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TECHNICAL DOCUMENT ON POWDERY MILDEW AND ANTHRACNOSE OF *Mentha* SPP

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Review Article

ABSTRACT

Mentha spp. (locally named mint or spearmint) is an important widespread vegetable crop in different countries around the world. It was infected by many fungal diseases including powdery mildew and anthracnose. Powdery mildew is an important and serious fungal disease on *Mentha* spp. caused by the fungus *Golovinomyces biocellatus* (Formerly *Erysiphe cichoracearum*) which overwinters on mint, stubble and many wild hosts. The disease symptoms represented by appearing white powdery spots on the leaves and stems of the plant. So, these spots become larger and denser when the disease progresses. This disease can be controlled by removing plant debris, removing infected plants from the former season and using many suitable fungicides. Anthracnose is another important fungal disease that infects *Mentha* spp. It caused by the fungus *Sphaceloma menthae* and *Colletotrichum* spp., which may be considered as seed-borne fungi. The disease symptoms include circular, oval or irregular spots which firstly appear yellow to brown, then they become black with the age progress. This disease can be controlled by using healthy plant materials, mechanical practices and applying some suitable fungicides. Both of these two diseases are very important and harmful to mint plants, significantly reduce the crop production and cause serious economic losses. So, powdery mildew is more harmful than anthracnose. In this technical document, we summarize the current knowledge of powdery mildew and anthracnose diseases epidemiology symptoms and signs, disease cycle, ecology and disease management.

Keywords: Anthracnose disease; *Colletotrichum* spp.; disease cycle; disease management; *Erysiphe cichoracearum*; *Golovinomyces biocellatus*; *Mentha* spp.; powdery mildew disease; *Sphaceloma menthae*.

1. INTRODUCTION

Mentha spp. (locally named mint) is a herb plant belongs to the *Lamiaceae* family and includes 42 species, 15 hybrids, and hundreds of subspecies, varieties and cultivars, which potentially crossbreed when in proximity [1]. These fragrant plants have been selected throughout millennia for use by humans as herbs, spices, and pharmaceutical needs [2]. Mint has a world-wide spread and distributes all over the world in both moderate and tropical regions including Asia, Africa, Europe, America and

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Australia [3]. Mint is an aromatic perennial herb [4] grows well under wet conditions and moist soil near rivers and lakes [5,6]. It was used as fresh food, in cooking, for producing essential oils and as alternative therapy treatments to cure many cases (prevention from cancer development and anti-obesity, antimicrobial, anti-inflammatory, anti-diabetic, cardio protective effects, etc.). It would also help as a biological control avoiding the irrational use of pesticides in agriculture [7,8].

Mint as well as any other plant, infected with many pests like aphids and whitefly and many diseases especially fungal diseases such as powdery mildew and anthracnose [5,6]. Powdery mildew disease is an important and serious fungal disease infected large numbers of plants including mint and causes large economic losses, it was caused by many different external obligate parasite genera and species belonging to the order Erysiphales, class Hymenoascomycetes and phylum Ascomycota such as *Erysiphe* [9]. Many species belonging to the genus *Golovinomyces* were also recorded as causal agents of powdery mildew on *Mentha* spp. [10].

Anthracnose is another important fungal disease of *Mentha* spp., it can spread quickly in wet and moderate conditions. It can be transmitted by the plant seeds. Anthracnose is caused by *Colletotrichum* spp. which belong to Coelomycetes, the teleomorph is *Glomerrella* which belongs to the order Glomerellales, class Sordariomycetes and phylum Ascomycota [11]. Other causal agent of this disease is *Sphaceloma menthae* which belongs to class Dothideomycetes and phylum Ascomycota, it also produces conidia in acervulus and contains about 52 species [12].

In this technical document, we summarize the current knowledge of powdery mildew and anthracnose diseases epidemiology, such as pathogen survival, dispersal, and host invasion. Most importantly, we identify knowledge gaps and research questions on how to live with the spread of fungus. The impact of biotic and abiotic factors and crop management practices on the disease intensity are discussed. Finally, a set of practices and their impact on disease intensity are discussed and proposed as an integrative management approach.

2. POWDERY MILDEW OF *Mentha* SPP.

2.1 Importance

Powdery mildew is one of the serious and very important disease on different vegetable plants including *Mentha* spp. and causes huge economic losses by reducing plant yield and lowering the plant quality and quantity. The disease spreads all over the world and found in approximately all countries especially in humid and moderate conditions, it also needs moderate to high humidity like the warm days and cool nights in late spring to early summer. Poor sun light and poor air circulation also help disease to be more effectiveness. The greenhouses provide very suitable conditions including moisture and temperature for well spreading of the disease and causing harmful for infected plants [7]. Powdery mildew of mint caused by many species belonging to the genus *Golovinomyces* such as *G. biocellatus* and *G. monardae* [10,13]. The disease also caused by different genera belonging to the family *Erysiphaceae*. These genera are distinguished from one another by the morphology shape of appendages growing out of the ascomata walls and the number of asci per cleistothecium and according to the host plant kind [9]. The causal agents of the disease are obligate parasites that can't grow on the artificial culture media. They produce their mycelia, conidia, conidiophores and ascomata externally on the surface of the plant tissues. Powdery mildew attacks all kinds of plants and all shoot systems of the plants including leaves, stems and fruits, the disease attacks about 10,000 species of different plants belonging to about 1600 genera [14].

2.2 Symptoms and Signs

Powdery mildew is one of the easier plant diseases to identify, as its symptoms are quite distinctive. Infected plants display white powdery spots on the leaves and stems. The lower leaves are the most affected, but the powdery mildew can appear on any above-ground part of the plant. As the disease progresses, the spots get larger and denser as large numbers of asexual spores are formed, and the mildew may spread up and down the length of the plant [15] (Fig. 1).

2.3 Cause and Disease Development

Powdery mildew is a fungal disease that affects a wide range of plants. The fungus, *Golovinomyces biocellatus* (syn = *Erysiphe biocellata*, formerly *Erysiphe cichoracearum*), which overwinters on mint, stubble, and many wild hosts is considered as the causal agent of this disease. It is seldom serious enough on peppermint to warrant control measures; however, it is very destructive on Scotch spearmint. Interactions with some herbicides increase susceptibility to this disease. *E. cichoracearum* was formerly reported to be the primary causal organism throughout most of the world [16,17].

Fig. 1. Symptoms of powdery mildew on leaves of *Mentha* spp.

Powdery mildew grows well in environments with high humidity and moderate temperatures [18]. Greenhouses provide an ideal moist, temperate environment for the well spread of the disease. This causes harm to agricultural and horticultural practices where powdery mildew may thrive in a greenhouse setting [15].

In an agricultural or horticultural setting, the pathogen can be controlled by using chemical methods, bioorganic methods, and genetic resistance. It is important to be aware of powdery mildew and its management as the resulting disease can significantly reduce important crop yields [19].

2.4 Disease Management

Plowing to cover all stubble reduces disease incidence and severity [17,20-24].

Remove and destroy infected plant tissues and debris that may serve as overwintering sources of these fungi. Crop residues can also be incorporated into the soil to reduce sources of overwintering fungi [17,20-24].

Fields should be clean cultivated in the fall to bury infested crop residues. Where practical, flaming can also be used to destroy diseased stubble [17,20-24].

Where powdery mildew has been a recurring problem, the use of alternative cultivars should be investigated [17,20-24].

Contact fungicides provide moderate levels of control when applied preventively. Systemic fungicides have provided excellent control under greenhouse and field conditions [17,20-24].

Badge SC (Group M1) at 0.75 to 1.5 pints/A on 10-day intervals. Demethylation inhibiting fungicides are labeled for use. Rally 40 WSP at 4 to 5 oz/A on 14- to 21-day intervals. Do not apply within 30 days of harvest. Tilt at 4 fl oz/A applies when plants are 2 to 4 inches high or when conditions become favorable for disease development. Make a second application 14 days later. Do not apply within 7 days for harvest [17,20-24].

JMS Stylet Oil at 1 to 2 gal/A; Do not spray if temperature is below 10°C, above 32°C or when plants are wet or under heat or moisture stress [17,20-24].

Kaligreen at 2.5 to 3 lb/A on 7- to 10-day intervals. Might supplement a normal program when powdery mildew is first observed. May be applied up to the day before harvest. Regalia at 1 to 4 quarts/A plus another fungicide on 7- to 10-day intervals [17,20-24].

Strobilurin fungicides are labeled for use. Do not make more than one application of a Group 11 fungicide before alternating to a labeled fungicide with a different mode of action. Headline at 9 to 12 fl oz/A prior to disease development on 7- to 14-day intervals. Preharvest interval is 14 days. Quadris Flowable at 6 to 15.5 fl oz/A on 7- to 10-day intervals. May be applied up to 7 days before harvest for processed mint and on the day of harvest for fresh mint [17,20-24].

Sulfur products; use wettable or flowable sulfur when plants are 5 to 6 inches height or when the fungus first appears. Repeat application twice more at 3-week intervals. After harvest, repeat when mildew first appears or at four- to five-leaf stage; repeat at 30-day intervals as necessary to cover new growth or until growth stops in fall. Applying elemental sulfur

increases sulfide concentration in mint oil; the length of time between sulfur application and harvest is more important than sulfur rates. Growers should have minimal problems with mint sulfide if they follow the rates and preharvest application interval as follows. Microthiol Disperse (80% sulfur) at 4 to 6 lb/A. Do not apply within 30 days of harvest. Do not apply if temperatures will exceed 32°C within 3 days after application. Do not use within 2 weeks of an oil treatment. Premixes of Group 3 + 11 fungicides are available for use. Quilt at 14 fl oz/A or Quilt Xcel at 10.5 to 14 fl oz/A. Apply when plants are 2 to 4 inches height or when conditions become favorable for disease development. Make a second application 14 days later. Do not apply within 7 days for harvest [17,20-24].

The use of biological fungicides; Ecoswing at 1.5 to 2 pints/A. Serenade ASO (Group BM02) at 2 to 4 lb/A [17,20-24].

3. ANTHRACNOSE OF *Mentha* SPP.

3.1 Importance

Anthracnose is an important fungal disease of many economic plants including *Mentha* spp., appears on foliar, stems and fruits of the plant and causes brown to black or dark spots with white centers on the infected parts. In some plants, spots are raised and gave corky like surfaces. Anthracnose diseases caused by several species of fungi which produce their conidia within acervuli and belong to the class Coelomycetes, phylum Deuteromycota such as *Colletotrichum*, *Sphaceloma*, *Marssonina* and *Cylindrosporium*, which stay to the next season as conidia or mycelia. Some of these pathogens produce their teleomorphs, such as *Glomerrella*, *Elsinoe* and *Gnomonia*, which are the most causal agents of anthracnose on different plants. They are mostly found as conidial stages in the nature. Thus, the anthracnose diseases which caused by *Colletotrichum* spp. or their teleomorph stages *Glomerrella* spp. are the most common on different plants including *Mentha* spp. The losses in crop production due to anthracnose disease can be more severe when humidity is high [14,25].

3.2 Symptoms and Signs

Symptoms include circular, oval or irregular spots, black with white centers, up to 5 mm diameter. It used to be a serious disease but it now controlled in commercial mint fields. On leaves of *Mentha* spp., anthracnose generally appears first as small, irregular yellow or brown spots. These spots darken as they age and may also expand, covering the leaves [26] (Fig. 2).

3.3 Cause and Disease Development

Sphaceloma menthae Jenkins and *Colletotrichum* spp. Corda are plant pathogens infecting *Mentha* spp. causing anthracnose disease, it is also known as mint anthracnose disease [27]. Infection occurs via an appressorium that develops from the germinating spore on the plant surface, followed by penetration of the cuticle and in some cases also of epidermal cells by infective hyphae [28]. *Colletotrichum* spp. and *S. menthae* may be seed-borne fungi and can survive well in soil by growing saprophytically on dead plant fragments, and may be spread via water-splash dispersal of conidia and air transmission [26].

Fig. 2. Symptoms of anthracnose on leaves of *Mentha* spp.

The development of anthracnose disease is favored by conditions of high precipitation [29,30], high relative humidity [31], moderate to high temperatures and large amounts of inoculum [32] as observed by research carried out in tropical environments of crops such as tomato [33], potato [34], corn [35] and sorghum [36,37], where anthracnose represents a phytosanitary problem for these crops. The maximum development of the symptom is observed at temperatures of 25ºC, likewise the intensity of light, before or during the inoculation process, is an important factor for the development of the disease. In fungal diseases, temperature is a limiting factor, since there is a threshold below which they do not develop [38]. On the other hand, rainfall usually acts as a determining factor in the development of the fungus, that is, in numerous diseases, the forms of reproduction (spores, conidia, for example) require the presence of liquid water to germinate [39].

3.4 Disease Management

Little information is available about the control of the anthracnose of *Mentha* spp. The infestation can be limited by using only healthy plant material and frequently changing the location of the cultures, on the other hand, the disease can be controlled by mechanical measures or chemical means. Cultural control of the anthracnose disease has already been successfully pursued [26,40].

Dermelj [41] recommends the use of copper lime or a treatment with Bordeaux mixture. Treatment with Bordeaux mixture [42], Thiram or Ziram [43] or with Zineb, Maneb or Ferbam [44] is recommended against the anthracnose of *Mentha* spp.

Among the new strategies for producing safe foods free of pesticide residues, essential oils represent a promising tool to control plant pathogens. *Mentha* spp. are known for a reasonably high content of essential oils (EO), which are deposited in the glandular trichomes, mostly located on the adaxial surface of their leaves. The active constituents of EOs represent natural sources of botanical fungicides. The biological activities of these EOs, which can be useful in agriculture, have been broadly researched, especially toward phytotoxic microorganisms. To a lesser extent, the insecticidal and herbicidal activities of mint EOs have also been studied. It is apparent that the prospect of using EOs in agriculture is increasing in popularity. A number of investigations showed that the *in vitro* efficacy of *Mentha* spp., as well as that of their main constituent, menthol, is pronounced. The results of *in vitro* researches are useful for choosing EOs for further investigations. However, it is clear that *in situ* experiments are crucial and should be more extensively developed. At the same time, known techniques are to be applied to this area and new methods should be worked out, aiming at the improvement of EOs' pesticidal efficacy and cost-effectiveness, for future implementation in agricultural pest control [2,3,45-48].

4. CONCLUSION

It was concluded that *Mentha* spp. can be infected by many different fungal diseases, among them is powdery mildew which caused by the obligate parasite fungi *Golovinomyces biocellatus* and *Erysiphe biocellata* which belong to the order Erysiphales. The disease attacks all foliar parts of plants externally producing a powdery appearance on the leaves or stems. It can be controlled by plowing to cover all stubble and plant debris, removing the infected plant tissues and using many suitable fungicides. Also, it was found that anthracnose is another important airborne disease on *Mentha* spp., but it has less effect than the first disease. It caused by *Colletotrichum* spp. and *Sphaceloma menthae* which belong to class Coelomycetes. The disease symptoms represented by appearing yellow to brown spots on the leaves, then the spots become black or dark with disease progress. The disease can be controlled by using healthy plant material, frequently changing the location of the cultures and using some suitable fungicides.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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