Good agricultural practices in the management of the Olive Quick Decline Syndrome

Xiloyannis C., Mininni A.N., Lardo E., Miccoli A., Fausto C.

in

D'Onghia A.M. (ed.), Brunel S. (ed.), Valentini F. (ed.).
Xylella fastidiosa & the Olive Quick Decline Syndrome (OQDS). A serious worldwide challenge for the safeguard of olive trees

Bari : CIHEAM
Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 121

2017
pages 83-85

Good agricultural practices in the management of the Olive Quick Decline Syndrome

Cristos Xiloyannis, Alba N. Mininni, Egidio Lardo, Alessandra Miccoli, Catia Fausto

Università degli Studi della Basilicata, Dipartimento delle Culture Europee e del Mediterraneo, Matera - Italy

Intensive agricultural practices have determined the loss of soil fertility and the depletion of soil organic carbon with negative effects on soil fertility, pollution, yield and fruit quality (Halvorson *et al*., 2002; Kabiri *et al*., 2016). Humus is the bond between living and non-living parts in soil and is part of the soil organic carbon that has severely declined mainly in the last 6 decades. Plants depend on beneficial soil organisms to protect them from pathogens, to help them to uptake nutrients from the soil, to increase water efficiency and to break down toxic compounds that could inhibit growth (Nannipieri *et al*., 2002; Acosta-Martinez *et al*., 2007).

Biotic and abiotic stresses are the main causes of productivity decrease and yield losses for crop species (Suzuki *et al*., 2014). In the case of Salento olive groves, the non-rational soil and canopy management could have facilitated the spread of the Olive Quick Decline Syndrome (Xiloyannis *et al*., 2015). Thus, soil management for sustainable olive production must involve the introduction of a number of practices with the general aim of improving orchard performance, bringing about greater autonomy for the grower, while at the same time increasing the stability of production (yield and quality), and reducing risk to the environment.

Increase of carbon in the soil

Soils represent the most diverse and important ecosystem on the planet. Soil has been recognized to play a double role in the entire agro-ecosystem: it is important for a good production as well as for a healthy environment (Noel *et al*., 2009; Turner *et al*., 2016). The sustainable management implies the increase of carbon in the soil. Research works showed that the recovery of carbon in the soil is a relatively slow process and takes 7-10 years before it can be revealed (Montanaro *et al*., 2012). This aspect emphasizes the urgency of promoting the actions for its recovery.

Soil and microbial activity

Most of the biodiversity of agroecosystems is found in the soil, and the functions performed by soil biota have considerable direct and indirect effects on crop growth and quality, nutrient cycle quality and sustainability of soil productivity (Barrios, 2007). The composition, complexity, genetic diversity and the use of nutrients of the soil microbial communities are positively influenced by a sustainable management system (Ghimire *et al*., 2014). This is the case of a study in which an olive grove managed for 12 years with sustainable practices showed a greater genetic, functional and metabolic diversity, and a greater amount of microbial species, compared to the conventional management (Sofo *et al*., 2010). Microbiological analyses revealed significant changes in the soil microbial communities in response to sustainable farming practices (Sofo *et al*., 2014). The management mode of the land has a significant effect on the number and biodiversity of fungal and bacterial populations of the soil. According to Sofo *et al*. (2014), the diversification of microbial communities was likely enhanced by the inputs to the soil of different quality organic material.

Increase of microbial-biodiversity in leaves and fruit

The interface between the aerial part of the plants and the atmosphere (phyllosphere for leaves and carposphere for fruits) constitutes a very specific habitat for epiphytic microorganisms and is normally colonized by a variety of bacteria, yeasts and fungi. Both in the phyllosphere and carposphere, bacteria are by far the most numerous organisms. On this basis, the bacterial communities of phyllosphere and carposphere of olive plants subjected for several years to two different management systems (conventional and sustainable) were recently characterized (Pascazio *et al*., 2015). From this study, it emerged that sustainable soil management significantly modified the composition of the bacterial communities of phyllosphere and carposphere, increasing their biodiversity.

Endophytic bacteria

Endophytes are organisms, often fungi and bacteria, that live between plant cells within a plant and usually establish a symbiotic relationship with the plant (Hallmann *et al*., 1997). Endophytic bacteria may play a significant role in protection against plant pathogens and in the overall productivity of an agricultural ecosystem (Mercado-Blanco and Lugtenberg, 2014). Different studies revealed that *X. fastidiosa* interacts with endophytic bacteria present in the plant xylem, and that these interactions, particularly with *Methylobacteriurn mesophilicum* and *Curtobacterium flaccumfaciens*, may affect disease progress. In addition, high frequency of *C. flaccumfaciens* had been observed in asymptomatic citrus plants and this suggests a role for this organism in the resistance of plant to Citrus Variegated Chlorosis (Lacava *et al*., 2009).

Agricultural practices

Water and nutritional stresses are often determining factors in the development of symptoms once a plant has become infected with *X. fastidiosa (*Janse *et al*., 2010*)*. Field practices should therefore be directed towards healthy, well growing plants and adequate nutrition. Iron deprivation possibly provides a way to reduce disease severity by preventing biofilm formation in the xylem vessels (Toney and Koh, 2006).
A good canopy management with frequent pruning may play a key role in the *X. fastidiosa* infection management, since it facilitates air circulation and prevents the increase in relative humidity. In this way, it is possible to reduce the amount of inoculum and of the upstream migration of the pathogen in the plant. In the areas in which the presence of *Xylella* is detected, it is necessary to remove all the infected shoots by cutting at 5-10 cm below the symptoms and disinfect the tools used for pruning before moving on to the next crop plant. After the cut, it is possible to perform a treatment with copper-based products for preventive purposes. After the attack of *Xylella fastidiosa*, a plant in a good nutritional status reacts issuing new lateral shoots, thus rebuilding the vegetation quickly. This is important when the attacks occur both on the upper or outer side of the canopy. In this situation, the sectoral pruning could permit to save the plant without eradicating it (Xiloyannis *et al*., 2015). Studies of bacterial infections on different crops (e.g. *Erwinia amilovora* and *Pseudomonas syringae* in kiwifruit, *X. fastiodiosa* of the Pierce's Disease in grapevine and *X. fastidiosa* of the Citrus Variegated Chlorosis in citrus) revealed that it is possible to coexist with the infection through the adoption of cultural practices directed towards healthy, well growing plants aimed at reducing the spread of the disease.

The conventional, non-sustainable, agronomic practices should evolve in a more sustainable management addressed to ameliorate the ecological networks and nutrient cycling in which soil microorganisms are involved. The adoption of a sustainable management of olive groves can increase the soil fertility and biodiversity and its capability to generate benefits for the environment. It is important to consider the olive grove as a whole and improve its "health condition" by adopting sustainable agricultural practices in order to increase the ability of plants to overcome the biotic and abiotic stresses. In this way, the coexistence with the *X. fastidiosa* bacterium will be possible limiting the spread of the disease.

References

Acosta-Martinez V., Mikha M.M., Vigil M.F., 2007. Microbial communities and enzyme activities in soils under alternative crop rotations compared to wheat fallow for the Central Great Plains. Appl Soil Ecol 37, 41–52.

Barrios E., 2007. Soil biota, ES and land productivity. Ecol. Econ. 64, 269-285.

Ghimire R., Norton J.B., Stahl P.D., Norton U., 2014. Soil Microbial Substrate Properties and Microbial Community Responses under Irrigated Organic and Reduced-Tillage Crop and Forage Production Systems. PLoS ONE 9(8): e103901. doi:10,1371/journal.pone.0103901.

Hallmann J., Quadt-Hallmann A., Mahaffee W. F., Kloepper J. W., 1997. Bacterial endophytes in agricultural crops . Canadian J Microbiol 43, 10, 895-914. (doi: 10.1139/m97-131).

Halvorson A.D., Wienhold B.J., Black A.L., 2002. Tillage, nitrogen, and cropping system effects on soil carbon sequestration. Soil Sci Soc Am J 66, 906–912.

Janse J.D., Obradovic A., 2010. *Xylella fastidiosa* : its biology, diagnosis, control and risks. J. Plant Pathol. 92, 35-48.

Kabiri V., Raiesi F., Ghazavi M. A., 2016. Tillage effects on soil microbial biomass, SOM mineralization and enzyme activity in a semi-arid Calcixerepts. Agric Ecosyst Environ 232, 73–84.

Lacava T.P., Azevedo J.L., Miller T.A., Hartung J.S., 2009. Interactions of *Xylella fastidiosa* and Endophytic Bacteria in Citrus: A Review. Tree and Forestry Science and Biotechnology 3, 40-48.

Mercado-Blanco J., Lugtenberg B.J.J., 2014. Biotechnological Applications of Bacterial Endophytes. Current Biotechnol3, 60-75.

Montanaro G., Dichio B., Briccoli Bati C., Xiloyannis C., 2012. Soil management affects carbon dynamics and yield in a Mediterranean peach orchard. Agric. Ecosyst. Environ. 161, 46-54.

Nannipieri P., Kandeler E., Ruggiero P., 2002. Enzyme activities and microbiological and biochemical processes in soil. In: Burns, R.G., Dick, R.P. (Eds.), Enzymes in the Environment: Activity, Ecology and Applications. Marcel Dekker, New York, 1–33.

Noel J.E., Qenani-Petrela E., Mastin T., 2009. A benefit transfer estimation of Agro-ecos. service. West. Econ. For., 1-28.

Pascazio S., Crecchio C., Ricciuti P., Palese A.M., Xiloyannis C., Sofo A., 2015. Changes in phyllosphere and carposphere bacterial communities in olive plants managed with different cultivation practices. Int. J.Plant Bi. 6, 15-19.

Sofo A., Palese A.M., Casacchia T., Celano G., Ricciuti P., Curci M., Crecchio, C., Xiloyannis C., 2010. Genetic, functional, and metabolic responses of soil microbiota in a sustainable olive orchard. Soil Science, 175, 81–88.

Sofo A., Ciarfaglia A., Scopa A., Camele I., Curci M., Crecchio C., Xiloyannis C., Palese A.M., 2014. Soil microbial diversity and activity in a Mediterranean olive orchard using sustainable agricultural practices. Soil Use Manag. 30, 160-167.

Suzuki N., Rivero R. M., Shulaev V., Blumwald E., Mittler R., 2014. Abiotic and biotic stress combinations. New Phytologist 203, 32–43.

Toney J., Koh M., 2006. Inhibition of *Xylella fastidiosa* biofilm formation via metal chelators. Journal of the Association for Laboratory Automation 11, 30-32.

Turner K.G., Anderson S., Gonzales-Chang M., 2016. A review of methods, data, and models to assess changes in the value of ecosystem services from land degradation and restoration. Ecol. Modell. 319, 190-207.

Xiloyannis C., Lardo E., Sofo A., Palese A.M. 2015. Contro *Xylella* su olivo le buone pratiche agronomiche. Informatore Agrario 19, 49-53.