.89
	Kulgam L-3	65.11	58.67	61.89
	Kulgam L-4	76.22	68.56	72.39
	Kulgam L-5	68.00	60.22	64.11
Overall mean± SE.(m)		**71.80±2.55**	**64.61± 2.35**	**68.11±2.44**
C.I 95% Limits		**64.50-79.04**	**58.10-71.12**	**61.23-74.99**
Shopian	Shopian L-1	44.78	39.44	42.11
	Shopian L-2	42.89	37.78	40.33
	Shopian L-3	49.33	43.44	46.39
	Shopian L-4	38.67	34.11	36.39
	Shopian L-5	36.44	32.11	34.28
Overall mean± SE.(m)		**41.83±2.83**	**36.81±2.49**	**39.32±2.66**
C.I 95% Limits		**32.80-50.86**	**28.86-44.76**	**30.83-47.81**
Total Disease Incidence± SE.(m)		**58.64±2.76**	**52.54±2.56**	**55.59±2.66**
C.I 95% Limits		**52.88-64.42**	**47.15-57.92**	**50.02-61.17**

**Average of three sites from each location in a District*
*** From each site 300 leaf samples were examined for the disease*
****C. I=Confidence interval*

Table 3. Intensity of Alternaria leaf blotch of apple at different districts of Kashmir valley during 2021 & 2022

District	Sites	Per cent Disease Intensity 2021	Per cent Disease Intensity 2022	Pooled Per cent Disease Inciden
Pulwama	Pulwama L-1	43.23	38.91	41.07
	Pulwama L-2	45.78	41.20	43.49
	Pulwama L-3	36.90	33.21	35.06
	Pulwama L-4	33.54	30.19	31.86
	Pulwama L-5	38.63	34.77	36.70
Overall mean ± SE.(m)		**38.71±2.58**	**34.84±2.32**	**36.78±2.45**
C.I 95% Limits		**30.50-46.93**	**27.45-42.24**	**28.97-44.58**
Srinagar	Srinagar L-1	32.65	29.71	31.18
	Srinagar L-2	32.45	29.53	30.99
	Srinagar L-3	27.89	25.38	26.63
	Srinagar L-4	30.11	27.40	28.76
	Srinagar L-5	34.89	31.75	33.32
Overall mean± SE.(m)		**31.34± 1.51**	**28.52± 1.37**	**29.92± 1.44**
C.I 95% Limits		**26.54-36.13**	**24.15-32.88**	**25.35-34.50**
Kulgam	Kulgam L-1	50.78	46.21	48.49
	Kulgam L-2	43.78	39.84	41.81
	Kulgam L-3	38.66	35.18	36.92
	Kulgam L-4	46.25	42.09	44.17
	Kulgam L-5	41.23	37.52	39.37
Overall mean± SE.(m)		**44.14± 2.09**	**40.17± 1.89**	**42.15± 1.99**
C.I 95% Limits		**38.34-49.94**	**34.89-45.44**	**36.62-47.69**
Shopian	Shopian L-1	25.66	23.61	24.63
	Shopian L-2	23.67	21.78	22.72
	Shopian L-3	26.52	24.40	25.46
	Shopian L-4	21.82	20.07	20.95
	Shopian L-5	20.55	18.91	19.73
Overall mean± SE.(m)		**23.14±1.29**	**21.28±1.19**	**22.21±1.24**
C.I 95% Limits		**19.02-27.26**	**17.49-25.08**	**18.25-26.17**
Total Disease Incidence± SE.(m)		**34.75±1.96**	**31.58±1.75**	**33.16±1.86**
C.I 95% Limits		**30.64-38.86**	**27.91-35.25**	**29.28-37.06**

**Average of three sites from each location in a District*
*** From each site 300 leaf samples were examined for the disease*
****C. I=Confidence interval*

Picture 1(a,b). Alternaria leaf blotch symptoms on apple leaves

4. DISCUSSION

Apple (*Malus domestica*Borkh) is predominant fruit crop of Jammuand Kashmir which has attained the status of an industry in the state. Like other horticultural crops, apple is attacked by several pathogens of fungal,bacterial and viral etiology which impair the quality and quantity of the fruit.However,huge crop losses are incurred mostly by fungal diseases.Among these Alternaria leaf blotch has assumed an alarming threat because of the prevalence of disease in all the major apple growing areas of Kashmir valley. Shahzad [7] recorded Alternaria leaf blotch with varied magnitude of disease incidence and intensity in four districts of kashmirviz, Anantang, Pulwama, Shopian and Baramulla. Survey conducted during the year 2021 and 2022 in four districts of Kashmir valley confirms the prevalence of disease in all the apple growing areas of the valley with an overall mean disease incidence and intensity of 55.59and 33.16 percent, respectively. The disease was severe during 2021 with overall mean disease incidence and intensity of 58.64 and 34.75 percent respectively in comparsion to 52.54 and 31.58 percent, respectively, in 2022. This higher disease severity could be attributed to higher inoculum build up because of more favourable climatic conditions in 2021 (RH78.23%, RF, 81.5 mm) than in 2022 (RH71.1%, RF, 68.3 mm), especially during June to August (the period conducive for the disease development). Such conducive environment favoring the disease development has been reported by many researchers [9,7]. The disease incidence and intensity in surveyed areas varied from 34.28 to 75.28 and 19.73 to 48.49, respectively with highest disease incidence and intensity recorded in kulgam and lowest in Shopian. The site selection varied from site selection earlier by Shahzad in [7] (deleted this paragraph) Of the sites surveyed, the highest disease incidence of 75.28 percent was recorded in Khee (Kulgam) followed by kachipora (Pulwama), Mulfaq (Srinagar) and kachdoora (shopian), with disease incidence of 67.22,53.89 and 36.44 percent, respectively. The highest disease intensity of 48.49 percent was also recorded in khee (Kulgam) followed by 43.49 in kachipora (Pulwama),33.32 in Shalimar (Srinagar) and 34.28 in kachdoora (Shopian). The variation in incidence and intensity of Alternaria leaf blotch disease in various locations have also been reported by Filajdic and Sutton [9]; Bulajic et al. [10], Shahzad [7] and Sharma et al*.* (2003). Maximum incidence and intensity of Alternaria leaf blotch of Alternaria leaf blotch of apple in Kulgam district could be attributed to non-disposal of the fallen leaves, besides heavy infestation of European red mite in the area [11] (Filajdic 1995). The less disease incidence and intensity could be attributed to better orchard management. The overall variation in disease severity may be because of the variation in various factors like altitude, climate, delayed rains, plant age and management practices [12-16].

5. CONCLUSION

Alternaria leaf blotch of apple caused by *Alternaria mali* is one of the major diseases of apple it can harm the foliar layer, lowers the fruit quality and productivity, and put growers in a difficult financial position .Khee had the highest mean percent disease incidence in the district Kulgam followed by Yaripora while Kachdoora had lowest .The effective disease management capsule based on the incidence of Alternaria leaf blotch of apple in Kashmir are crucial to alleviate the impact of alternaria leaf leaf blotch.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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