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Studies on Change in Apple Phenolic Content Due to Alternaria Leaf Blotch Infection

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Abstract

Alternaria leaf blotch is an important foliar disease of apple. In the present study while ascertaining the impact of Alternaria blotch on phenols in apple it was found both the total and O, D-phenol content were initially low in the leaves, with a slight increase observed after they reached physiological maturity. However, O,D-phenol levels in susceptible healthy cultivars showed an early rise followed by a rapid decline compared to resistant cultivars. Furthermore, total and O, D-phenol content were significantly higher in healthy and resistant cultivars compared to susceptible diseased cultivars.

Key words *: Phenols, alternaria leaf blotch, biochemistry.*

Introduction

Alternaria mali Roberts is an important foliar disease of apple. The disease is characterized by the development of circular brown or blackish spots with dark brown to purple margins on leaves affecting petiole (1). Under severe conditions, chlorotic leaves abscise early in the season causing premature defoliation to the extent of 60-80% (2,3,4). This can also lead to a significant reduction in quality and quantity of the crop by hindering its profitable cultivation (5, 6).

Biochemical resistance or susceptibility in plants against any disease depends mainly on pre-existing, pre-formed or induced substance by the pathogen. The nutritional status and concentration of biochemical constituents in plants prior to infection may determine the severity of disease. The association of the phenols with resistance to invasion by pathogens in crop plants has been studied in considerable detail (7). Since very little work has been carried out to ascertain the impact of Alternaria blotch on phenols in apple, the studies on biochemical resistance or susceptibility against the disease was carried out.

Materials and Methods

The study comprised of five trees of uniform vigour and age from 3 apple cultivars (Red Delicious, American Apirouge and Versified) during the year 2017. The experimental trees were kept unsprayed throughout the season. Each tree, represented as unit of treatment, was replicated five times in a randomized block design. Fresh leaf samples of both diseased and healthy from selected cultivars were randomly collected from the entire canopy of the selected trees. Leaf samples collected at six different phenological stage viz., petal fall, fruitlet, fruit development stage I, II and III and 25 days before harvest were utilized for assessment of percent disease incidence and intensity and then for the estimation of total phenols and orthodihydroxy phenols by standards methods.

Percent disease incidence

$$= \frac{\text{No. of Infected Leaves}}{\text{No. of Leaves Examined}} \quad 100$$

For calculating disease intensity modified Horsefall Barrat scales of 0-5 as adopted by (8) was used after some modifications. Leaves under observation were categorized as under

Grade	Disease severity
0	No disease
1	0.1-3.0% leaf covered with spots
2	3.1-6.0% leaf covered with spots
3	6.1-12% leaf covered with spots
4	12.1-25% leaf covered with spots
5	25.1% and above leaf covered with spots

Per cent disease intensity PDI $= \frac{(n \quad v)}{N \quad S} \quad 100$

Where = summation : n= no of leaves in each category; v= category value

N=Total number of leaves assessed:

S=highest category value

Results and Discussion

Periodical disease incidence/intensity of Alternaria blotch

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Table-1 : Disease incidence and intensity of Alternaria leaf blotch in different apple cultivars at different phenological stages.

Cultivars	Inc/Int	Petal Fall	Fruit let	Fruit development			25 days before harvest
				I	II	III	
Red delicious	Inc	-		13.14	22.40	23.45	37.32
	Int	-		2.55	6.76	8.93	13.75
American Apirouge	Inc	-		11.34	12.32	13.76	16.69
	Int	-		0.23	5.75	6.73	10.59
Versified	-	-	-	-	-	-	-

(-) = no disease

Table-2 : Total phenol and Orthodihydroxy phenol content (mg/g) of healthy and Alternaria blotch infected leaves in different apple cultivars at different phenological stages.

Cultivars	Phenols	Petal Fall	Fruit let	Fruit development			25 days before harvest
				I	II	III	
Red delicious Healthy	P	20.43	25.52	26.57	28.13	30.57	28.67
	ODP	18.62	20.27	21.48	22.01	28.18	23.23
Red delicious (Diseased)	P	-	-	19.42	20.03	22.37	19.64
	ODP			12.76	18.83	20.91	13.20
American Apirouge Healthy	P	21.37	23.61	35.47	36.00	38.19	36.31
	ODP			24.54	25.45	29.62	26.97
American Apirouge diseased	P	-	-	34.62	35.15	37.27	36.37
	ODP			13.32	15.67	18.37	17.15
Versified Healthy	P	50.13	51.37	54.14	56.19	65.96	58.93
	ODP	40.82	41.05	42.01	43.89	45.09	44.07
C.D. (p=0.05)	P	5.61	6.27	6.63	5.71	5.69	6.37
	ODP	7.64	4.26	2.69	3.20	4.13	3.43

(-) = no disease

revealed that Red Delicious and American Apriouge were susceptible whereas cultivar versified showed tolerant reaction (Table-1). The disease intensity varied from 2.55 to13.57% and 0.23 to10.59% in Red Delicious and American Apirouge, respectively. The disease was first observed in Red Delicious 30 days leafing out. Overall, the disease intensity was minimum at fruit development stage-I (2.55% and 2.33%) but it increased with the advancement in growth stage till it was maximum at 25 days before harvest (13.75% and 10.59% in both the cultivars i.e Red Delicious and American Apirouge, respectively). The disease incidence in susceptible Red Delicious cultivar ranged from 13.13 to 37.32% while in American Apriouge ranged from 11.34 to16.69%. The disease intensity ranged from 2.55% to 13.75% on Red Delicious cultivar whereas American Apirouge exhibited 0.23% to 10.59%. Workers from different apple growing regions of the world have also recorded varied degree of susceptibility/ tolerance in different cultivars of apple in field conditions. (9, 10) have also reported Red Delicious and American Apirouge as Susceptible to Alternaria leaf blotch as compared to other commercial varieties of apple under Kashmir conditions. Similar finding has been reported from other parts of the world (8).

The total phenol content at six different phenological stages in the healthy and diseased leaves of Red Delicious and American Apirouge and that of in healthy leaves of Versified cultivar (Table-2) ranged from 18.42 to 65.96 mg/g and varied significantly between the cultivars as well as between the healthy and diseased with some exceptional at all the six phenological stages. The total pheonl content was lowest at the petal fall stage, increased with the advancement of growth stage till it reached maximum at fruit development stage III, then it declined again in all the five treatments. (11) made similar observations in total phenols from 6^{th} to 10 day in the healthy controls and the inoculated coconut tree. Further it was observed that the total phenols were higher in resistant and healthy cultivars as compared to diseased ones. (12) have also observed a higher content of phenolics in apple powdery mildew resistant lines than the infected apple leaves. Similar finding were reported by (12) in respect of banana leaves infected by leaf spot pathogen.

Persual of the data in Table-2 revealed that the orthodihydroxyphenols (O,D-Phenol) content at six different phenological stages in the healthy and diseased leaves of diseased leaves of Red Delicious and American Apirouge and that in the healthy leaves of versified cultivars ranged from 12.76 to 45.09 mg/g and varied significantly between the cultivars as well as between the healthy and diseased leaves. The O-D phenol content in

leaves was recorded minimum at initial stage of plant growth (petal fall) then it increased with the advancement of growth stage till it reached maximum at fruit development stage III. Thereafter showed identical decreasing trend in all the samples of diseased leaves of Red Delicious, American Apirouge and Versified. The decrease in O-D phenol in later stages may be because of slow down of biochemicals in the latter parts of the growing season. It was observed that O-D phenol content by resistant cultivar was significantly higher than that of susceptible healthy and diseased cultivar (Table-2). The results are in agreement with the findings of (13,14), who also reported a higher content of O-D phenol in susceptible healthy (Amber, Benoni, Red Delicious) and resistant (Liberty, Priscilla, Priam) cultivars as compared to susceptible diseased (Ambri, Benono, Red Delicious) cultivars under *Venturia inaequalis* pathogens.

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