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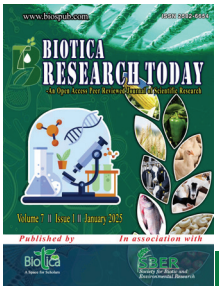

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Popular Article

Phytophthora: An Emerging Threat to Olive Cultivation

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Abstract

Phytophthora and its devastating damage to various agricultural, horticultural and forestry species is a never-ending saga. However, a recent survey in Sardinia, Italy has made headlines as a widespread dieback and decline of wild olives across 200 ha area. The two yearlong studies focused on the identification of causal agents and mapping the diseased area. Isolation of multiple *Phytophthora* species from such a small area has astonished researchers with *P. pseudocryptogea* and *P. bilorbang* being the two most frequent. However, the involvement of *phytophthora* in olives is not new and possesses a great historical significance worldwide. Infection on wild olives, which serve as rootstock for commercial olives, has the potential to bring down the overall olive production. Thus, to save the olive cultivators and this valuable component of agroforestry landscape, further research on the pathogen with advanced disease monitoring and management practices are waiting to be ventured more intensely.

Keywords: Agriculture, Agroforestry, Olive, *Phytophthora*

Introduction

Olive (*Olea europaea* L.) has occupied a vitally important role culturally, socially and economically in the human civilization since its domestication around the 8th millennium BC. Its origin refers to the Middle East, gradually spreading to the Fertile Crescent area first, then to Palestine, Turkey, Israel, Lower Egypt, Greece, Spain and Italy. The global production of olive for the 2023-24 crop year^{-1} is estimated to achieve 2,828,500 tons. Spain being the world's largest producer producing nearly half of the world's olive oil alone. Based on data provided by the International Olive Oil Council (IOOC, 2016), more than 10 million hectares area is under olive cultivation and 95% of them are located in the Mediterranean basin. Other notable producers are Greece, Portugal, Tunisia, Turkey and Morocco. Wild olive (*Olea europaea* var. *sylvestris*) in the family Oleaceae, serves as the rootstock for grafting commercial olive cultivars which are the sclerophyllous woody plants that are most iconic in the Mediterranean Basin especially representing a crucial component of the agroforestry landscape. Apart from its ecological importance it is also efficiently tolerant to drought and salinity. Moreover, wild olives are a great source of genetic variability and thus utilized in breeding programmes.

On the other hand, *Phytophthora* (*Pythiaceae*, *Peronosporales*, *Oomycota* and *Chromista*) has always been the most iconic and economically impactful pathogen in the history of plant pathology. From causing the devastating epidemic in 1845 through Irish famine to infecting a wide range of crops worldwide, damaging natural forests and herbaceous species through invasion to newer areas, *Phytophthora* has always been the constant headache to plant pathologists and farming community. *Phytophthora* is mainly soil and water inhabiting, necrotrophic to hemibiotrophic pathogen with a remarkably large host range. The genus contains a notable series of infamous pathogens, namely - *P. infestans (most important), P. cinnamomi, P. capsici, P. nicotianae, P. megakarya, P. plurivora, P. palmivora, P. ramorum* and many more.

In Italy, wild olive is found mostly in Calabria, Apulia, Tuscany and in the islands, at an altitude up to 800 m (average sea level). In Sardinia, this species is found prevalent in the coastline to inland areas. However, a recent study reported a severe dieback resulting in death of olive trees in Italy that has gained significant attention.

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The Whole Picture of *Phytophthora* in Italy

In nearly 200 ha areas of central Sardinia, Italy a widespread dieback and plant death in case of wild olives has been reported since 2022. The typical symptoms in the affected trees include leaf chlorosis, defoliation of the whole crown and wilting (Figure 1), frequent root rot along with necrotic lesions on the feeder roots, shoot blight and epicormic shoots, which progressively died over time, usual to the common *Phytophthora* damage. With aid of drones (unmanned aerial vehicle) along with field surveys, severe outbreak and spread of the disease was recorded, impacting roughly 1200 ha and infecting over 10,000 wild olive trees. The fear of possible transmission of pathogens to cultivated olive species, soon drew attention of researchers to identify the causal organism and extent of damage. The inspection revealed, disease spread from downstream regions upwards to the hillside with chances of dispersal of *Phytophthora* inoculum by the movement of contaminated soil particles stuck to tractor tyres, by livestock grazing and through wild animals (*e.g.*, wild boars).

Figure 1: Defoliated olive tree and widespread damage in Sardinia (Image source: Deidda *et al*., 2022)

Overall, nine described *Phytophthora* species were isolated from diseased trees in the surveyed area namely, *P. pseudocryptogea, P. bilorbang, P. oleae, P. crassamura, P. asparagi, P. inundata, P. kelmanii, P. syringae* and *P. sansomeana*. Among this, *Phytophthora pseudocryptogea*, an aggressive pathogen of agricultural crops and forest plants, was the most frequent one (17.2%) mostly during the winter, spring and summer sampling months. The second position was occupied by *P. bilorbang* (13.8%) being the only species to be isolated in all the seasons. Among the other species, *P. paulensis* was isolated (11.4%) during winter, spring and early summer; *P. kelmanii* and *P. crassamura* were recovered in winter; *P. crassamura* was identified during autumn, while *P. kelmanii* was detected in spring and summer with rest five *Phytophthora* species isolated with lower frequencies. The top two species massively impacted both young and mature trees and root architecture system (Figure 2). The detection of many members under *Phytophthora* genus reflects the site characteristics as the majority are aquatic in nature, commonly prevalent in water courses and strongly associated with water logged areas in winter that suffer from severe aridity during summer. The progression of disease is shaped by geo-pedological features of the area under study - a basaltic plateau with superficial top soils prone to water-logging during the autumn and winter months, which become dry during summer. Even before conduction of survey this area witnessed nearly 60 days of continuous rainfall before the disease was reported.

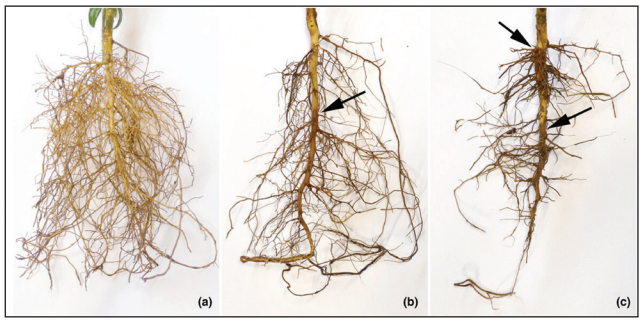

Figure 2: a) Healthy root, b) Root growth in soil infested with *Phytophthora pseudocryptogea*, c) root growth in soil infested with *Phytophthora bilorbang* (Image source: Deidda *et al*., 2022)

Therefore, following these favourable conditions, even weak or opportunistic pathogens cause severe disease outbreaks on susceptible hosts. The occurrence of nine different species from such a small area in Sardinia raised questions whether these species are endemic opportunistic pathogens that emerge from nearby rivers during flooding or if they have been introduced *via* planting material and transmitted by anthropogenic activities. Further experimentations on pathogenicity test produced characteristic impairment in root development, *P. inundata* and *P. oleae* leading to the most damage (Deidda *et al.*, 2024).

Is It New?

From the beginning of the 1990s, the commercial olive cultivation in southern Spain is hindered by the prevalence of *Phytophthora megasperma* and *P. inundata* causing wilting and death of olive trees. However, association of *Phytophthora* to olive was not new to Italy. Since 2009, the severe attack due to *Phytophthora megasperma* and *P. cryptogea* caused serious decline in 5 ha land of protected wild olive forest of high ecological value (Dehesa de Abajo, Seville, Spain). *Phytophthora megasperma* was detected from declining wild olives in 2009. Later, *P. cryptogea* appeared as the chief reason behind wild olive root disease in 2013. An interesting hypothesis is currently revolving around *P. cryptogea* which is a high temperature species, hence capable of replacing low-temperature species - *P. megasperma* infecting wild olives in the Mediterranean basin, as the global trend is surging towards raised temperature due to climate change. However, *P. oleae*, a dominant low temperature loving species, was reported as a new pathogen for wild olive, producing typical root rot symptoms in natural forest at south-western Spain. This suggests its ability to withstand severe summer droughts in dormant state (oospore) and rapid resume of growth along with sporulation after autumn-winter rainfalls, providing a competitive edge over other species when temperatures fall unusually (González *et al.*, 2019). However, *Phytophthora oleae* was earlier reported as the causal agent behind rot on mature olive fruits in southern Italy in 2018. *P. pseudocryptogea* was detected in nurseries and forests in Spain, Italy and Turkey 2019 onwards, indicating its adaptability to the Mediterranean region. *Phytophthora bilorbang* was also known for its severe dieback and mortality on wild olive

trees, which is well adapted to Mediterranean environments paving its way from forest and natural ecosystems across Europe to rhizosphere soil of Mediterranean maquis vegetation, riparian ecosystems to stream water in cork oak ecosystems. *Phytophthora palmivora*, alone or in association with *Verticillium dahliae*, was recorded as causal pathogen against rot of fine roots and wilt of young olive trees in nurseries and new plantings in Italy. Climate change models often predict the correlation between pathogen occurrence and severity to increased heavy rain concentrated in a short span of time and following prolonged summer droughts. However, different *Phytophthora* species have well been associated to cause root rot in olive cultivars in diverse areas globally: *P. inundata* and *P. megasperma* in Spain and Italy, *P. drechsleri* and *P. citricola* in California, *P. megasperma* in Greece, *P. palmivora* and *P. nicotianae* in Argentina and Italy, *P. palmivora* in Morocco and olive nurseries in Spain.

Conclusion

Olive cultivation is serving a stable source of income to farmers globally. The presence of multiple species in the small area of Sardinia is hypothesized to be a result of infected nursery material as traditionally, olive cultivars are grafted of wild olive rootstocks and thus, limitations upon use of infected nursery material is a must with significant attention on the aggressiveness of pathogens. However, it is always advised to follow well sanitised practices in the nursery (avoiding non-sanitized containers and splashing *Phytophthora* contaminated irrigation water). Alongside nursery management, efficient disease monitoring measures combined with field surveys and other new technologies (modelling, remote sensing) must be utilised in efficient disease monitoring and reducing risk associated with spreading of the disease. As new pathogen species are being reported, further research upon epidemiology is crucial. Interestingly multiple wild olive genotypes with complete resistance to the *Verticillium* wilt (Jiménez-Fernández *et al.*, 2016) have been identified and utilised as rootstocks for susceptible olive cultivars. But there may exist a significant risk of susceptibility towards *Phytophthora* species, thus further research is advocated.

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