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Field Evaluation of Different Fungicides Application to Control Olive Leaf Spot

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Abstract: *Olea europaea* L. is one of the oldest agricultural tree crops which are cultivated in some area especially north of Iran. The olive tree is affected by some pests and diseases such as Olive leaf spot (OLS) which is widespread in all olive growing regions of the world, and has been known in the Mediterranean areas and resulting in fruit drop and decreased oil yields. In this study different fungicides were used to evaluate their efficiency to reduce OLS incidence under field condition. Before fungicide application, Mission variety was the most susceptible and Kroneiki was the most resistant variety to OLS but after using fungicide Rawghani variety showed most reduction in OLS incidence and grouped as most resistant variety. Benomyl as a systemic fungicide, Rovral TS as a combination of systemic (Carbendazim) and non systemic (Ipridion) fungicide and Copper oxychloride showed the most effect to control OLS under field condition.

Key words: Olive leaf spot, olive, fungicide

INTRODUCTION

Olea europaea L. is one of the oldest agricultural tree crops which is cultivated in about 71 thousand ha, situated in the north, southwest, central west and southeast regions (8). The olive tree is affected by some pests and diseases, although it has fewer problems than most fruit trees. Because the olive has fewer natural enemies than other crops, and because the oil in olives retains the odor of chemical treatments, the olive is one of the least sprayed crops (4).

Olive leaf spot (OLS), also called peacock spot disease or Cycloconium leaf spot, is caused by the fungus, *Spilocaea oleagina,* Castagne (Hughes) (syn. *Cycloconium oleagina).* The disease causes severe premature defoliation of olive *(Olea europaea L),* and sometimes leads to twig death (1, 9). It is widespread in all olive growing regions of the world, and has been known in the Mediterranean areas for over a century (2). OLS usually occurs on the upper surface of the olive leaf. As the spots expand and coalesce to cover a large proportion of leaf area, leaves often senesce and are shed from the tree prematurely. Leaf spots are usually more abundant on the lower parts of olive trees, and many shoots in these parts become completely defoliated. Recurrent infections often cause poor growth and dieback of defoliated twigs (9, 7). Under very wet conditions, small sunken brown lesions may be found on the petioles, fruit peduncles and fruit (5), resulting in fruit drop and decreased oil yields (16). OLS symptome on olive leaf is shown on Fig 1.

Infection of fruit can cause unacceptable blemishes on table olives, and when it occurs on oil producing cultivars, infection may cause a delay in ripening and a decrease in oil yields (16). The disease is common worldwide and serious in cooler olive-growing regions, with yield losses estimated to be as high as 20% (18). *S. oleagina* survives during summer as mycelium in the lesions on living leaves. In autumn, the margins of these lesions expand into adjacent healthy tissues from where conidia are produced and then dispersed by rain splash and run-off (9). Moist weather conditions favour *S. oleagina* sporulation, conidium germination and infection, and young olive leaves are more susceptible to infection than older ones (5). Obanor *et al.* (2008a) reported that conidium production was optimal at 15° C and under high humidity (100%), whereas conidium germination and infection required continuous free moisture for 12–24 h and temperatures ranging from 5 to 25° C.

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In warm, dry climates the disease is not usually a significant problem because cool, moist weather is required for epidemic development. The principal method used to control OLS throughout olive-growing regions of the world is chemical fungicides (5, 15). The most commonly used fungicides contain copper, and these have included Bordeaux mixture, copper hydroxide, copper oxide and copper oxychlorides, although some long-persisting preventative fungicides (e.g. chlorothalonil and dodine) have also been used to control the disease (13).

Timing of the fungicide applications is vital for effective control of OLS (5). In the Mediterranean region, fungicides are usually applied before the onset of the main infection periods, which often coincide with the main shoot-growth seasons (spring and/or autumn) (13). In Californian olive groves, Teviotdale *et al.* (1989) reported that one annual application of copper-containing fungicides in late autumn, before the rainy period, effectively controlled OLS under low disease pressure.

In Israel, Shabi *et al.* (1994) reported that 89–95% of the leaves on olive trees treated in autumn with a mixture of difenoconazole (Score 25 EC) and mineral oil (Texaco Spraytex CT774) were free from OLS when assessed the following spring, whereas only 66–82% of the leaves from trees treated with copper sulphate (Bordeaux Mixture) were free from the disease.

Olive *(Olea europaea* L.) is one of the few trees that can still produce fruits even on rocky and unproductive land. In Iran there are many age-old local cultivars and also many cultivars, which have been imported from the other countries. The oldest olive orchards and the first olive research station (established in 1966), is located in Roudbar. Few cultivars are grown commercially in Iran, while most of them have a local diffusion. Iranian government is planning to increase olive cultivation area from 80,000 to 600,000 ha.(6). The olive industry in Iran is relatively new, but olive trees being planted in area near to Caspian see and the moisture is so high in these areas. Olive production is affected by olive leaf spot (OLS).

Fig. 1: Olive leaf spot symptom on olive leaf

In the present study, different fungicides were screened for their effects on field control of *S. oleagina,* to identify chemicals that have potential for control of OLS in Gorgan (northern area of Iran) and that may be suitable for further evaluation.

MATERIAL AND METHOD

The expriment was performed in an olive grove in Gorgan (North of Iran). The trees were 7 years old and spaced on a 6 x 6 grid. Fungicide treatments contain Copper oxychloride (4:1000), Bordeaux fix (5:1000), Rovral TS (3:1000) and Benomyl (2:1000). Each fungicide applied with and without slow release fertilizer. Slow release fertilizer which contained N:P:K (15:5:30) and microelements was applied with water volumes 2:1000 as foliar sprays. The experiment contained 10 plots and each plot contains different number of each variety (Mission, Rawghani, Koroneiki and unknown). Half of the trees (randomly selected) in plots sprayed with one fungicide and other half receiving same fungicide and slow release fertilizer. Each plot was separated from the next one in the row by one to four buffer trees and from adjacent rows by one buffer row. One plot was as control with unsprayed trees. All other practices were performed normally during the trial. Each fungicide was applied once in late winter 2007.

Disease was evaluated at the beginning of the trial (March 2007) before fungicides application and seven months later at the early autumn (October 2008). For evaluation, 4 branches per tree were randomly selected and labeled. On these branches, incidence disease was evaluated as percentage of infected leaves before and after fungicide spraying. Reduction percentage on disease incidence computed based on the results of before and after fungicides spraying.

Statistical Analysis:

All data before spraying were subjected to analysis of variance (ANOVA) using unbalanced completely randomized design to evaluate the genetic potential of different olive varieties for resistance to OLS. All data after spraying also were subjected to analysis of variance using slit plot design to evaluate the effect of treatment, responses of different olive varieties to different fungicides and their interaction. Disease incidence after fungicide spraying was transformed to relative disease incidence compared with the untreated control (before spraying). Treatment means were compared using Fisher's unprotected least significant differences test at the 5% probability levels. All statistical analysis was performed using SAS V8 software.

Results:

Before Fungicide Spraying:

Different olive varieties showed different responses to OLS and the effect of variety was highly significant ($P<0.0001$). Based on the mean comparison results, Mission had significantly higher disease incidence compared to other varieties before using fungicide, therefore it is the most susceptible variety to OLS and Koroneiki as well as unknown variety are the most resistant varieties to OLS (Fig 2). Rawghani showed moderate response to OLS.

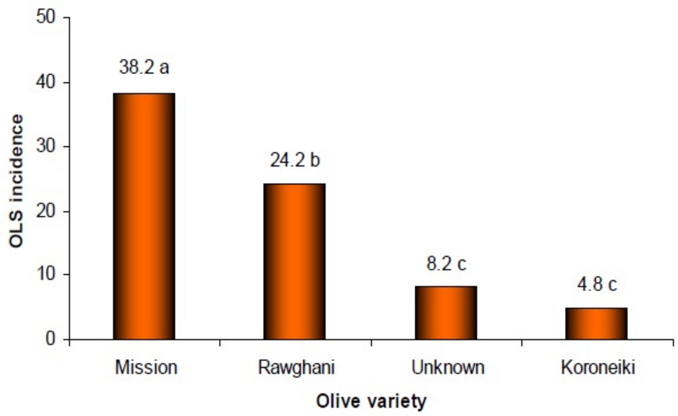

Fig. 2: Mean comparison of olive leaf spot incidence on different olive varieties under field condition before fungicide application based on LSD test in %5 level. Means having different letter showed significant differences.

After Fungicide Spraying:

When fungicides were applied, the main effect of fungicide, and variety were significant ($P<0.0\ 1$) and interaction didn't show significant effect which shows all plants that had received fungicides had significantly less incidence disease than untreated control plants for all fungicides. As shown in Fig 3 Rawghani had most reduction in disease incidence after fungicides and has significant differences with three other varieties.

Therefore there are genetic differences between Olive varieties to response to fungicide because the order of variety in terms of OLS incidence is different before and after fungicide application.

Effect of fungicide was significant to control OLS ($P<0.01$), but interaction effect was not significant which shows different fungicides have the same effect on different olive varieties. Based on mean comparison, Benomyl, Rovral TS (Carbendazim and Ipridion) and Copper oxychloride showed most effect on reduction of OLS incidence relative to unsprayed control and other treatments didn't have significant differences comparing to control in reduction of OLS incidence (Fig 4)

Discussion:

Based on the results, before fungicide application Mission was the most susceptible and Koroneiki was the most resistant variety to OLS. But after using fungicide, Rawghani showed most reduction in OLS incidence and unknown variety was least reduction in OLS incidence and grouped as most resistant and most susceptible varieties, respectively. Changing in variety order after fungicide application is due to persistence of genetic differences between varieties for response to OLS.

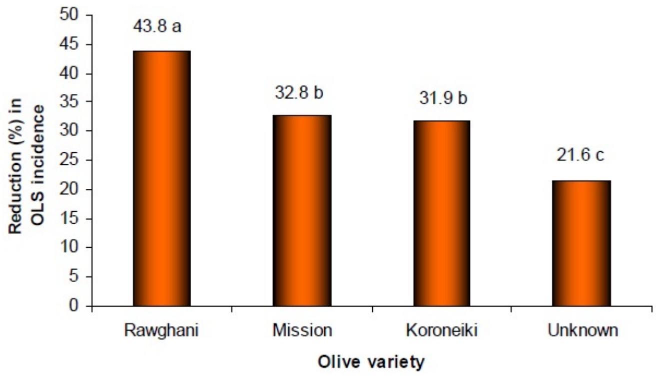

Fig. 3: Mean comparison of reduction in olive leaf spot incidence relative to unsprayed control treatment on different olive varieties under field condition after fungicide application based on LSD test in %5 level. Means having different letter showed significant differences.

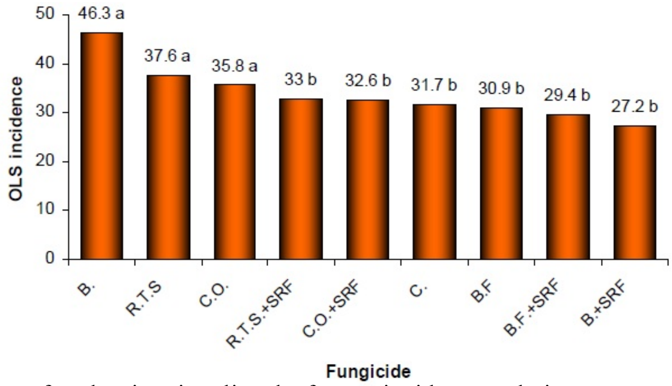

Fig. 4: Mean comparison of reduction in olive leaf spot incidence relative to unsprayed control treatment using different fungicides under field condition based on LSD test in %5 level. Means having different letter showed significant differences. B.=Benomyl, R.T.S.=Rovral TS, C.O.=Copper oxychloride, SRF=Slow release fertilizer, C. Control, B.F.=Bordeaux Fix

In this study Benomyl as a systemic fungicide, Rovral TS as a combination of systemic (Carbendazim) and non systemic (Ipridion) fungicide and Copper oxychloride showed the most effect to control OLS under field condition. Apple scab, caused by *Venturia inaequalis*, has been successfully controlled by systemic fungicides such as carbendazim, difenoconazole and fenarimol (3). Given that *S. oleagina* and *V. inaequalis* are closely related and have similar modes of infection (5), it is likely that fungicides which control *V. inaequalis* could be effective in controlling OLS. An *in vitro* evaluation using fungicides known to be effective against *V. inaequalis* showed that the systemic fungicides, carbendazim and kresoxim-methyl, have the potential to effectively inhibit conidium germination and germ tube growth of *S. oleagina* (10). These fungicides are more target-specific than contact fungicides such as captan and copper-containing fungicides, and may also have a curative effect when applied within 10 d of infection (17).

Obanor *et al*., 2008b also reported copper sulphate and a mixture of kresoxim-methyl and copper hydroxide were the most effective, reducing disease incidence by 8 5–96% and 63–93%, respectively. But in present study Copper sulphate (Bordeaux fix) didn't show significant effect to control OLS compared to control (unsprayed plot). Also Application of slow release fertilizer in combination to fungicide reduced their efficiency to control OLS. It seems the efficiency of fungicides to control OLS is more related to environmental conditions and it can be vary by different area and different climate. Also it would be related to time of fungicide application. That's why sometimes the results are not consistent.

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