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Symptomatological studies on almond scab caused by *Cladosporium carpophilum* in Kashmir, India

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ABSTRACT

Almond scab caused by *Cladosporium carpophilum* Thum, is one of the most important diseases of almond worldwide. The characteristic symptoms initiated on twigs in first week of May as indistinct, olive green, minute water-soaked spots, measured 1.0-2.0 mm in size. Later on, these lesions coalesced to form dark reddish brown irregular patches. On leaves, the spots appeared on lower side in the second week of May as minute translucent, indistinct to somewhat circular and light yellow in colour with an average size of 0.61 mm. Later on, brownish-black circular to irregular patches of 8.53 mm size were observed due to coalescing of numerous lesions which resulted in premature defoliation. On fruits, the symptoms were noticed in the third week of May as small superficial, circular, olive green lesions on the upper exposed side measuring an average of 1.22 mm in size. The lesion later on coalesced to form grey to black patches giving sooty appearance with an average of 7.98 mm in size. Finally, severely infected fruits shrivelled and developed cracks.

Keywords : Almond, scab, *Cladosporium carpophilum,* symptomatology.

INTRODUCTION

Almond (*Prunus amygdalus* Batsch.), belonging to the family *Rosaceae* is one of the most important nut crops mostly cultivated in temperate regions of the world. In India, almond is mainly grown in Jammu and Kashmir and Himachal Pradesh over an area of 11,000 ha yielding 13.69 thousand MT (Anonymous, 2018). However, its yield as well as area under cultivation has shown a declining trend during the recent past. This reduction is attributed to several biotic and abiotic constraints which include diseases, the occurrence of spring frost, poor pollination during cool, cloudy, or rainy weather, or low temperature as the main abiotic factors (Qureshi and Dalal, 1985; Connel, 2002). During the last few years, the almond orchardists of the Valley have been facing scab problems on almond plants (Kacho *et al.,* 2017). The preliminary survey has revealed the occurrence of almond scab in most of the commercial almond growing areas in Kashmir necessitated exposing an aspect of the disease to have an exact knowledge of disease development. Retrieval of the literature revealed that no systematic work has been conducted on any aspects of the disease in India. Hence, the present investigation was undertaken on symptomatological studies on the disease caused on the almond plant in Kashmir valley.

MATERIALS AND METHODS

The symptomatology of the disease was studied on three randomly selected plants of almond cv. Makhdoom at the almond orchard block of Central Institute for Temperate Horticulture, Rangreth, Srinagar during the year 2016-17. The selected plants were tagged and kept unsprayed throughout the growing season to study the symptoms of the disease under natural epiphytotic conditions and randomly selected ten leaves twigs, and fruits each from the three selected plants. The first observation was taken as soon as the disease appeared and periodic observations were recorded concerning size, shape, coalescing, and colour of the lesion on leaves, twigs, and fruits. The size of the lesions was recorded in terms of range and average lesion size in mm

RESULTS AND DISCUSSIONS

Symptoms on twigs: The symptom of disease on twigs was first noticed in the first week of May, as slightly raised water-soaked, indistinct olive green specks (measuring 1.0-2.0 mm in dia. With an average of 1.43 mm. Periodic changes in size, shape and colour of the lesions have been presented (**Table 1; Fig. 1a**).

Table 1: Symptomatological development of almond scab on twigs

Period of observation		Symptom development	Lesion characters*			
			Shape	Colour	Size (mm)	Sporu-lation
Month	Week					
April	IV	Symptomless	–	–	–	–
May	I	Slightly raised, water soaked specks	Indistinct	Olive green	1.0-2.0 (1.43)	–
May	II	Increase in the size of specks; specks get transformed into lesions	-do-	-do-	2-3.5 (2.63)	–
May	III	Number and size of previously formed lesions increased	Circular to elliptical	White center with brown periphery	3-7.5 (4.72)	–
May	IV	-do-	-do-	Reddish brown with darken periphery	7-12 (9.82)	+
June	I	Coalescing of 3-5 lesions emerging in patches	Irregular	-do-	10.5-15.0 (11.57)	+
June	II	-do-	-do-	-do-	–	+
June	III	Coalescing of more than 5 lesions	-do-	Dark reddish brown	–	+
June	IV	Dark purplish brown coloured lesions resembling with the colour of bark				

*Value in parenthesis are mean of 30 observations; - = absent ; += present

The lesion enlarged up to the first week of June with an average of 11.57 mm and the colour changed to reddish-brown with a dark periphery. The shape of the lesion was circular to elliptical up to the fourth week of May beyond which due to coalescing of 3-5 spots, irregular patches were formed. In the fourth week of June colour of the lesion changed to dark purplish brown which resemble the colour of bark.

Symptoms on leaves: On leaves, the disease was first observed in the second week of May and reached its peak

during June (**Table 2**). Disease symptoms initially appeared as minute translucent, indistinct to somewhat circular and light yellow in colour. The initial size of the lesions was

Table 2. Symptomatological development of almond scab on leaves

Period of observation		Symptom development	Lesion characters*					
Month	Week		Shape	Colour	Size (mm)	Sporu-ation	Petiole infection	Defolia-ion (%)
May	I	Symptomless						
May	II	Minute translucent lesions appear undersurface of leaf, best seen by holding the leaf towards light	Indistinct to somewhat circular	Light yellow	0.5-1.0 (0.61)	–	–	–
May	III	Increase in the number and size of lesions	Circular	Pale green	0.75-2.0 (1.15)	–	–	–
May	IV	Lesions also develop on midrib	-do-	Olivaceous	2.0-3.5 (2.22)	–	–	–
June	I	Increase in the number and size of lesions	-do-	Brownish black	3.0-7.0 (4.25)	+	–	–
June	II	Coalescing of numerous lesion on lower side and appearance of new lesions on upper surface of leaf	Circular to irregular	-do-	7.0-9.5 (8.53)	+	–	–
June	III	Coalesced lesions emerging in patches	Irregular	-do-	–	+	–	–
June	IV	Coalescing continued covering more than 50% area;	Irregular	-do-	–	+	–	–
July	I	Defoliation of severely infected leaves	–	–	–	+	–	6.67
July	II	-do-	–	–	–	–	–	17-0
July	III	-do-	–	–	–	–	–	39.33

*Value in paranthesis are mean of 30 observations; - = absent; + = present

recorded with an average of 0.61 mm. Later in the third week of May, the lesions turned circular. In the first week of June, the colour of the lesions changed from olivaceous green to brownish-black (**Fig. 1b**). The development of olivaceous lesions was also seen on midribs in the fourth week of May. Later on, coalescing of numerous lesions were observed on the lower side of the leaves during the second week of June and formed brownish-black circular to irregular patches attaining a maximum average size of 8.53 mm. During the second fortnight of June irregular brownish-black patches of coalesced lesions covering more than 50% of the leaf area. Finally, premature defoliation of severely infected leaves was recorded in the first week of July and maximum pre-mature defoliation of 39.33 per cent in the third week of July.

Symptoms on fruit: Symptoms on fruits were noticed in the third week of May in the form of small superficial, circular, olive green lesions developed on the upper side of the fruit. The lesions, later on, turned to velvety black and slightly raised in the first week of June (**Table 3; Fig. 1c**).

In the second and third week of June coalescing of lesions and formation of grey to black patches. During the fourth week of June, the coalesced lesions giving a sooty appearance on the upper side of the fruit. Finally, severely infected fruits shrivelled and developed cracks on fruit surface during the first week of July.

In the present investigations, the scab disease symptoms initially appeared on twigs and then on leaves and fruits. Jones and Sutton (1984) also observed that scab lesions on current twigs of peach developed in early spring while on

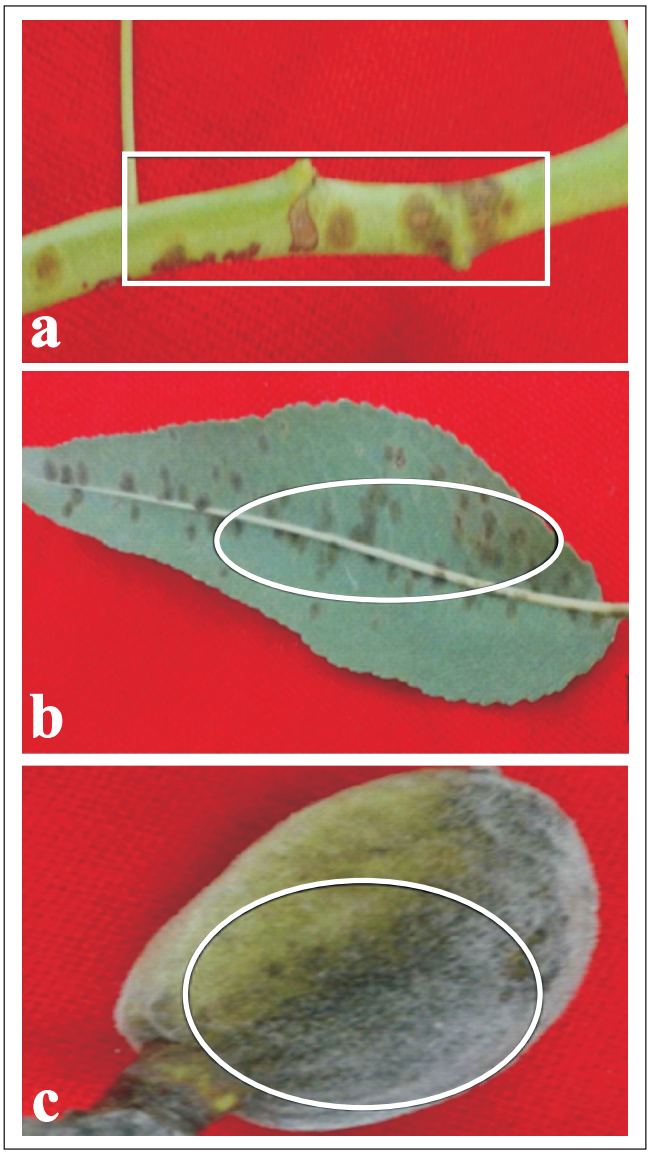

Fig. 1: Characteristic symptoms of scab in the form of: a) Reddish brown spots with dark periphery on almond twig, b) Brownish-black lesions on lower surface of the almonds leaf, and c) Circular velvety black lesions on almond fruit skin.

fruits and leaves it becomes evident after calyx-split. On current year twigs the disease symptoms first appeared in the first week of May as indistinct, raised, water-soaked, olive green specks measuring an average of 1.43mm in size and attained the maximum size of 11.57 mm in the first week of June. These symptoms are in agreement with Dzhafarov (2003) and Horst (2013) who observed similar symptoms on a peach twig as a result of infection by the pathogen *Cladosporium carpophilum*. Later on, in the third week of May the number and size of lesions increased simultaneously whereas the shape turned circular to elliptical and colour became white with the purple periphery. In the third week of June due to coalescing of 3-5 spots, lesions developed into patches, and finally, in the last week of June, the colour of

lesions turned to dark purplish-brown resembling the colour of bark and the lesion lost their identity. These findings are more or less supported by the observations made by Adaskaveg (2013) on almond twigs and Khosla *et al.* (2009) on peach twigs.

Table 3: Symptomatological development of almond scab on fruits

Period of Observations		Symptom development	Lesion characters*			
			Shape	Colour	Size (mm)	Sporu-lation
Month	Week					
May	I	Symptomless	–	–	–	–
May	II	Symptomless	–	–	–	–
May	III	Small superficial lesions developed on upper side	Circular	Olive green	1.0-1.5 (1.21)	–
May	IV	Increase in the number and size of lesions	Circular	-Do-	2.0-3.0 (2.38)	–
June	I	Increase in the number and size of lesions and previously formed lesions become slightly raised	-do-	Velvety black	3.0-6.5 (4.26)	+
June	II	Coalescing of lesions emerging in patches	Irregular	Grey to Black	5.5.9.5 (7.98)	+
June	III	-do-	-do-	-do-	–	+
June	IV	Lesions coalesce together covering the upper side of fruit giving sooty appearance	–	Grey to Black	–	–
July	I	Severely infected fruits shrivelled while as some fruits cracks				

*Value in parenthesis are mean of 30 observations - = absent; += presents

On leaves, the initial symptoms were observed in the second week of May as minute indistinct translucent, pale yellow lesions measuring an average of 0.61mm in size on under the surface of the leaves, best seen by holding the leaves towards the sun. A similar observation was made by Chernomorski (2010) in China on almond leaves. The size and number of the lesions increased simultaneously whereas the shape turned to circular and pale green in the third week of May. The maximum average size of the lesion attained 8.53mm in the second week of June. Lesions become circular to irregular owing to coalescing and colour changed to brownish-black on the lower side of leaves and lesions also began to appear on the upper surface of leaves and defoliation started from the first week of July which reached up to 39.33 per cent in the third week of July. Almost similar symptoms were noticed by Connel (2002) on almond leaves. On fruit, the initial symptoms of the disease were seen in the third week of May usually on the upper exposed side towards the sun as small superficial, circular, olive green coloured lesions measuring 1.21mm in size which gradually increased and attained the maximum average size of 7.98 mm in the second week of June. Previously formed olive coloured lesions became slightly raised and changed to velvety black during the first week of June. Irregular patches emerged due to coalescing of lesions and colour turned grey to black in the second and third week of June. Maximum lesions in the fourth week of June coalesced together covering the upper side of fruit giving the sooty appearance and in severe infections cracking of fruit often occurred. These observations are supported by Gottwald (1983).

CONCLUSIONS

Almond is a high-value crop. However, its yield, as well as the area under cultivation, have shown a declining trend during the recent past. Besides several biotic and abiotic constraints, this reduction during the last few years is attributed to the serious scab disease problem on almond plants. The disease affects fruits and leads to premature leaf-fall resulting in low productivity and poor fruit quality. Keeping in view the significance of disease in limiting almond production, this study calls for an urgent disease management strategy employing eco-friendly and cost-effective approaches

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