ANTHRACNOSE IN OLIVES: SYMPTOMS, DISEASE CYCLE AND MANAGEMENT

V. Sergeeva

School of Natural Sciences University of Western Sydney, Locked Bag 1797 Penrith South DC, NSW 2751, Australia

Corresponding author: sergeeva@tpg.com.au

Abstract

Anthracnose, caused by the fungi *Colletotrichum acutatum* and *C. gloeosporioides*, is a widespread and severe disease in most olive-growing countries, causing significant yield losses, poor fruit and oil quality. The disease incidence depends on olive variety, environment and virulence of the pathogen among other factors. Warm, rainy, misty and humid conditions or heavy dews have been observed to be associated with severe anthracnose epidemics. The disease may affect up to 80% of olives in susceptible cultivars such as 'Barnea' and 'Manzanillo' in Australia.

The anthracnose pathogen infects several parts of the olive tree such as flowers, leaves, shoots, twigs, buds, fruits, sepals, pedicels, peduncles, receptacles, petioles and, leaf scars are also become infected. The fungus over winters as mycelium and conidia on infected mummified fruits, twigs and leaves.

Affected groves may have one or both species of the pathogen present. Variability exists within each of the species with different isolates displaying different appearance, colour (pigment production), growth rates in different temperatures and different tolerance to copper fungicides *in vitro*.

Field trials carried out in this work showed that applications of copper-based fungicides and strobilurins failed to control anthracnose disease.

Successful management of anthracnose relies on understanding the conditions that promote disease development. Knowledge of disease cycle is essential for developing strategies for effective and timely control of the disease and also in reducing the number of fungicide applications.

The complexities seen in anthracnose epidemiology including the presence of different species of the pathogen point to the need for continued research involving relevant approaches to disease management.

Keywords: Anthracnose, olives, symptoms, disease cycle, management

Introduction

Anthracnose is arguably the most economically significant disease of olives in Australia and in most olive-growing countries in the world. Inoculum is present year-round throughout the canopy. Fully open flowers and ripening fruit are very susceptible to infection. Flower infection on olives can destroy flowers, leading to fruit rot and significant crop failure (Sergeeva et al., 2008a). The disease may cause premature fruit drop, but major fruit losses occur during ripening when quiescent infections break out and cause spreading brown lesions (Trapero and Blanco, 2010). Heavy infections cause rapid rotting of fruits. Light infections of fruit causes minor damage resulting in rotting and sometimes shriveled fruit (Sergeeva, 2011b). In Australia mummified olive fruits are observed at the time of ripening. Mummified fruits may persist on the tree, providing inoculum for new infections. The fungus over winters on infected mummified fruits, twigs

and leaves. Epidemiology and disease cycles are not fully understood in the olive anthracnose system (Talhinhas et al., 2010).

Successful management of anthracnose relies on understanding the conditions that promote disease development and the control measures taken to obtain olive oil of good quality. A project is currently being undertaken to evaluate new-generation copper and strobilurin fungicides for their efficacies against anthracnose. Observations on the etiology and epidemiology that lead to practical disease management are presented here.

Material and Methods

One olive orchard each in Victoria and South Australia and three in New South Wales were selected to study the effect of fungicide application on the development of anthracnose. Copper-based fungicides such as copper hydroxide, cuprous oxide, tribasic copper sulphate and strobilurins (azoxystrobin) and (pyraclostrobin) were used in the spray application trials. These products were compared with the industry standard application with copper oxychloride. The treatments for the timing of applications in each of the five orchards were: tribasic copper sulphate before and after flowering; copper hydroxide, cuprous oxide, tribasic copper sulphate, azoxystrobin and pyraclostrobin three times between fruit set till the fruits change colour. Untreated trees served as control. Flowers, fruits, leaves, shoots and twigs were sampled from the treated and control plants every month. They were placed in a humid chamber at 25^{o}C and incubated for five days. The samples were then examined for the presence of the anthracnose fungus.

Results and Discussion

Field trials carried out in this work showed that applications of copper-based fungicides and strobilurins failed to control anthracnose disease.

Successful management of anthracnose relies on understanding the conditions that promote disease development. Knowledge of epidemiology is essential for developing strategies for effective and timely control of the disease and also in reducing the number of fungicide applications.

Symptoms and Disease Cycle

The anthracnose pathogen infects several parts of the olive tree such as buds, flowers, sepals, pedicels, peduncles, leaves, petioles, leaf scars, shoots, twigs, receptacles and fruits.

Anthracnose fungi overwinter in mummified fruits on the trees and also in infected woody tissue, peduncles and leaves infected the previous year still attached to the tree. Fungal inoculum to start the disease cycle comes primarily from infected twigs, buds, peduncles, mummified fruits, leaf scars, leaves; fungus produces conidia from the overwintering fungal structures or in acervuli that develop on infected tissues and exude sticky masses of conidia.

The fungi may affect developing shoots and expanding leaves. If weather conditions conductive to anthracnose prevail during flowering, the disease can build up, causing severe flower infection and reducing fruit set. Brown spots carrying sporulating colonies of the fungus were observed on the surface of leaves (Sergeeva et al., 2008b).

Different olive cultivars had varying responses to flower and fruit infection. Infection that occurs on the pedicels after flowering can also move into the fruit, causing them to rot in immature fruits or before harvest. The peduncle and flowers are the most destructive phase of the disease, as it affects fruit set and ultimately the yield. Flowers are very susceptible to anthracnose. Infected flowers dry quickly. Infection of flowers, leading to fruit rot, is of economic importance as anthracnose results in significant losses in yield and reduced oil quality.

Developing fruit that are infected may show symptoms soon after infection, when they are at peppercorn and pea size. Infected fruit at both stages can drop; however they may also remain on the tree, carrying the sporulating pathogen.

The first symptoms of anthracnose fruit rot are brown tiny spots or brown sunken lesions rapidly expending; or infected areas that may shrivel with time. These expand, leading to the partial or total rot of any part of the fruit. However, the lesions are more often seen in the apex, as this remains wet longer after rain and dew. The spots grow and coalesce to become a single spot that can cover half the fruit. Infection of olive fruits by pedicel causes end rots infect fruits by invasion from fungal mycelium growing down the pedicel. The dark decay with a well-defined margin develops and as immature and ripens fruit, decay spreads and rots the entire fruit, which becomes dark and shriveled. Infected fruits eventually dry up and mummify and can become a source of inoculum for the following season. Additional spores, which also are splash-dispersed, are produced upon new infections and these can rapidly spread the disease through multiple repeating cycles of new infection and additional spore production. Under favourable conditions, *Colletotrichum* species produce salmon- orange or cream-colored slimy masses of spores on the fruit. The infection can be present and survive from season to season.

Integrated pest management (IPM)

Integrated pest management (IPM) of anthracnose in olives involves managing yield and creating an environment less appealing to disease.

The disease epidemiology and disease cycle play an important role in working out strategies for effective and timely management of anthracnose and in reducing the number of unnecessary fungicides applications. Anthracnose is difficult to control after the symptoms appear, particularly when environmental conditions are favorable for infection.

Environmental factors play an important role in managing diseases. Weather is a crucial in the development of anthracnose throughout the year, especially at flowering and prior to harvest. Optimum conditions for disease development depend on temperature, wetness, relative humidity and rain period. If these weather conditions prevail during flowering they cause severe flower infection and consequently, reduce fruit set. Latent infection of developing fruit in spring may permit survival of the pathogen in the following summer even under hot conditions (Moral et al., 2008). Epidemics occur when olive varieties susceptible to the anthracnose pathogens grow under warm and humid conditions.

Infection can be controlled in a number of ways (Sergeeva, 2011a; 2011b). Effective disease control is obtained through a combination of methods, including prevention, observation and intervention.

<u>Prevention</u>

Preventive cultural practices:

- Selecting varieties tolerant/resistant to anthracnose.
- Maintaining healthy crops (when planting a new olive grove, start out with diseases-free planting material)
- Plant quarantine (plant sanitation, biosecurity)

<u>Observation</u>

Monitoring:

- Inspection and identification (regular monitoring is the cornerstone of IPM).
- Recording degree days to determine the optimal time for the onset of anthracnose disease outbreak.
- Periodical field survey and sampling method are required to forecast of pests that can spread the disease.

Intervention

Cultural management - cultivars, agronomic techniques such as pruning, grafting, soil management, irrigation etc.

Cultivars

- Planting cultivars resistant to the anthracnose pathogens.
- Re-planting or grafting cultivars resistant to pathogens enabling the use of varieties better adapted to local biotic and abiotic conditions.
- When planting new olive groves, use certified healthy plants.

Fertilizer

- Fertilize as needed, using a balanced fertilizer with fairly low nitrogen content for moderate growth. Excess nitrogen accumulates in the fruit, and negatively affects fruit quality more susceptible to pests and diseases (Fernándes-Escobar et al., 2002), can promote anthracnose (Smith, 2009).

Irrigation

Olive is drought-tolerant, but grows best when it has sufficient water. Over watering should be avoided in the grove where anthracnose is present.

Pruning

- Pruning is important to maximize sunlight infiltration and air movement within the tree. This helps with the natural control of anthracnose and reduces the pressure on the fungicide. Trying to disrupt the lifecycle from starting or be interrupting the lifecycle once it has started.
- Pruning can be effective in anthracnose disease management strategy. Diseased twigs, peduncles, pedicels should be pruned during the dormant season and removed from the grove and destroyed, high levels of anthracnose spores and these sources should be specifically targeted for removal as part of anthracnose management program.
- Pruning improves air movement in the canopy. A less dense canopy encourages faster drying of foliage and fruit surfaces. Increase penetration of pesticides, allows more effective spray coverage.
- If numerous infected fruits remain on the floor, the spores originating from them can be largely negated by covering the fruits with soil through cultivation or, if practical, covering them with mulch.
- Sun and heat will help to kill spores of anthracnose left in the material. Growers may burn diseased pruning.
- Mechanical removal is preferable, although other alternatives may be slashing/mulching fruit and leaf to encourage desiccation/decomposition
- After pruning remove and destroy mummified fruits and dead plant materials as they are potential sources of infection.
- Cleaning and disinfecting equipment, tools and machinery decreases the likelihood of infection.

Chemical control

Field trials carried out in this work showed that applications of copper-based fungicides and strobilurins failed to control anthracnose disease irrespective of the timing of application.

Timing of application and type of fungicides: Apply antifungal compound after pruning to ensure the pruning cuts and tissues left behind on the tree prevent entry of pathogen.

If an anthracnose epidemic has occurred in the previous year, fungicides may play an important part in the following year's methods of disease control. Fungicide application

focuses on reducing damage to the inflorescence from latent infection by the pathogen. An early season application of protective fungicides is a key factor for successful management of anthracnose. The frequency of sprays is dictated by weather, region (climatic conditions), history of diseases and current disease incidence, variety and other factors.

The best strategy is to prevent disease spread from infected shoots, twigs and mummified fruits before spores are dispersed. The flowering stage appears to be critical for infection; however infection also occurs during fruit set. The level of inoculum and environmental conditions during flowering may generally promote rapid disease development which can lead to a decrease in both olive yield and quality.

For good results apply one or two sprays with fungicides one before flowering and one in early fruit set. Two applications may be necessary through the spring if the disease pressure is high and if infection is left after the previous spray.

Spraying is generally more effective if applied before disease development to prevent disease spread from infected twigs, mummified fruits before spores are dispersed and disease become well-established in the grove. It is important to achieve good spray coverage with an appropriate fungicide. Complete coverage of large, tall trees is difficult to achieve; spraying is not very efficient and might not be justified or visible. While control might occur in some situations, anthracnose can return annually and warrant a continued, preventive spray program. In rainy seasons the application of chemical treatments can be difficult.

Pest control: Damage by green vegetable bug (GVB) and Queensland fruit fly (QFF) provides entry points for fungal rots such as anthracnose (Sergeeva and Spooner-Hart, 2010). Control of pests which provides entry points for fungal rots will limit surface damage of the fruit and reduce severity of anthracnose. In general, spray applications should be based on disease epidemiology during the growth of the crop. Spray programs will depend on individual factors such as location, olive variety and disease history. Complete spray coverage is crucial in preventing the disease. Sanitation should play a prominent role in anthracnose management.

The complexities seen in anthracnose epidemiology including the presence of different species *C.acutatum* and *C.gloeosporioides* of the pathogen, point to the need for continued research involving different approaches to disease management.

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References

Elmer PAG., Spiers T M. and Wood P.N., 2007. Effects of pre-harvest foliar calcium sprays on fruit calcium levels and brown rot of peaches. Crop Protection 26: 11-18.

Fernándes-Escobar R., Sanchez-Zamora M.A.,Uceda M., Beltran G. and Aquilera M.P., 2002. The effect of nitrogen overfertilization on olive growth and oil quality. Acta Hort. 86: 429-431.

Moral J., Oliveira R. and Trapero A., 2009. Elucidation of the Disease Cycle of Olive Anthracnose Caused by Colletotrichum acutatum. Phytopathology 99: 548-556.

Sergeeva V., 2011a. Integrated pest management of diseases in olives. Australian and New Zealand Olive Grower & Processor Magazine 80: 16-21.

Sergeeva V., 2011b. What is effective against anthracnose? The Olive Press 3 (16): 22-24.

Sergeeva V., Spooner-Hart R., 2010. Anthracnose and Queensland fruit fly in olives, The Olive Press 15 (2): 23-24.

Sergeeva V., Spooner-Hart R., and Nair N., 2008a. Evidence of early flower infection in olives (*Olea europaea*) by *Colletotrichum acutatum* and *C. gloeosporioides* causing anthracnose disease. Australasian Plant Disease Notes 3: 81-82.

Sergeeva V., Spooner-Hart R. and Nair N., 2008b. First report of *Colletotrichum acutatum* and *C. gloeosporioides* causing leaf spots of olives (*Olea europaea*) in Australia. Australasian Plant Disease Notes 3: 143-144.

Smith B.J., 2009. Influence of nitrogen, phosphorus and potassium on the severity of strawberry anthracnose crown rot. Acta Hort. 842: 235-237.

Talhinhas P., Mota-Capitão C., Martins S., Ramos A.P., Neves-Martins J., Guerra-Guimarães L., Várzea V., Silva M.C., Sreenivasaprasad S. and Oliveira H., 2011. Epidemiology, histopathology and aetiology of olive anthracnose caused by *Colletotrichum acutatum* and *C. gloeosporioides* in Portugal. Plant Pathology 60: 483-495.

Trapero A. and Blanco M.A., 2010. Diseases pp. 523-577. Olive Growing 1st English edition of the 5th revised edition of 'El cultivo de olivo' [Eds. D. Barranco, R. Fernandez-Escobar, L. Rallo].