Rafidain Journal of Science

https://rsci.mosuljournals.com

Vol. 32, No.1, pp.90-101, 2023

Biodiversity of some Species of *Alternaria* Fungi Causing Spotting in Ornamental Plants

Noor A. Al-healy
Medical Laboratory Technique/ Al Noor University Collage/ Mosul/ Iraq
Warka S. Al-Taee
Department of Biology/ College of Science/ University of Mosul

p-ISSN: 1608-9391
e -ISSN: 2664-2786

Article information

Received: 7/9/2022
Accepted: 5/10/2022

DOI: 10.33899/rjs.2023.177291

corresponding author:
Warka S. Al-Taee
warsbio22@uomosul.edu.iq

ABSTRACT

The pathogenic fungi causing leaf spotting of several species of ornamental plants were isolates, diagnosed and purified. a (229) fungal isolates belonging to several fungal genera was obtained and the species belonging to the genus *Alternaria* were selected to conduct experiments on them. Where (89) isolates of the fungal type *Alternaria dianthi* and (68) isolates of the type *A.alternata* were obtained in addition to three isolates of the type *A.longipes* and one isolate of the type *A.radicine*. The phenotypic qualities represented by the forms of colonies, which are considered evidence in classification and innate diagnosis, have also been studied, and the colors of colonies belonging to this genus ranged from dark olive to pale in addition to some other phenotypic qualities such as the emergence of the phenomenon of sectors characterized by some fungal isolates.

Keywords: *Alternaria dianthi*, spotting, *Alternaria Alternata*, Ornamental plants, leaf spotting, pathogen.

INTRODUCTION

The fungal kingdom is interest in the study, which 100,000 species are described and 15,000 cause diseases to plants (Maharshi and Thaker, 2012). The complexity of pathogenic mechanisms in fungi at the morphological level is increased due to Increased fungal and plant diversity, as fungi form highly specialized structures of infection (Hawkswort, 1991; Horbach *et al*., 2011). The genus Alternaria species have been described based on the form (Kordalewskal *et al*., 2015). It is dedicated to the breadwinner and includes pathogenic species, (Woudenberg *et al*., 2015). As well as the ability of this genus to widely distributed and thus cause agricultural problems (Espiritu, 2018; Meena1 *et al*., 2020; Nishikawa and Nakashima, 2020). For example, *Alternaria alternata* alone is known for its ability to infect more than 100 species of plant, causing leaf spotting and other diseases (Rotem, 1994; Thomma, 2003; Shoaib *et al*., 2021). And that the occurrence of plant disease is the result of a complex interaction of the rapidly susceptible host plant and the presence of the pathogenic organism and the environment. Infected flowers are usually not exportable and are not recommended in local markets (Singh *et al*., 2016). Chase (1998) showed that species of the genus *Alternaria* cause diseases of ornamental plants, infecting their leaves and flowers, and when severe injuries occur, they cause the leaves to fall out quickly. In particular, type *A.dianthi* and *A.dinthicola,* which cause infection to the dianthus plant, the infection appears on the corolla leaves and is purple in color and then black lumps are spores inside (Pryor and Michailides, 2002) showing symptoms of infection with the fungus *Alternaria* in the form of spots on leaf spots (Gao *et al*., 2020; Kgatle *et al*., 2018; Li *et al*., 2022) or in the form of leaf blights (Laemmlen, 2001; Kokaeva *et al*., 2017).

Leaf Spots diseases is a term given to several diseases that have an impact on the leaves of trees for shade and ornamental plants that are usually caused by the presence of fungi or may sometimes occur due to bacteria as damage can occur in plant leaves and these spots vary in size and color depending on the affected plant and the stage of development of the disease and the affected organ for example, the symptoms of spotting on the leaves of the Leaf blight disease of jasminum appear as a result of infection with the fungus *Alternaria alternata* in the form of irregular brown areas surrounded by dark colored beams that appear on the surface of the leaf that sometimes cause "fire necrosis symptoms" (Matic *et al*., 2020). When the plant itself is infected with the fungus *Alternaria* jasmine, it appears in the form of circular spots of reddish-brown color with a diameter of (8-2) mm on the upper surface of the leaf, and the edges of the leaves appear affected internal wrinkles become hard and brittle, and in acute infection the terminal bouton and small branches are dry out, the infected leaves must be collected and burned to get rid of them (Singh *et al*., 2016). When the rose of ornamental plants are infected with the fungus *Alternaria* it causes them great losses, and the symptoms appear in the form of small to irregular oval spots, light brown to black scattered initially observed on the edge of the leaves which later grow and merge to cover the entire surface of the leaf, and the pathogens remain on the affected leaves and other parts of the plant, the fungal type *Alternaria dianthi* cause Rot diseases of flower bud to the plant and the symptoms of the disease appear mainly on young floral buds leading to their rotting, necrosis and discoloration of the stem, hood and small flowers also become brown. At the last stage of the disease the bud become wilt, dark brown and dry. Symptoms are less pronounced in mature buds but these buds do not bloom. As well as brown necrotic spots that appear on the edges and tops of old leaves (Singh *et al*., 2016; Matic *et al*., 2020).

Ornamental plants include all plants used for decorative purposes, with floral sales ranging from $40-60 billion (Lecomte *et al*., 2016). Many fungal pathogens cause leaf spotting and falling into their incubating plants and arguably the most harmful and widespread are caused by species of the genus Alternaria (Matić *et al*., 2020). the most common fungal species found in ornamental plants are *Alternaria dianthi*, *Alternaria alternata* and *Alternaria dinthicola* which possess a wide range of plant hosts such as Ficus, Dahlia and Hedera. A single plant can also be attacked by more than one species of the genus *Altenaria,* as well as the presence of other fungal species that cause spotting to ornamental plants and include *Bipolaris, Corynespora, Drechslera, Helminthosporium,*

Stemphylium and *Ulocladium*. This fungus is closely associated with the genus *Alternaria*. Home gardens are a unique ecosystem, and the ornamental plants in them are exposed to many pathogens such as rusts that form fungi of virulence that cause damage to the plant but do not survive in the absence of plant host tissues, other species such as Botrytis that are opportunistic and found everywhere and attack only physiologically weak plants. The use of chemical control to control these pathogens is based on each group, in initially It is important to determine the nature of the disease to choose the right substance in control (Matić *et al*., 2019). and to use different fungicides because repeated use of the same fungicide causes the target pathogen to be resistant (Chung Hong, 2018).

MATERIAL AND METHODS

Sample Collection:

Samples of the leaves of ornamental plants infected with leaf spotting disease were collected from the nursery areas in Mosul including: Al-Faisaliah, Al-Darqzliyah, Mohandessin and Gardens of the University of Mosul for the period from the beginning of November 2017 to May 2018 and the rate of a visit every 20 days and these samples were represented by taking infected leaves for each of the plants *(Aralia elegantissima, Schefflera arboricola, Dracaena Fragrans, Thuja, Ficus, Nephrolepis exaltata, Syngonium Podophllum, Hedera, Lablab, Yucca, Gardenia Jasmineoides, Rosa, Gerbera Jasmesonii, Iris*). They were packed in clean Nylon bags labeled, and transported to the laboratory for study.

Potato-Sucrose Agar (PSA) Medium

This medium was used to isolate and preserve the used isolates and activate them and save the medium until use (Pitt and Hocking, 2009; Sibounnavonng *et al*., 2009).

Isolation of fungus *Alternaria* from the leaves of infected Ornamental plants

Plant leaves that showed symptoms of spotting were selected and distributed to dishes containing potato extract, sucrose and agar, incubated in the incubator for 7 days at temperature (2±25) °C with daily observation during the incubation period (Naik *et al.*, 2010). After the end of the incubation period, the fungal isolates of the genus *Alternaria* were identified and preserved.

Conditions of preservation of fungal isolates

The various fungal isolates were kept in an inclined shape inside the Slants test tubes in the refrigerator at a temperature of 4°C, and the plantations were renovated every two weeks. (Aggarwal *et al*., 2014).

Unification of fungal isolates of the genus *Alternaria*

The Single spore technique was used to purify fungal isolates (Simmons, 2007). For pure fungal cultures originating from a single fungal spore (Pryor and Michailides, 2002).

Diagnosis of fungal isolates

Lactofenol stain (phenol 20g, glycerol 40ml, lactic acid 20ml, distilled water 20ml) was used. To diagnose fungal isolates of the genus Alternaria using the implantation method on the slide which was described by (Deshmukh, 1998; Benson, 2002; Koneman *et al*., 1997) and using the diagnostic keys described by (Ellis, 1971, 1976).

Morphological characteristics of the colony

The medium of potatoes, sucrose and agar was used to observe the formal qualities of colonies of all isolates of the genus *Alternaria* after their development on the center of the PSA where (7) qualities were selected based on taxonomic keys (Ellis, 1971; Moubasher, 1993; Pitt and Hocking, 2009) to describe the fungal colony.

Table 1: Morphological Characteristics of the fungal Colonies Approved for the Classification of Isolates of the genus *Alternaria* (Altaee, 2007)

Adjective	Extent		
The color of the colony	dark olive	pale olive	Gradient from pale to dark olive
The surface of the colony	Smooth	Warts	Cotton
	Un rough	Rough	
The center of the colony	Different	Not different	
Colonial edges	wide white edge	narrow white edge	
The perimeter of the colony	Plane	An uneven plane	
The phenomenon of sectors	Present	Non present	
The back of the colony	dark olive	pale olive gradient to dark	pale olive gradient to bleach
	Dark olive to black	gray to olive	

RESULT AND DISCUSSION

Fungi isolated from infected ornamental plants

The fungus was isolated from the leaf spots of various types of infected ornamental plants, and (229) fungal isolation of species belonging to the genus *Alternaria* as well as other fungal genera was obtained from the beginning of November 2017 until May 2018 during visits every 20 days as shown in (Table 2). Ornamental plants that are most susceptible to fungal infections during this period were selected, and cause economic losses to nursery owners as a result of their high prices and other plant species, despite their low price, have been selected but are among the most sought-after native plants. These plants fall into seven botanical groups, Some of them within the group of woody plants include thuja, aralia, shefflera, dracaena, ficus, and other plants within ferns including nephrolepis, group of climbers and purls including hedera, Syngonium and lablab, group of succulent plants including yucca plant, group of perennial herbaceous plants including gerbera, group of ornamental shrubs including cardenia and rosa and the group of ornamental bulbs represented by the Iris plant, and these plants belong to different plant families, namely:
Asparagaceae, Araliaceae, Agaraceae, Moraceae, Cupressaceace, Popilionaceae, Araceae, Lomariopsidaceae, Asteraceae, Rosaceae, Rubiaceae, Iridaceae.

The lowest incidence of fungi was recorded during the month of July and August due to the high temperature leading to the cessation of the vital activities of most fungi, which does not encourage any fungal infection, while fungal infections increase during the months of February and March to raise the temperature to the ideal degree of infection (30-25)°C. Some of these selected plants were flowering ornamental plants of aesthetic importance to gardens and nurseries and others of climbers that are considered to be vegetation that remains green throughout the year Fern and woody plant species were also selected. The fungal species of the genus *Alternaria* that appeared during isolation have varied, and this fungal genus is known to cause diseases of ornamental plants and in cases of severe infection may cause their leaves to fall (Chase, 1998). Also, the difference of the fungal species shown during isolation is due to the difference of the plant species isolated from it and four fungal species belonging to the genus *Alternaria* were obtained, namely *A. dianthi, A. longipies, A. radicine, A. alternata* and the fungal species *A. dianthi* was the most frequent as (15) isolation was obtained With a percentage of 100% isolation in Nephrolepis and (13) isolation of the same species and an isolation rate of 81.3% in the Ficus plant, while the number of isolates in the Dracaena plant was (15) isolation and with an isolation rate of 68.2%, and in the Shefflera plant the number of isolates (12) isolation and a percentage of isolation of 66.6%, while the Gerbera plant had a percentage of isolation of 65.5% and the number of isolates (19) isolation. It was followed by the fungal type *A. alternata* with (68) fungal isolates in all plants, while the type *A. longipies* was the least frequent with three isolates in lablab plant and a percentage of isolation of 17%. The fungal species *A. radicine* also has one isolation and a 12% isolation in the Thuja plant. Other fungal species also appeared during isolation, namely *Stemphylium.sp*, particularly in the yucca plant, where the number of isolates was (14) isolates and a percentage of isolation of 100% and

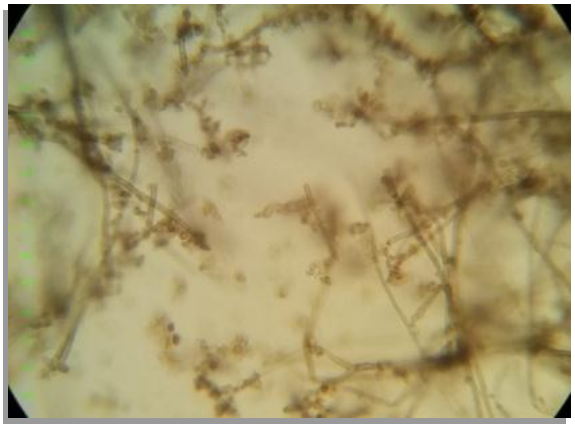
Ulocladium.sp, and in the Syngonium plant with an isolation rate of 6.25% and one isolation, which are considered to be taxonomic brothers of the genus *Alternaria* (Pryor and Gilbretson, 2000). as well as *Cladiosporum* sp. whose number of isolates in lablab plant was (14) isolates and with an isolation rate of 93%. Thus, it turns out that the most contagious and frequent fungal species in ornamental plants is *A. dianthi* because of its possession of this peculiarity in infecting ornamental plants (Thomma, 2003). In practice, the genus *Alternaria* depends in its pathogenesis on the resistance and sensitivity of the host (Meena *et al*., 2017a). The increase in disease is also influenced by various physical factors such as heat, light and pH (Jadhav and Wadikar, 2018). Therefore, we note a high incidence of fungal infection in plant species such as the rosa and the syngonium with thin leaves, while the species *A. dianthi*, *A.alternata* is absent in the yucca plant due to the thickness of its leaves and its resistance. And explain the emergence of one isolation for each of the species *A. radicine* in the thuja plant and three isolates *A. longpies* in lablab, although they specialize in infecting plant families as the type A. longipies are known to be infected with the tobacco plant (Meena *et al*., 2017). Type *A. radicine* infects the carrot plant, causing its black rot (Laemmlen, 2001), but this does not prevent them from infecting other plant families as pathogens when positive conditions are available to cause infection in the same season and thus the disease becomes a problem for these plant species, as stated (Thomma, 2003). Some species of the genus *Alternaria* can penetrate the tissues of the plant and remain static until the appropriate surrounding conditions are available and the infection appears.

Table 2: Fungi isolated from ornamental plants for the period from the beginning of November 2017 to May 2018

Percentage of Insulation	Number of Isolates	Fungal Species	Scientific Name	Common Name of Type	Botanical Family	Botanical Classification	
21 31.5 47.4	4 6 9	*A. alternate* *Cladiosporium sp.* *Stemphylium sp.*	*Finger Aralia plant paper*	*Aralia elegantissima*	Araliaceae	Wooden plants	Leafy plants
100	19	Total					
66.6 33.3	12 6	*A. dianthi* *A. dianthi isolation* *A. dianthi* *Stemphylium sp.*	*Umberlla tree*	*Schefflera arboricola*	Araliaceae		
100	18	Total					
22.7 68.2 9.09	5 15 2	*Cladiosporium sp.* *Alternaria dianthi* *Alternaria alternate*	*Madagascar Dragontree*	*Dracaena Fragrans*	Asparagaceae		
100	22	Total					
12 50 38	1 4 3	*Alternaeia radicine* *Alternaria alternata* *Cladiosporium sp.*	*Thuja Orientalis (Biot Orientalis)*	*Thuja*	Cupressaceace		
100	8	Total					
18.8	3	*A. alternate* *A. dianthi*	*Ficus Hawaii*	*Ficus*	Moraceae		

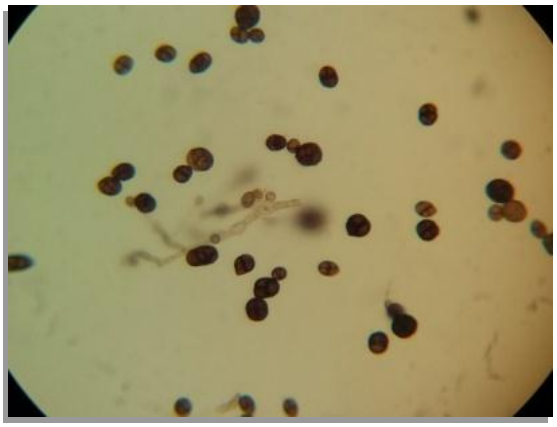
Percentage of Insulation	Number of Isolates	Fungal Species	Scientific Name	Common Name of Type	Botanical Family	Botanical Classification	
81.3	13	*A. dianthi isolation A. dianthi*					
100	16	Total					
100	15	*A. dianthi*	*Ladder Fern*	*Nephrolepis exaltata*	Lomariopsidaceae	Ferns	
100	15	Total					
6.25 62.5 31.3	1 10 5	*Ulcladium sp.* *Stamphilum sp.* *A. alternate*	*Goose foot plant,Syngonium*	*Syngonium Podophllum*	Araceae	Purls and Climbers	
100	16	Total					
100	13	*A. alternate*	*Canary island IVY*	*Hedera*	Araliaceae		
100	13	Total					
82 17.6	14 3	*Cladiosporum sp.* *A. longipies*	*Lablab Dolichos*	*Lablab*	Popilionaceae		
100	17	Total					
100	14	*Stamphilum sp.*	*Spineless yucca*	*Yucca*	Asparagaceae	Succulent plants	
100	14	Total					
55 45	11 9	*A. alternate* *A. dianthi*	*Gardenia Cape,Jasmine*	*Gardenia Jasmineoides*	Rubiaceae	Ornamental bushes	Ornamental Bushis
100	20	Total					
69.2 30.8	9 4	*A. alternata* *A. dianthi*	*Rose damascene*	*Rosa*	Rosaceae		
100	13	Total					
34.5 65.5	10 19	*A. alternata* *A. dianthi*	*Gerbera Diasy,Barbeton Daisy*	*Gerbera Jasmesonii*	Asteraceae	Perennial herb	
100	29	Total					
77.8 22.2	7 2	*A. alternata* *A. dianthi*	*Iris Cristata*	*Iris*	Iridaceae	Ornamental bulbs	
100	9	Total					
229		Total number of isolates					

A. Radicine

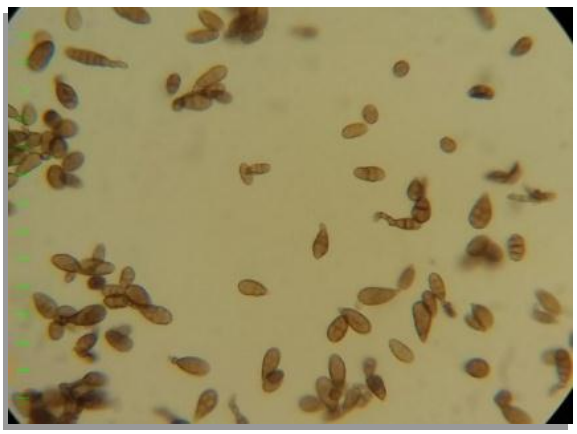


Cladiosporium sp.

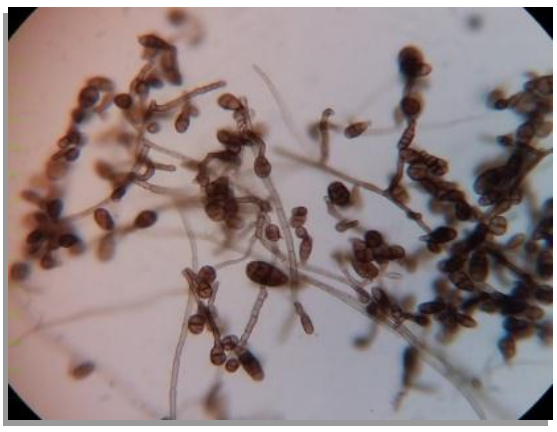
A. Longipies



Stemphylium sp.



A. alternata



A. Dianthi

Fig. 1: Microscopic image of fungal species isolated under 40X zoom force, image resolution 8 MP.

Formal qualities of the colony

The variation in the traits of fungal cultures of all species visible during isolation belonging to the genus *Alternaria* and based on the taxonomic keys of the (Table 3) within the materials and methods, as the colors of the fungal colonies of the genus *Alternaria* ranged from dark olive to light as well as the color of the back of the colony between dark olive and gray to olive and pale olive to

white. The surface of the colony is characterized as smooth or contains cotton-shaped fluffs. The study showed that all colonies are not producing pigments that cause the medium color change and this is in line with their findings (Chethana *et al*., 2018). The innate isolation of *A. dianthi*4a isolated from the schefflera plant was characterized the surface color of the colony was pale olive with fluffs with wide edges and the center of the colony in some of them showed a difference, while the back of the colony was of a dark olive color to black with the perimeter of a zigzag colony as shown in Fig. (2). As for the fungal isolates of the type *A.alternata*, the isolation *A. alternata 5* taken from the hedera plant was characterized the surface of the colony is smooth with wide and flat edges, and in some isolates the edges were narrow, as the color of the back of the colony ranged from brown to olive, and in other isolates belonging to the same species and was of a dark olive color with a different colony center, as well as the phenomenon of sectors in a distinctive way in it, which can express that the fungal filaments includes inside the nuclei and is a cellular integrated Some may vary heterokaryotic spores produce spores of two different colors and the growth of homokaryon produces a different color sector as the appearance of this phenomenon can be considered as a result of the pyramid of the colony due to the repeated transplantation of fungal filaments at the edge of the colony (Burnett, 1976). These sectors usually appear at or within the edge of the colony and differ in color from the rest of the colony. As for the fungal isolation of the type *A. radicine* shown in the thuja plant, the color of the colony was dark olive, a smooth surface with narrow edges, the color of the back of the colony gray to olive, the absence of the phenomenon of sectors in it, and the perimeter of the colony was flat, and this is confirmed (Gilbertson and Pryor, 2000) about the characteristics of the fungal colony. As for the fungal isolates of the type *A. longipies* isolated from the lablab plant, the colony had a smooth surface and a dark olive color, and the back of the colony was gray to olive in color and the phenomenon of sectors in it did not appear, and these qualities are similar to what he mentioned (Andersen *et al*., 2001).

Table 3 Formal qualities of the fungal colonies of some species of the genus *Alternaria*

Isolation	Color of the colony	Color of the back of the colony	Center of the colony	Edges of the colony	Phenomenon of sectors	Surface of the colony	Perimeter of the colony
A. dianthi$_5$	Pale olive to bleach	olive to dark	No differ	Narrow	Present	Cotton	Plane
A. dianthi$_3$	pale olive	Gray to Olive	Differ	Wide	No present	Rough	Plane
A. dianthi$_7$	dark olive	Pale olive to bleach	No differ	wide	No present	Smooth	Plane
A. alternata$_4$	dark olive	Dark olive gradient to pale	No differ	Wide	No present	Rough	Plane
A. dianthi$_{6a}$	dark olive	Dark olive to pale	No differ	Wide	No present	Smooth	Zigzag
A. dianthi$_2$	dark olive	Pale olive to bleach	Differ	Narrow	No present	Smooth	Plane
A. radicine	dark olive	Gray to Olive	No differ	Narrow	No present	Smooth	Plane
A. dianthi$_{4a}$	Dark olive to black	Pale olive	Differ	Wide	Present	Rough	Plane\ zigzag
A. alternata$_5$	Dark olive	Gray to olive	Differ	Wide	Present	Smooth	Plane
A. dianthi$_1$	Dark olive	Dark olive	Differ	Narrow	No present	smooth	Plane
A. alternata$_1$	Gray to black	dark olive	Differ	Narrow	No present	Rough	Plane
A. longipies	Dark olive	Gray to olive	Differ	Narrow	No present	Smooth	Plane
A. alternata$_1$	Gray to black	dark olive	Differ	Narrow	No present	Rough	Plane
A. longipies	Dark olive	Gray to olive	Differ	Narrow	No present	Smooth	Plane

Isolation	Color of the colony	Color of the back of the colony	Center of the colony	Edges of the colony	Phenomenon of sectors	Surface of the colony	Perimeter of the colony
A. alternata$_1$	Gray to black	dark olive	Differ	Narrow	No present	Rough	Plane
A. longipies	Dark olive	Gray to olive	Differ	Narrow	No present	Smooth	Plane
A. alternata$_1$	Gray to black	dark olive	Differ	Narrow	No present	Rough	Plane
A. longipies	Dark olive	Gray to olive	Differ	Narrow	No present	Smooth	Plane

Pathogenesis and symptoms of infection with the fungus Alternaria in various types of ornamental plants

The development of signs of plant disease is associated with the accumulation of mycotoxins produced by fungi that colonize the living tissues of the plant and are responsible for the production and accumulation of these toxins within the plant tissue over time, as well as have a biological effect on the functions of plant organs and this effect is not noticeable as a result of the presence of mycotoxin, despite the absence of signs of the disease (Ismaiel and Papenbrock, 2015). Through the collected samples of the leaves of ornamental plants with spotting, it was found that the symptoms of the disease of the genus Alternaria were in the form of dark brown to black, multi-wide, centered in the form of rings and surrounded by a different color, as in the Fig. (2). Chester (1950) explained that the symptoms of spotting in nursery plants caused by infection with Alternaria fungus formed on the leaves are in the form of light brown spots and then turn dark brown over time as a result of the death of plant tissues, and may be irregular or irregular in shape (Woudenberg *et al*., 2015). If the spotting is caused by infection with type A. dianthi, the spots are luminous brown with purple-brown edges on the stems and leaves, the lower leaves attack first and then the disease progresses upwards to the upper leaves. As harm increases it leads to corruption and early death of the leaves (Kumar *et al*., 2012). Since the species of the genus Alternaria spp. have the ability to produce specialized and non-specialized toxins, they have the ability to spread to neighboring tissues from the site of injury and thus cause their death, as well as the species of this genus are characterized by symptoms of infection and the fact that a small number of Fungi have the ability to form such spots (Laemmlen, 2001; Aggarwal *et al*., 2014). Because of the necrotic nature of the Alternaria species, they lead to extensive damage to the plant (Mamgain *et al*., 2013).

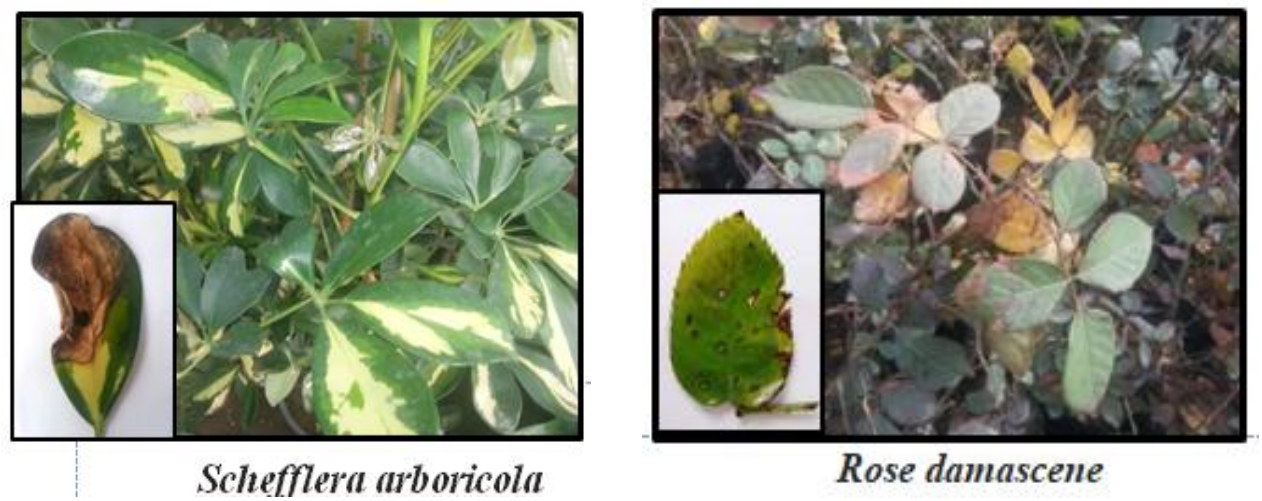


Fig. 2: Symptoms of leaf spotting disease in various types of ornamental plants.

CONCLUSIONS

The fungi belonging to the genus *Alternaria* are among the important pathogens of Ornamental plants, especially the fungi belonging to the two species *A. dianthi* and *A. alternata*, and they are widespread in the nurseries and gardens of the city of Mosul.

REFERENCES

Aggarwal, N.K.; Kaur, M.; Kumar, V.; Saini, A.K. (2014). Mycobiota associated with *Parthenium hysterophorus* isolated from North India. *Indian J. Weed Sci*., **46**,155–160.

Andersen, B.; Kroger, E.; Roberts, R.G. (2001). Chemical and morphological segregation of *Alternaria alternate*, *A. gaisen* and *A. longipes*. *Mycol. Res*., **105**, 291-299.

Benson, H.J. (2002). "Microbiology Application". 8th ed. McGraw-Hill Companies, Inc. USA. pp. 22-105.

Burnett, J.H. (1976). "Fundamentals of Mycology". Arnold, London.700 p.

Cacace, J.E.; Mazza, G. (2003). Mass transfer process during extraction of phenolic compounds from milled berries. *J. Food Eng*., **59**(4), 379-389.

Chase, A.R. (1998). *Alternaria* diseases of ornamentals. *Western Connection Turf and Ornamentals Newsletter*. **3**(1), 1-4.

Chester, (1950). "Nature Prevention and Pant Disease". McGraw, Hill, 525 p.

Chethana, B.S.; Girija, G.; Archana, S.R.; Bellishree, K. (2018). Morphological and molecular characterization of *Alternaria* isolates causing purple blotch disease of onion. Int. *J. Curr. Microbiol. App. Sci*., **7**(4), 3478-3493. ISSN: 2319-7706.

Chung Hong, C. (2018). Home ornamentals: Control of ornamental diseases, extension plant pathologist. *Hampton Roads AREC*., **3**,14.

Deshmukh, A.; Sawant, D.G. (1998). "Studies of Leaf Spot and Fruit Rot of Chilli Caused by *Alternaria alternata* Keissler". MPKV, Rahuri.

Ellis, M.B. (1971). "Dematiaceous Hyphomycetes". Common wealth Mycological Institute. Kew, Surrey, England. UK. 608p.

Ellis, M.B. (1976). "More *Dematiaceous Hyphomycete*". Commonwealth Mycological Institute. (C.M.I). Publication, Kew, Survey, England. UK. 507 p.

Gao, J.; Yang, M.; Xie, Z.; Lu, B.; Hsiang, T.; Liu, L. (2020). Morphological and molecular identification and pathogenicity of *Alternaria* spp. associated with ginseng in Jilin province. *China Canadian J. Plant Pathol.,* **43**(4), 537–550.

Hawkswort, D.L. (1991). The fungal dimension of biodiversity: magnitude, significance, and conservation. *Mycol. Res*., **95**, 641–655.

Horbach, R.; Navarro-Quesada, A.R.; Knogge, W.; Deising, H.B. (2011). When and how to kill a plant cell: infection strategies of plant pat Hoganic fungi. *J. Plant Physiol*., **168**, 51–62.

Ismaiel, A.A.; Papenbrock, J. (2015). Mycotoxins: Producing fungi and mechanisms of phytotoxicity. *Germany Agricult.*, **5**, 492-537.

Jadhav, S.B.; Wadikar, M.S. (2018). Effect of different physical factors on growth of *Alternaria* isolates from Capsicum annum L. *International J. Botany Stud.,* (**1**), 137-139.

Kgatle, M.; Truter, M.; Ramusi, M.; Flett, B.; Aveling, T. (2018). *Alternaria alternata*, the causal agent of leaf blight of sunflower in South Africa. *European J. Plant Pathol.* **151**(3), 677–688.

Kokaeva, L.; Belosokhov, A.; Doeva, L.; Skolotneva, E.; Elansky, S. (2017). Distribution of *Alternaria* species on blighted potato and tomato leaves in Russia. *J. Plant Diseas. and Protect.,* **125**(7), 685.

Koneman, E.W.; Allen, S.D.; Janda, W.M.; Schreckenberger, P.C.; Jr, W.C.W. (1997). "Color Atlas and Textbook of Diagnostic Microbiology". 5th ed. Lippincott-raven publishers, Philadelphia, pp.121-139.

Kordalewska, M.; Brillowska-Dąbrowska, A.; Jagielski, T.; Dworecka-Kaszak, B. (2015). PCR and real-time PCR assays to detect fungi of *Alternaria alternata* species. *Warsaw, Poland.,* **62** (4), 707–712.

Kumar, P.; Singh, Y.; Singh, V.K. (2012). Diseases of ornamental plants and their management. *Eco-Friendly Innovat. Approach. in Plant Dise. Management*. (India). 543-572. Chapter 34.

Laemmlen, F. (2001). *Alternaria* diseases. University of California. *Agriculture and Natural Resources*. http://anrcatalog.ucdavis.edu.

Lecomte, C.; Alabouvette, C.; Edel-Hermann, V.; Robert, F.; Steinberg, C.; Robert, F.; Steinberg, C. (2016). Biological control of ornamental plant diseases caused by *Fusarium oxysporum.* France. *Biolog. Contr.,* **101**, 17-30.

Lil, Y.; Dong1, X.; Yang1, A.; Zhang1, H. (2022). Diversity and pathogenicity of *Alternaria* species associated with the invasive plant *Ageratina adenophora* and local plants. *Peerj.,*

Maharshi, A.R.; Thaker, V.S. (2012). Growth and development of plant pathoganic fungi in define media. *Eur. J. Exp. Biol.,* **2**, 44–54.

Mamgain, A.; Roychowdhury, R.; Tah, J. (2013). *Alternaria* pathogenicity and its strategic controls. *Research J. Biol.,* **1**, 01-09.

Matić, S.; Gilardi, G.; Varveri, M.; Garibaldi, A.; Gullino, M.L. (2019). Molecular diversity of *Alternaria* spp. from leafy vegetable crops and their sensitivity to azoxystrobin and boscalid. *Phytopathol. Mediterr*., **58**, 519-533.

Matić, S.; Tabone, G.; Garibaldi, A.; Gullino, M. (2020). *Alternaria* leaf spot caused by *Alternaria* species: an emerging problem on ornamental plants in Italy. *Plant Disease*. **104**(8), 2275-2287.

Meena, M.; Zehra, A.; Dubey, M.K.; Aamir, M.; Gupta, V.K.; Upadhyay, R.S. (2017). Comparative evaluation of biochemical changes in tomato (*Lycopersicon esculentum* Mill.) infected by *Alternaria alternata* and its toxic metabolites (TeA, AOH, and AME). *Front. Plant Sci.,* **7**, 1408.

Meena, P.R.; Saran, L.P.; Kalariya, A.K.; Manivel, P. (2020). Efficacy of fungicides and plant extracts against *Alternaria alternata* causing leaf blight of chandrasur (*Lepidium sativum*). *Indian J. Agricultur. Sci.*, **90**(2), 337-40.

Moubasher, A.H. (1993). "Soil Fungi in Qatar and other Arab Countries". The Center of Scientific and Applied Research. University of Qatar, Doha, pp. 32-37.

Naik, M.K.; Prasad, Y.; Bhat, K.V.; Rani, D.G.S. (2010). Morphological, physiological, pathoganic and molecular variability among isolates of *Alternaria solani* from tomato. *Indian Phytopathol.*, **63**(2),168 -173.

Nishikawa, J.; Nakashima, C. (2020). Japanese species of *Alternaria* and their species boundaries based on host range. *Fungal System. and Evol.*, **5**(1), 197–281.

Power, A.; Mitchell, C. (2004). Pathogen spillover in disease epidemics. *The American Natur.*, **164**(S5), S79–S89.

Pitt, J.I.; Hocking, A.D. (2009). "Fungi and Food Spoilage". 3rd ed. Spring Science Business Media, LLC, New York, USA. 519 p.

Pryor, B.M.; Gilbertson, R.L. (2000). Molecular phylogenetic relationships among *Alternaria* species and related fungi based upon analysis of nuclear ITS and mtSSU rDNA sequences. *Mycol. Res*., **104**(11), 1312-1321.

Pryor, B.M.; Michailides, T.J. (2002). Morphological, pathogenic, and molecular characterization of *Alternaria* isolates associated with *Alternaria* late blight of pistachio. *Phytopathol.*, **92**, 406–416.

Rotem, J. (1994). "The Genus *Alternaria"*. Biology, Epidemiology and Pathogenicity. APS Press, St. Paul, Minnesota, USA.

Shoaib, A.; Akhtar, M.; Javaid, A.; Ali, H. (2021). Antifungal potential of zinc against leaf spot disease in chili pepper caused by *Alternaria alternata*. *Physiol. and Molec. Biol. of Plants*. **27**(6),1361-1376.

Sibounnavong, P.; Kalaw, S.P.; Divina, C.C.; Soytong, K. (2009b). Mycelial growth and sporulation of *Emericella nidulans*, a new fungal antagonist on two culture media. *J. Agricult. Technol.,* **5**(2), 317-324.

Simmons, E.G. (2007). *Alternaria*: an identification manual: Fully Illustrated and with Catalog Raisonne 1796-2007-1571-8859 ISSN. Utrecht: Central Bureau voor Schimmelcultures Baarn. series 6. CBS Fungal Biodiversity Center..

Singh, V.K.; Singh, Y.; Kumar, P. (2016). Diseases of ornamental plants and their management. *Eco-friendly Innovat. Appr. in Plant Dis. Manag.*, Chapter 34, Pantnagar. 145-263. Uttarakhand, India.

Thomma, B.P. (2003). *Alternaria* spp.: from general saprophyte to specific parasite. *Mol. Plant Pathol*., **4**, 225–236.

Woudenberg, J.; Seidl, M.; Groenewald, J.; De Vries, M.; Stielow, J.; Thomma, B.; Crous, P. W. (2015). *Alternaria* section *Alternaria*: species. *Formae Specials or Pathotypes? Studies in Mycol*., **1**, 1-21.

التنوع الحيوي لبعض أنواع الفطر *Alternaria* المسبب لتبقع أوراق نباتات الزينة

نور احمد شهاب احمد الحيالي — قسم تقنية المختبرات الطبية / كلية النور الجامعة

ورقاء سعيد قاسم الطائي — قسم علوم الحياة / كلية العلوم / جامعة الموصل

الملخص

تم عزل وتشخيص وتنقية الفطريات المُمرضة المسببة لتبقع الاوراق لعدة أنواع من نباتات الزينة، إذ تم الحصول على (229) عزلة فطرية عائدة لعدة أجناس فطرية وانتخبت الأنواع التابعة لجنس *Alternaria* لإجراء التجارب عليها. حيث تم الحصول على (89) عزلة للنوع الفطري *Alternaria dianthi* و (68) عزلة للنوع *A. alternata* بالإضافة إلى ثلاث عزلات للنوع *A. longipies* وعزلة واحدة للنوع *A. radicine*. كما تمت دراسة الصفات المظهرية المتمثلة بأشكال المستعمرات والتي تعتبر من الادلة في التصنيف والتشخيص الفطري وقد تراوحت ألوان المستعمرات التابعة لهذا الجنس بين الزيتوني الغامق إلى الشاحب بالإضافة إلى بعض الصفات المظهرية الأخرى كظهور ظاهرة القطاعات التي تميزت بها بعض العزلات الفطرية.

الكلمات الدالة: *Alternaria dianthi*، فطريات، *Alternaria Alternata*، نباتات الزينة، تبقع الأوراق، امراضية.