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## Alternaria leaf spot disease of Aloe vera

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#### Abstract

*Alternaria alternata* is infected to aloe vera plants and causing quantitative and qualitative yield losses. *Alternaria* has more than 50 species. The character of these fungi is more diversified. Typical characteristics of the species are formation of chains, multi-celled with pigmentation. Atmospheric temperature between 23 to 28 °C, relative humidity between 65 to 95 per cent and higher rainfall were conducive for development and progression of the disease. The biomolecules of plants were found alterate that were directly associated with adverse effect of pathogens during the progression of infection in aloe vera leaves. Phylloplane isolate *Cladosporium herbarum*, *Aeurobasidium pullulans*, *Aspergillus flavus*, *Aspergillus niger*, *Trichoderma sp.* and *Penicillium sp.* are most effective for reducing the growth of *Alternaria alternata*.

**Keywords:** *Alternaria*, *Cladosporium herbarum*, *Aeurobasidium pullulans*, *Alternaria alternata*

#### Introduction

Aloe vera is an important perennial drought resistant succulent plant belongs to Aloeaceae family. Aloe is derived from the Arabic word "Alloeh," which means "shining better stuff," whereas "vera" in Latin means "truth." Two thousand years ago Greek scientists thought aloe as a result of the universal treatment. It is one of the most important contemplative plants in India, and is known for its elemental and medicinal properties. It is grown in large quantities in many parts of the country, including Uttar Pradesh, Chhattisgarh, Madhya Pradesh, Gujarat, and Rajasthan. The Aloe vera leaf contains 90-96 per cent water, as well as other 75 elements such as enzymes, lignin's, mono and poly saccharides, 2-hydroxybenzoic acid, saponins, sterols, and vitamins (Barcroft and Myskja, 2009) [7]. The fat-soluble vitamins C and E found in aloe gel are antioxidants. Thiamine, niacin, ovoflavin (riboflavin), and vitamin complex are all essential nutrients. They contain most common polysaccharides are known as glucomannans [beta-(1, 4)- Acetylated mannan]. Aloe plants are used to flavour a number of medicines and drinks that help people stay healthy (Davis and Moro, 1989) [12]. Aloe gel is said to be extremely useful for treating sores and wounds, cancer, skin problems, colds and coughs, constipation, piles, and mycosis (Gill, 1992; Kafaru, 1994; Daodu, 2000; Djeraba and Quere, 2000, Olusegun, 2000) [17, 19, 11, 13, 31]. Rumoured succulent plants are used for treatment of respiratory illness, ulceration and polygenic disorder. Aloe is well-known for assisting digestion, blood circulation, and urinary organ, liver, and gall bladder function with at least three medicinal fatty acids, which aids in the smooth functioning of the belly, small intestines, and colonies. The aloe juice concentrates are abundant in vital enzymes that drive digestion and liver activities. Saponins, a rare natural substance created naturally to cleanse and drain waste and toxins from the body, are also found in aloe supplements (Kumar *et al.*, 2010). In the cosmetics business, succulent is used to produce bath soap, shampoo, hair wash, tooth paste, and body lotions (Daodu, 2000) [11]. Aloe is susceptible to fungi-caused foliar diseases such as leaf spot, tip rot, base rot, and leaf rot, among these leaf spot is the most serious disease caused by *Alternaria alternata*. It is one of the most common disease in the field that not only affects the leaf texture but also reduces the quality and quantity of gummy gel used for health and business purposes. Severely infected plant begins drying far away from the tip leading a big reduction within the yield of leaves. It is absolutely true that infected leaves of aloe have less antimicrobial potential (Gosh *et al.* 2016) [15]. Unfolded leaf spot illness badly stricken by weather factors i.e. temperature and rainfall ratio. (Singh *et al.* 2019) [38]. Fungicide treatment is the most essential method of preventing plants from plant pathogen attack. Several antifungal drugs are available in the market, but chemical fungicides are harmful and have negative effects on a variety of creatures that dwell in the environment. Because these synthetic fungicides are non-biodegradable, they will accumulate in the soil, plants, and water, and so have an organic effect on human health.

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As a result, it's exciting to employ some environmental friendly approaches for plant disease management. Natural products appear to be a viable answer to the environmental issues caused by artificial pesticides, and many researchers are working in this area to find out an effective natural product to replace artificial pesticides (Kim *et al.* 2005) [23]. An effort has been made to review the work done in India and abroad on the "Alternaria leaf spot of Aloe vera (*Aloe barbadensis* Miller)" with following objectives:

1. Leaf spot of Aloe vera and characterization of pathogen
2. Epidemiology of leaf spot disease of aloe vera
3. Biological management of leaf spot disease of aloe vera
4. Alteration of biomolecules in Aloe vera due to leaf spot disease

### 1. Leaf spot of Aloe vera and characterization of pathogen

*Alternaria alternata* causing leaf spot disease on *Aloe barbadensis* in India and has suffered heavy losses during 2006 in Tamil Nadu. The symptoms were observed small, circular to oval dark brown necrotic sunken spots located mostly on the leaf tip, with average diameter of 1.0 mm and reaching 3.0 mm. Pathogen was isolated and identified as *Alternaria alternata* and pathogenicity was established. The conidiophores were branched, straight, golden brown in colour, measuring 15 µm long and 2–6 µm thick. The conidia were golden brown in colour, produced in long branched chains, obclavate in shape, with short conical flask (Kamalakkannan *et al.*, 2008) [20]. A leaf spot disease was observed in Pakistan on *Aloe vera* plants as small, circular to oval dark brown necrotic sunken spots on the leaves. Infected tissues collected from different sites in diseased fields were cultured on malt extract agar medium, and the pathogen was identified as *Alternaria alternata* on the basis of morphological and cultural characteristics. The fungus produced effuse, olivaceous black colonies with dark olive-green margins, and abundant branched septate, golden brown mycelium. The conidiophores were branched, straight, golden-brown, smooth-walled, measuring up to 60 µm long by 3 µm wide with one conidial scar. The conidia were obpyriform, golden-brown, smooth-walled, produced in long branched chains, with a short pale beak. Pathogenicity tests conducted on healthy potted aloe plants in a glasshouse showed typical leaf spot symptoms after four to seven days (Bajwa *et al.* (2010) [6]. Chavan and Korekar (2011) [10] conducted study on three plants *viz.*, *Aloe vera*, *Datura* and *Withania*. He was identified the common diseases on all the three plants. Leaf spot causes harmful effects on medicinal value of the plant parts. Silva and Singh (2012) [37] reported that *Alternaria alternata* causing leaf spot on *Aloe vera* in Louisiana with large, necrotic, sunken, circular to oval, dark brown spots on both surfaces of the leaves. Pieces of infected leaf tissue were surface disinfested with 1% NaOCl solution for 1 min and plated on potato dextrose agar (PDA). Plates were incubated at 28 °C in the dark for 4 days. A dark olivaceous fungus with profuse golden brown, branched, and septate hyphae was consistently isolated from the infected tissue on PDA. The fungus produced conidia with longitudinal and transverse septa, and was morphologically identified as an *Alternaria* sp. Conidia were produced in long chains, pale to light brown, obpyriform, with a beak (6.0 µm long), one to seven transverse and up to three longitudinal septa, and measured 10 to 45 µm long × 7 to 18 µm wide. Conidiophores were straight, septate, light to olive golden

brown with conidial scar, and measured 35 to 100 µm long × 2 to 5 µm wide. On the basis of morphology and genomic analysis the fungus was identified as *Alternaria alternata*. Pathogenicity tests were carried in potted aloe plants Seven days after inoculation, necrotic leaf spots were observed on the inoculated plants and *Alternaria alternata* was reisolated from these spots. The percentages of disease incidence in March, June and August were found 5, 50 and 60%, respectively

### 2. Epidemiology of leaf spot disease of aloe vera

Leaf spot incidence was greatly influenced by weather parameters *viz.*; temperature (25.9 °C to 33.7 °C) relative humidity (89 to 95 per cent) and rainfall (Borkar and Patil 1995) [8]. Sharma *et al.* (2016) [35] reported that the *Alternaria alternata* was more between 27–28 °C temperature and relative humidity 65–90 per cent with frequent rainfall. Sharma and Amrate (2009) [34] conducted surveys during 2008 revealed that *Alternaria* leaf spot disease of *Aloe barbadensis* was prevalent at all the locations *viz.* Ludhiana, Malerkotla, Nawanshahar (Ballawal Saunkhri) and Bathinda. Disease incidence and severity was highest at P.A.U. Regional Research Station, Bathinda which recorded 90.0 and 34.0 per cent respectively. *Alternaria alternata* (Fr.) Keissler was isolated from diseased leaves and pathogenicity was proved on healthy leaves. Disease development and progression were correlated with prevailing environmental factors at Ludhiana during the year 2008. Highest disease incidence and intensity was recorded during August. However correlation study showed that all the factors (atmospheric temperature, relative humidity and cumulative rainfall) were positively correlated with disease development. This investigation revealed that the atmospheric temperature between 23 to 30°C, relative humidity between 65 to 95 per cent and higher rainfall were conducive for development and progression of the disease. Anonymous (2013) [4] survey of disease showed that highest *Alternaria* leaf spot incidence was recorded during May whereas leaf blight incidence was maximum during August and September. Ghosh *et al.* (2018) [16] studied epidemiology of leaf spot disease of *Aloe vera* and found that the PDI peaked during the hot and humid conditions from May to September (76.57%–98.57%) but decreased during the winter from December to January (35.71–46.66%). Correlation of disease with environmental factors revealed that high relative humidity coupled with temperature of 27–28°C is most favourable for the disease development. The pathogen could survive in infected leaves up to 8 months under natural conditions and 10 months *in vitro* conditions, thus forming an important source of disease perpetuation (Sharma *et al.*, 2016) [35]. *Aloe vera* leaves showed susceptibility to the disease at all the stages (1 to 10 week old) but maximum susceptibility was at 10 week old leaves. Seven to nine days old cultures of *Alternaria alternata* showed maximum virulence. Very young and very old cultures were found less virulent. Studies on conidial germination of *Alternaria alternata* revealed that 25 °C temperature and 100 per cent RH were most favourable for germination.

### 3. Biological management of leaf spot disease of aloe vera:

Phylloplane isolate of tomato *Fusarium solani* was found inhibitory effect on the mycelial growth of *Alternaria solani* (Ahmed and Saleh, 1989) [2]. Blue berry isolate *Pseudomonas cepacia*, and *Aerobasidium pullulans* were showed inhibitory

effect against *Alternaria alternata* (Stretch, 1989) [39]. Phylloplane isolate of onion *Cladosporium herbarum*, *Penicillium*, *Aeurobasidium pullulans* were most effective on *Alternaria porri* for reducing the growth of mycelium (Tyagi *et al.*, 1990) [42]. Kamalalakshmi (1996) [21] reported that *Aspergillus flavus*, *Aspergillus niger*, *Trichoderma sp.*, *Penicillium sp.*, were effectively reduced the mycelial growth of *Alternaria alternata*. Catska (1987) [9] was reported that *Azospirillum brasiliense*, *Pseudomonas putida* and *Agrobacterium radiobactor* inhibited the growth of *Alternaria alternata* *in vitro*. *Pseudomonas fluorescens* inhibited the mycelium growth of *Alternaria alternata* and reducing the disease intensity of various host plant (Adul Hafeeza *et al.*, 2001. Karthikeyan *et al.* 2005. Vihol *et al.* 2009) [1, 22, 44]. *Bacillus subtilis* was also found to inhibit the mycelial growth of *Alternaria sp.* By 45.3 – 26.7 per cent (Babu *et al.* 2005. Vihol *et al.* 2009) [44].

#### 4. Alteration of biomes in Aloe vera due to leaf spot disease

Total sugar content in aloe vera leaf was found to reduce due to infestation of *Alternaria* leaf spot (Avasthi *et al.* 2018) [5]. This reduction of sugars is might due to increased respiration of host or utilization of sugars by fungi (Prasad *et al.* 1976., Neema, 1989, Naik *et al.* 1988., Hossain *et al.*, 1999., Alberto, 2014) [33, 29, 27, 18, 3]. Other workers also reported similar results in Mulberry (Ghosh *et al.*, 2012) [14], *Phakospora pachyrhizi* (Mengane and Kamble 2012) [26] and *Cymbopogon* spp (Tamuli *et al.*, 2013) [41]. It has been observed that the pathogen attack has increases the stress level in plant leaves which lead to increase the concentration of flavonoid in aloe vera (Vdyasagar and Kotresha 2003, Awasthi *et al.*, 2018) [43, 5]. Shivanna and Mallikarjunswamy (2009) [36] has reported similar results in *Terminalia arjuna*, *T. bellirica*, *T. paniculata* and *T. tomentosa*. Total phenolics and anthraquinone were increased in leaf spot infected leaf of aloe vera due to shikimic acid pathway or enzymatic activity of host in infected host tissue (Naveroske *et al.* 1964., Neish, 1964) [30, 28]. Similar effect in other plant hosts were observed by Mishra *et al.* (2008). Mengane and Kamble (2012) [26] and Parashurama *et al.* (2013) [32]. Chlorophyll-a, b, total chlorophyll and carotenoid contents was significantly reduced in infected leaves of aloe vera as compared to healthy leaves. Swarbrick *et al.* (2006) [40] stated that pathogen tries to manipulate metabolism of plants for its own need and causes an increased demand for assimilation in plant. Reduction of chlorophyll was also observed in common bean infected by *Colletotrichum lindemuthianum* (Lobato *et al.* 2009) [25], tomato and cotton leaves infected with *Alternaria alternata* (Zhao *et al.* 2013) and aloe vera infected with *Fusarium proliferatum* (Avasthi *et al.* 2018) [5].

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