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SOOTY MOLD ON LEMON TREES – FIRST RECORDING FROM EL-BEIDA CITY, LIBYA

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ABSTRACT

Sooty molds are a lineage of follicolous fungi that cover the upper surface of leaves with black mycelia. Sooty molds do not infect plants, but grow on surfaces where honeydew deposits accumulate. Sooty moulds fungi proliferate in abundance on the foliage of lemon subsisting on the honeydew secreted by insects. whiteflies was found in different stages on lower leaf surface. The black color was checked and Alternaria alternata described and reported as new recorded on lemon leaves were infected with white fly in El-Beida, Libya.

1. INTRODUCTION

Sooty mould are a dark-pigmented fungi which live saprophytically and superficially on plants. Sooty mold is a fungus but is not a plant disease. However, when your plants are completely covered with sooty mold, it may interfere with photosynthesis which can affect the overall health and growth of a plant. Sooty moulds are a common sight on the leaves, twigs and sometimes fruits of many crops [1]. They form thin, black, papery films; black, voluminous growth, black pellicles, or psuedoparenchymatous crusts and they can last a long time. Traditionally, sooty molds have been regarded as deriving their sustenance from honeydew excreted by some insects, and it provide excellent platform for sooty mould growth, which has been found to contain sugars, free amino acids, proteins, minerals and other organic compounds [2].

White flies are invasion the plants in greenhouse or open field, and they obtain their nutrition from leaf diffusate or guttation fluid [3] and the cuticle which provide a rich and potential source of nutrition [4, 5]. They feed on plants through a needle-like mouthpart. Typical symptoms can include leaf yellowing, leaf wilting, leaf drop, and overall plant decline. Some whiteflies may also produce a white, waxy substance and a sticky substance that can cover parts of the plant. Honeydew and sooty mold can reduce photosynthesis and crop value. Plant death can occur if large populations of whitefly are left untreated [6, 7].

The disease can be a problem when growers pick fruits for juicing, because infested fruits require more thorough washing, and the mold spores contribute to total mold counts in the processed juice, which must be kept to a minimum [8]. The negative effects of sooty mold on plants include: reduced leaf photosynthesis and gas exchange, and a consequent alteration of the normal metabolism and physiology of the plant and ultimately its growth [9]. cosmetic damage reducing marketability of plants or produce and detracting from the aesthetic attributes of landscapes and mold spore counts in processed juices and purees made from infested materials

Chomnunti, et al. [1]. Passos-Carvalho, et al. [10] mentioned the negative effects of sooty mold on parameters such as photo-synthesis, chlorophyll, and respiration. In Libya no information about the sooty mold and insects that related with them. The aim of this work is to isolate the fungus and identified insect involved with the phenomenon of sooty mould.

2. MATERIALS AND METHODS

The survey was conducted in some homes gardens in El-Beida city. Specimens with sooty mould from 20 trees were collected and observed under a stereomicroscope. From each plant, 20 leaves, and 10 fruits were selected for observation of sooty mold and recorded. Its causative agent, damage symptoms were also recorded.

2.1. Isolation and identification of Fungi

The black material collected was identified based on the morphology of the fungus in the laboratory. To isolate the fungus, samples were treated according to the method of Pinto [11] they were placed on potato sucrose agar (PSA) medium amended with streptomycin (100 ppm) and incubated at 25°C in the dark, for 7 days. The taxonomic identification of fungi was performed considering the morphological characteristics of the vegetative mycelium and the reproductive structures [12, 13].

2.2. Identification of Insects

The insect specimens were collected and preserved in 70% ethanol and identified based on the morphological characters recorded in [14-16]. Whitefly species identification can be made most easily on the pupal stage. The pupae have species-specific shape, color pattern and wax filament arrangement. Adults can be identified, but identifying species according to pupal stages is more accurate. Under stereomicroscope, Some stage were examined and photographed.

Figure-1. Symptoms of sooty mold on leaf and fruit lemon

3. RESULTS AND DISCUSSION

3.1. Symptoms

Leaves and fruit showed that the dark, felty growth from sooty mold was covering large areas of all surfaces. They can be scraped off of plant surfaces (Fig. 1). Infested plantations lose leaves and decreased their annual growth, leaf lamina became dry and brown Excretes honeydew as waste product after sucking the sap of plant leaf,

which fell on underneath plant leaves and became a well medium of sooty mold fungus. As a result plant leaves became completely black due to sooty mold reduced leaf photosynthesis and gas exchange and became unfit.

Mycelia settle on the surface of leaves to form a black film which caused slow growth and it make xylem to became brown and leaves rolled to their inner face, with color changing from yellow to brown. In our study we observed that the sooty mold can be completely rubbed off from the leaves or plant surfaces with our finger tips.

These fungi are responsible for sooty mold in Libya with the high dispersion of their spores [17]. Several sooty mold was reported on different horticulture crop plants such as apple fruits [18, 19] Sour orange [20] longan [21] and olive Santos, et al. [9]. Illahi, et al. [22] has reported the fungus on mulberry. sooty mold is a complex of dark-pigmented fungi of several genera, which have been described as nonparasitic, saprophytic, and superficial on plants [23, 24]. This fungal complex covers both leaf surfaces and small branches, giving a black aspect to the olive tree [23].

3.2. Mechanisms of Infection

The insects feeding on lower surface of plant leaf and excreting a sweet sticky substance called honeydew. the honeydew falls on the plant or onto plants or structures below the host plant which facilitates the installation and growth of fungi. The fungi spread from one plant to another by water splashed spores and hyphal fragments, and by air-borne spores. The fungus growth it on leaves turned their color to black (Fig. 2).

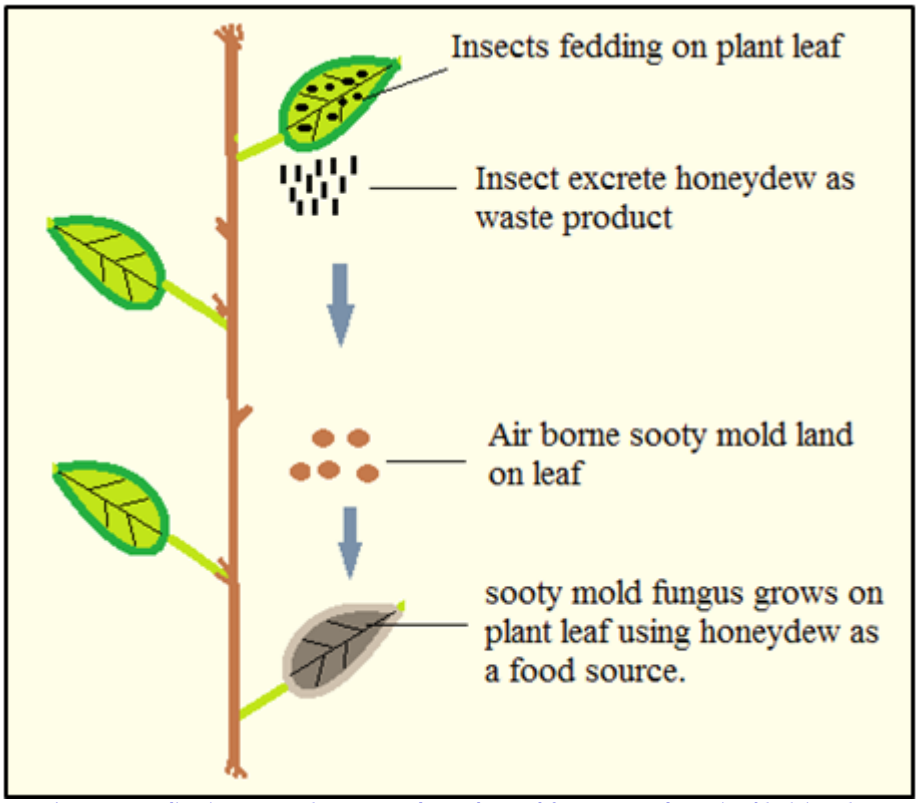

Figure-2. Feeding insects on plant excrete honeydew and fungus growth turning black in color.

3.3. Causes of Sooty Mold

Leaves with sooty mold showed a dark color covering large areas of upper surfaces. Fungal colonies present in our leaves as sooty mold is: *Alternaria alternata*, producing a flat, spongy subiculum colony of sooty mold on the leaf and (Fig. 3). Colonies circular, 1-7mm in diameter, amphigenous, dense, easily seceding, well defined, sub-epiphyllous. Primary conidiophores arise directly from hyphae at the PSA surface; they can be simple or branched. Conidia (22 to 38 × 5.8 to 11.2 μm) are short ellipsoid to oval, tapering in the lower half into a narrow tail extension. The upper part which was materialized by a very short beak well rounded ending abruptly appears

allowing the formation of new spores, thus furnishing evidence of catenation. The asexual spores of the fungus are thick-walled, multicellular, and pigmented and thus tolerate adverse conditions like dry weather. The symptoms from infected leaves were very similar to those described for sooty mold of olive tree. The mould fungus isolated has been reported to be very common together with *Saissetia oleae* on olive trees Ilias, et al. [25]. Hughes [26] showed that the mycelium of many sooty molds has a mucilaginous outer wall which absorbs water very readily, acts as an adhesive, and maintains a moist leaf surface for a long period. These morphological features and the dark pigmentation, serve to protect sooty molds from adverse conditions such as wetting, drying, and direct sunlight. Despite their relative abundance and obvious presence, sooty molds have received scant attention as to their effect upon phylloplane (leaf-surface) ecology [27].

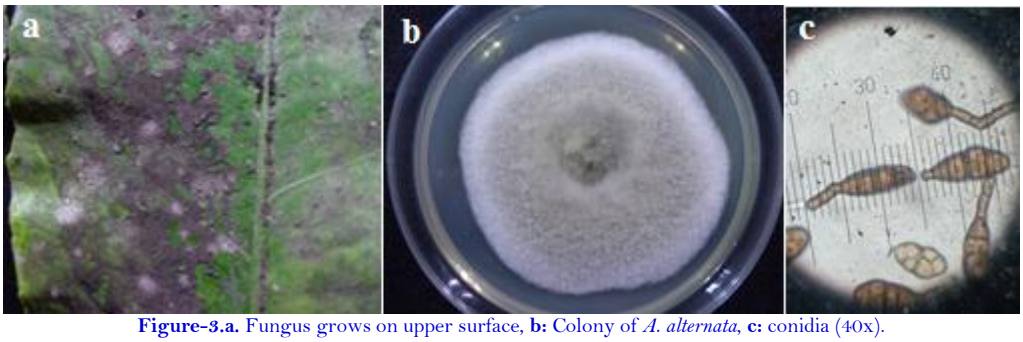

Figure-3.a. Fungus grows on upper surface, **b:** Colony of *A. alternata*, **c:** conidia (40x).

3.4. Insect Description and Life Cycle

The whitefly, correlated with sooty mold on plant leaves in the surveyed areas of El-Beida, has been identified as *Dialeuredes citri*. (Homoptera: Aleyrodidae) on lemon. The life cycle consists of an egg, 4 nymphal instars, a pupal and an adult stage. Stages of insect were observed in abundance on lower leaf surface (Fig. 4). Adults (1/16 inch) are snow-white with four wedge-shaped wings that are held roof like over their body at rest (Fig. 5) Whiteflies resemble small moths and swarm plants when disturbed.

Nymphs (immature) were difficult to see and were pale green, flat and oval shaped (Fig. 6). Nymphal instars behave in a manner similar to scale insects (Fig 7). The first nymphal instars are active and they are sometimes called crawlers or pupa with a fringe of hairs on its back (Fig. 8). The remaining nymphal instars are sedentary and may mimic immature scales (Fig. 9). Both adults and nymphs cause damage by sucking sap (Fig. 10) from the foliage. Large populations of insects mean large amounts of honeydew, and dense growths of sooty mould fungus over leaves.

Infested plants were stunted and leaves turn yellow and may drop off. Whiteflies secrete honeydew on which sooty mold may develop [28]. Several studies reported that the sooty mold can grew on leaf surface of plant [10, 24, 25, 29].

Figure-4. Lemon with an infestation of whitefly on the lower surface

Figure-5. Whitefly adult resembling

Figure-6. Immature nymphs which a moth resemble scale insects

Figure-7. Nymphs

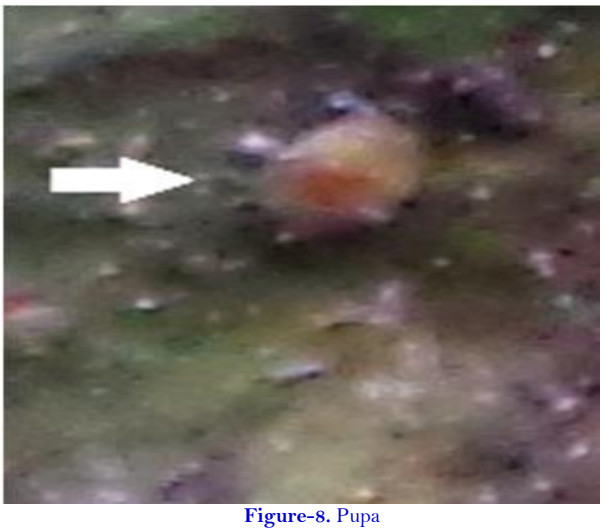

Figure-8. Pupa

Figure-9. Ecdysis like T shape

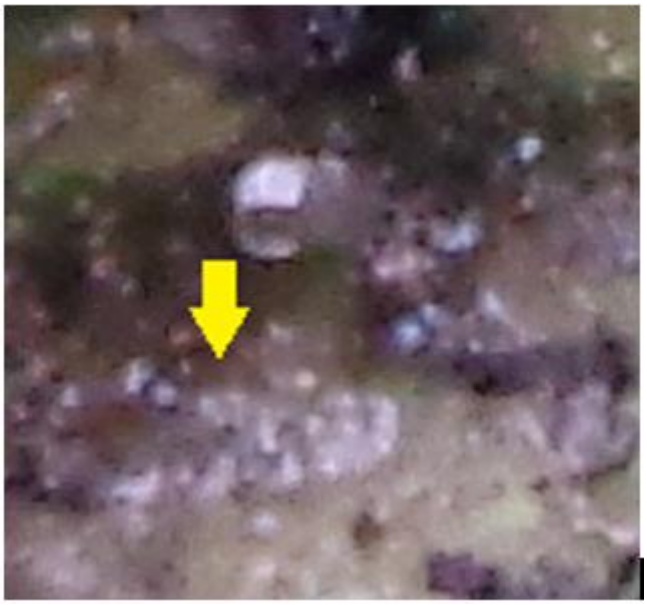

Figure-10. Excrete honeydew

4. CONCLUSION

Sooty mould caused disease by coating fruit and leaves with a black mycelial covering the plant. In the present study, fungus/insect interaction is reported as new record from Libya, hence, needs to more studies as prevalence, severity and distribution of is not only confined to El-Beida but also entire all citrus production areas.

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REFERENCES

[1] P. Chomnunti, S. Hongsanan, B. A. Hudson, Q. Tian, D. Peršoh, M. K. Dhami, A. S. Alias, J. Xu, X. Liu, M. Stadler, and K. D. Hyde, "The sooty moulds," *Fungal Divers*, vol. 66, pp. 1–36, 2014.

[2] J. L. Auclair, "Aphid feeding and nutrition," *Annual Review of Entomology*, vol. 8, pp. 439-490, 1963. *View at Google Scholar | View at Publisher*

[3] H. B. Tukey, *Leaching of substances from plants. In ecoiogy of leaf surface micro-organisms (Eds. TF. Preece and CH. Dickinson)*. London and New York: Acad. Press, 1971.

[4] E. A. Baker, *Chemical and physical characteristics of cuticular membranes. In ecology of leaf surface micro-organisms. (T.F. Preece and C.H. Dickinson)*. London and New York: Acad. Press, 1971.

[5] P. J. Holloway, *The chemical and physical characteristics of leaf surfaces. In ecology and leaf surface micro-organisms. (Eds. TF. Peerce and CH. Dickinson)*. Acad. Press: London and NewYork, 1971.

[6] G. Haniotakis, "Olive pest control: Present status and prospects," *IOBC/Wprs Bulletin*, vol. 28, pp. 1-9, 2005. *View at Google Scholar*

[7] N. Scot, *Sooty mold in: Plant disease by cooperative extension service, college of tropical agriculture and human resources*: University of Hawaii. PD, 2008.

[8] S. Nelson, "Sooty molds," *Plant Disease*, vol. 52, pp. 1–6, 2008. *View at Google Scholar*

[9] S. A. P. Santos, C. Santos, S. Silva, G. Pinto, M. Laura, L. M. Torres, and A. J. A. Nogueira, "The effect of sooty mold on fluorescence and gas exchange properties of olive tree," *Turkish Journal of Biology*, vol. 37, pp. 620-628, 2013. *View at Google Scholar | View at Publisher*

[10] J. Passos-Carvalho, L. M. Torres, J. A. Pereira, and A. A. Bento, *A cochonilha-negra saissetia oleae (Olivier, 1791) Homoptera: Coccidae*. Lisbon, Portugal: INIA/UTAD/ESAB, 2003.

[11] G. Pinto, "Regeneracao de plantas de eucalyptus globulus por embriogenese somatica," PhD, University of Aveiro, Aveiro, Portugal, 2007.

[12] P. Zalar, G. S. de Hoog, H. J. Schroers, P. W. Crous, J. Z. Groenewald, and N. Gunde-Cimerman, "Phylogeny and ecology of the ubiquitous saprobe cladosporium sphaerospermum, with descriptions of seven new species from hypersaline environments," *Studies in Mycology*, vol. 58, pp. 157–183, 2007. *View at Google Scholar | View at Publisher*

[13] J. H. C. Woudenberg, J. Z. Groenewald, M. Binder, and P. W. Crous, "Alternaria redefined," *Studies in Mycology*, vol. 75, pp. 171–212, 2013. *View at Google Scholar | View at Publisher*

[14] G. Fadhwel, A. Meamar, H. Belal, and M. Aboghrra, *Agriculture pests and their control*: Damask University, 1998.

[15] B. V. David, *Elements of economics entomology*. Chennai: Popular Book Depot, 2001.

[16] R. C. Rajgopal, R. P. Dharma, R. Rajasekhar, and R. P. Lakashmi, "Whitefly: A new pest of mulberry in Andhra Pradesh," *Indian Silk*, vol. 40, pp. 9-10, 2001.

[17] Z. I. El-Gali, E. Mohamed, and N. A. Mohamed, "Distribution of some molds in the atmospheric air of El-Beida City, Libya," *International Journal of Innovative and Applied Research*, vol. 2, pp. 1-7, 2014.

[18] M. Grabowski, "The study of new fungus species causing apple sooty blotch," *Folia Horticulture, Ann*, vol. 19, pp. 89–97, 2007. *View at Google Scholar*

[19] E. M. Mróz and M. W. Krysiak, "Diversity of sooty blotch fungi in Poland acta sci," *Polonorum Horticulture Cultus*, vol. 10, pp. 191-200, 2011. *View at Google Scholar*

[20] K. R. Summy and C. H. Little, "Using color infrared imagery to detect sooty mold and fungal pathogens of glasshouse-propagated plants," *Hortscience*, vol. 43, pp. 1485–1491, 2008. *View at Google Scholar*

[21] L. M. Serrato-Díaz, L. I. Rivera-Vargas, and R. Goenaga, "First report of sooty mold of longan (Dimocarpus Longan L.) caused by trispermum porosporiferum Matsushima and T. variabile Matsushima in Puerto Rico," *Journal of Agricultural Research*, vol. 94, pp. 285-287, 2010. *View at Google Scholar | View at Publisher*

[22] I. Illahi, A. Shabnam, V. Mittal, and A. Dhar, "Sooty mold of mulberry – first report from Kashmir," *Journal on New Biological Reports*, vol. 1, pp. 38-41, 2012. *View at Google Scholar*

[23] D. R. Reynolds, "Capnodium citri: The sooty mold fungi comprising the taxon concept," *Mycopathologia*, vol. 148, pp. 141-147, 1999. *View at Google Scholar*

[24] V. A. Jouraeva, D. L. Johnson, J. P. Hassett, D. J. Nowak, N. A. Shipunova, and D. Barbarossa, "Role of sooty mold fungi in accumulation of fine-particle-associated PAHs and metals on deciduous leaves," *Environmental Research*, vol. 102, pp. 272-282, 2006. *View at Google Scholar | View at Publisher*

[25] F. Ilias, S. Bensehaila, K. Medjdoub, I. El Haci, and N. G. Benyelles, "The role of phenolic compounds in the defense of sooty mold of olive leaves (Olea Europea L.)," *African Journal of Microbiology Research*, vol. 9, pp. 1075- 1081, 2015. *View at Google Scholar | View at Publisher*

[26] S. J. Hughes, "Sooty moulds," *Mycologia*, vol. 68, pp. 693-820, 1976. *View at Google Scholar | View at Publisher*

[27] C. L. Schoulties, "Sooty molds," *Plant Pathology Circular*, vol. 208, pp. 1-2, 1980.

[28] J. T. Knodel, K. Kinzer, and R. Smith, "Houseplants- proper care and management of pest problems. Retrieved from www.ag.ndsu.edu," p. 744, 2009.

[29] S. A. Khodaparast, F. Byrami, and M. J. Pourmoghadam, "A further contribution to the knowledge of sooty mould fungi from Iran," *Mycologia Iranica*, vol. 2, pp. 46 – 58, 2015. *View at Google Scholar*