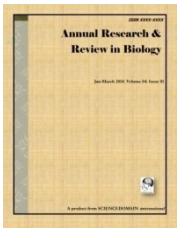

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Latent Infection of Olive Leaf Spot Disease on Palestinian Olives

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Authors' contributions

This work was carried out in collaboration between all authors. Authors HH and MS designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors RA and MA managed the analyses of the study. Authors MJ, AAH and BAR managed the literature searches and conducted sample collection. All authors read and approved the final manuscript.

Original Research Article

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ABSTRACT

Olive Leaf Spot (OLS) or peacock disease is one of the most destructive diseases on olive trees in many parts of the world. The disease is caused by the fungus *Spilocaea oleagina* and can reduce the growth and yield of olive trees (*Olea eurapaea* L.). Investigations were carried out during October 2011 and October 2012, to determine the latent incidence and severity of OLS infection in Palestine. Five growing regions (Tulkarm, Qalqilyah, Salfit, Nablus and Jenin) were visited routinely every two weeks to collect olive leaves from two groves in each region. In each grove, 100 new and another 100 old leaves from 5 trees were collected and transported to the laboratory. Disease incidence was determined by recoding the percent of infected leaves per tree. OLS was found in all study areas with Salfit and Qalqilyah the most infected. The grade of latent severity in these regions (2.3 and 2.1 in old and new leaves, respectively) was significantly higher than that in the other regions. Interestingly, the highest latent severity and incidence in all regions (new and old leaves) occurred in March during the winter season. The rate of visible incidence and severity (70 and 4%) in old leaves was higher than that in the new leaves (40 and 3%). This survey might provide reliable information on the prevalence of OLS in Palestine.

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Keywords: Olive leaf spot; severity; incidence; peacock.

1. INTRODUCTION

The olive tree (*Olea eruopeas* L.) is the first important cultivated fruit tree in Palestine, covering more than 50% of agricultural land grown with fruit trees [1]. Currently there are more than 10 million trees (67.3% of horticulture trees) being grown in Palestine. The olive trees are very important to the social and economical life of Palestinian people contributing to about 13% of agriculture production in good years [2].

Olive Leaf Spot (OLS) disease is caused by the mitosporic fungus *Spilocaea oleagina* [3]. The disease also known as peacock eye is wide spread in all olive growing regions of the world [4]. In Palestine, OLS is considered the most important foliar disease affecting olive trees, and is widely spread in almost all regions with high severities and incidences [5]. Moreover, all cultivars are susceptible to the infection [6].

Symptoms of OLS are obvious on the upper surface of olive leaves and show dark green to black spots surrounded by yellow halos [7]. The disease causes severe premature defoliation of olive, and sometimes leads to twig death resulting in a subsequent loss in crop yield that might reach 20% of annual yield [8]. Infection of fruit can delay ripening, decrease in oil yield and cause unacceptable blemishes on table olives [9,10].

Infection with *S. oleaginea* is normally associated with high humidity and winter conditions (cool and low light), where high temperatures restrict spore germination [11,12]. Infections may occur throughout the year, usually, the incubation period is about two weeks; however, if infection is followed by a hot season, it may last several weeks [13]. Spots already formed in spring may stop growing in summer and resume their growth and sporulation in autumn [13]. The growth of *S. oleaginea* is found to be most prevalent in the period from late autumn to spring [11,14] and of minor significance in the period from the beginning of July until the middle of November. OLS infection can occur at any time of the year, but usually during late autumn to early summer if environmental conditions are favorable. In hot dry weather conditions, conidia remain viable but inactive on infected leaves and start to germinate early in winter. Conidium production is optimal at 15ºC and or temperatures ranging from 2 to 25ºC and high humidity (>85%) [11,15,16]. Conidia of *S. oleagina* are dispersed by rain splash or wind-borne water droplets [17].

The objective of this study was to study the evolution of OLS latent infection at the main Palestinian olive growing district, such data will be useful for developing more effective and environmental friendly disease control strategies and development of a forecasting system for OLS epidemics.

2. MATERIALS AND METHODS

2.1 Sample Collection

Ten olive groves in five Palestinian districts (Tulkarm, Qalqilyah, Salfit, Nablus and Jenin) grown with olive trees cultivar Nabali Baladi were sampled routinely every two weeks. Two fields, in each district were selected and in each selected grove five olive trees were marked to collect olive leaves. In each grove, 100 new and another 100 old leaves were collected and transported to the laboratory.

2.2 Disease Incident and Severity

To assess the incidence and severity of latent infection, as described by Salman et al. (2011) [5], the leaves were immersed in 5% NaOH at 50ºC for 2 min and the number of lesions after NaOH treatment was then counted. Disease incidence was determined by recording the percent of infected leaves per tree. For disease severity, the number of lesions per leaf was counted and graded; 1 (1 lesion), 2 (2 lesions), 3 (3 - 5 lesions), 4 (6 - 10 lesions) or 5 (> 11 lesions).

2.3 Statistical Analysis

The obtained data of one year were subjected to statistical analysis; data on the percent of infected leaves were Log transformed. All data were analyzed for variance by analysis of Variance (ANOVA). Significant differences among treatments were computed after Tukey's HSD test at $P<0.05$.

3. RESULTS AND DISCUSSION

A huge number of olive leaves was assessed for the presence of OLS symptom, during the 12 months period of the study. As expected, OLS disease was found in all visited fields. The OLS incident varied from 58.2% in March to 0.9% in September, the highest was at Qalqilyah during March (74.5%), the lowest was at Salfit (0.125%) during September (Fig. 1), while the OLS severity was varied from grade 1 in to grade 5 in all visited district, the highest severity was observed during March.

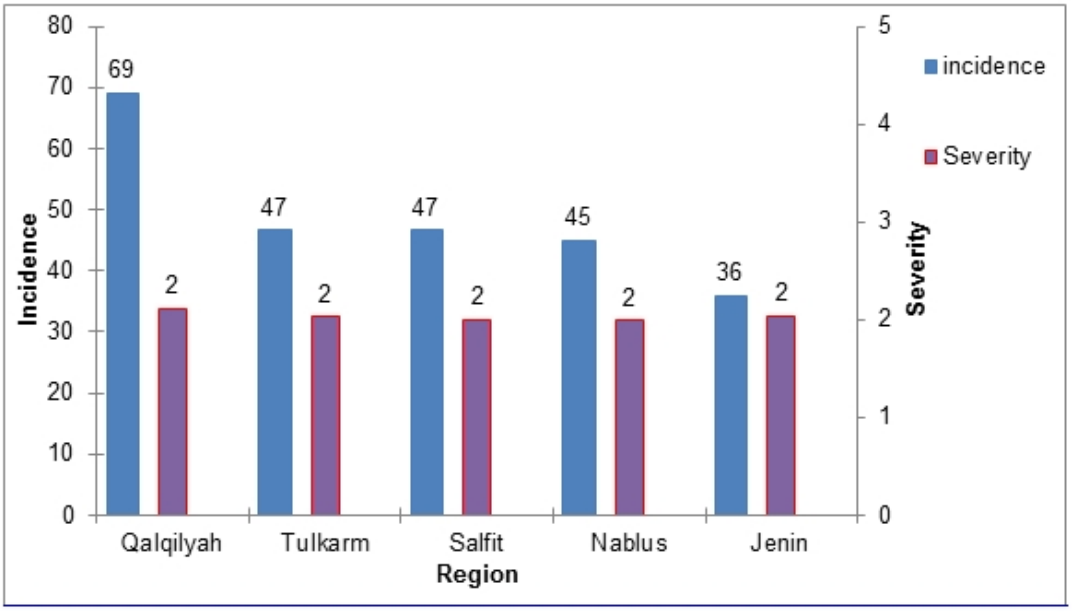

Fig. 1. Monthly occurrence of OLS infection in different district of Palestine. Data is pooled across all dates

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Comparison of visible and latent incident and severity of OLS infection obtained from old and new leaves showed that the incidence is slightly different in favor to the old leaves (Fig. 2A). Only during July incident and severity of infection were in favor of new leaves (Fig. 2B). Percentages of infection were relatively high from September to May, with the peak of infection occurred in March. The severity was relatively stable and varied from grade 2 to grade 3, with a peak in March.

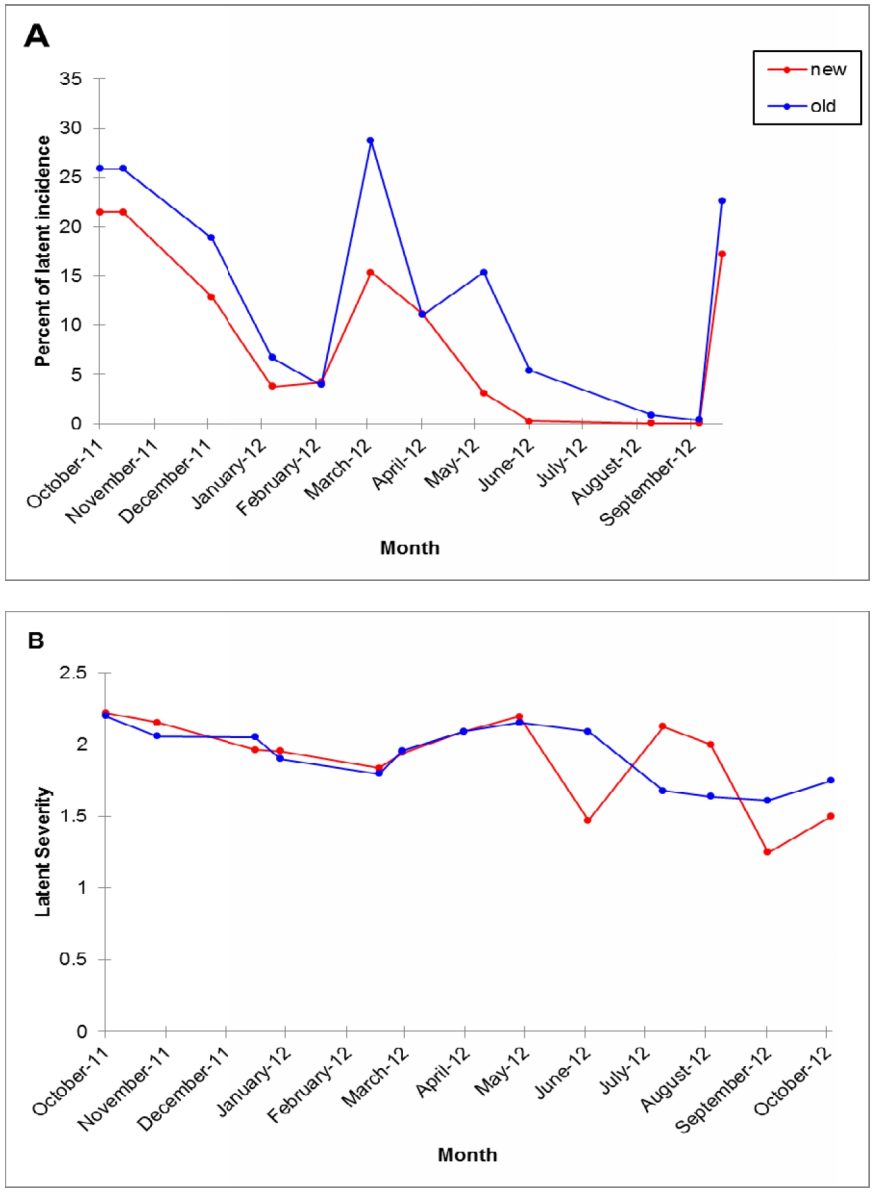

Fig. 2. Latent infections with OLS on new and old leaves, (A) Incident and (B) Severity. Data is pooled across all regions

The disease latent incident and severity were obtained monthly for the five different districts. Latent disease incident were variable from 65% at Qalqilyah during September to 5% at Qalqilyah and Salfit during June. Moreover, incident of latent infection was the highest at Qalqilyah comparing to the other four districts during October and November, 2011(Fig. 3). Severity of latent infection varied from grade 1 in Qalqilyah and Salfit during July to grade 4 in Qalqilyah during March.

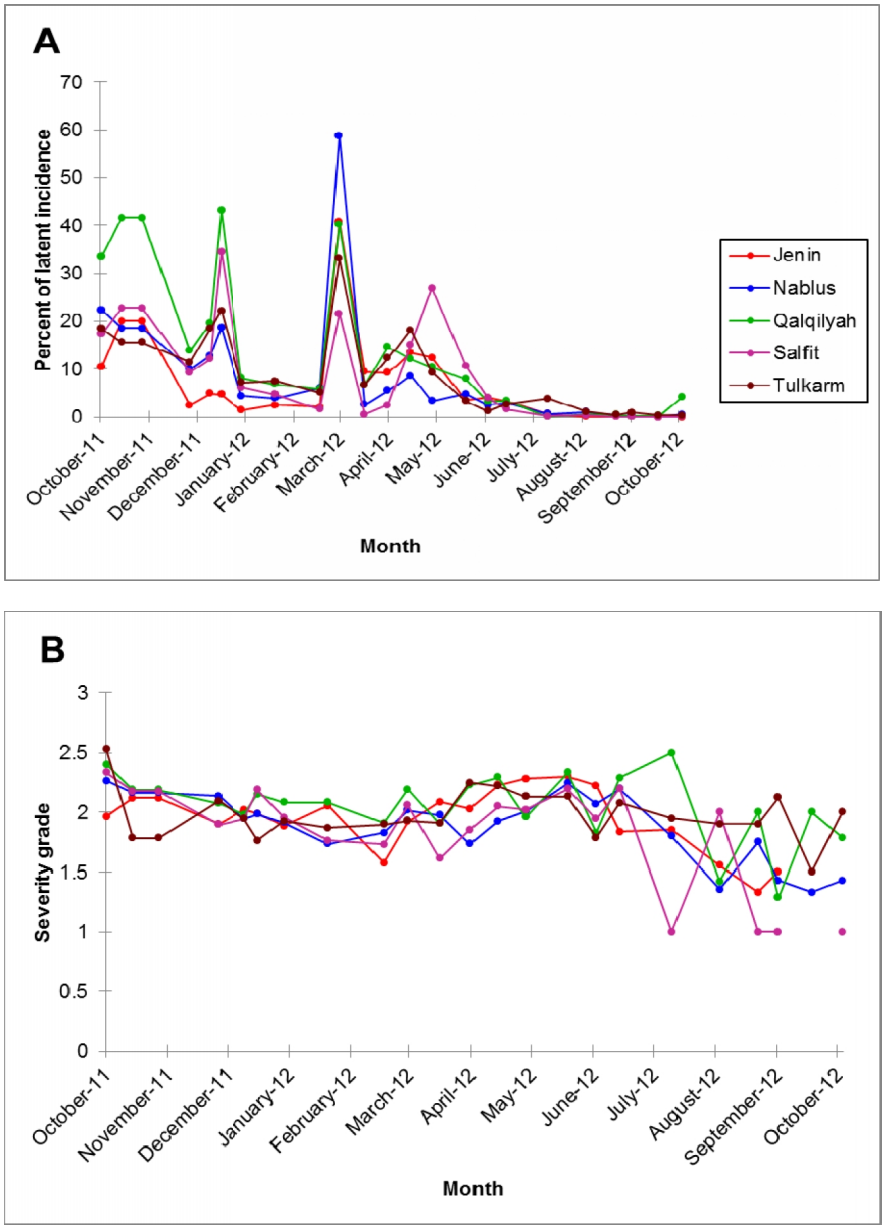

Fig. 3. Latent incidence (A) and severity (B) of infection with OLS in different regions. Data is pooled across all regions

The disease incident was significantly different in Qalqilyah (F =6.41, df = 4, 1, P<0.00001) compared to the other four district (Fig. 4). Old leaves were slightly more infected than new leaves (Fig. 4A). The disease severity was significantly different among the different districts and between old and new leaves (F =1.846, df = 4, 1, P<0.00001), with higher severity in Qalqilyah and Salfit compared to other districts (Fig. 4B).

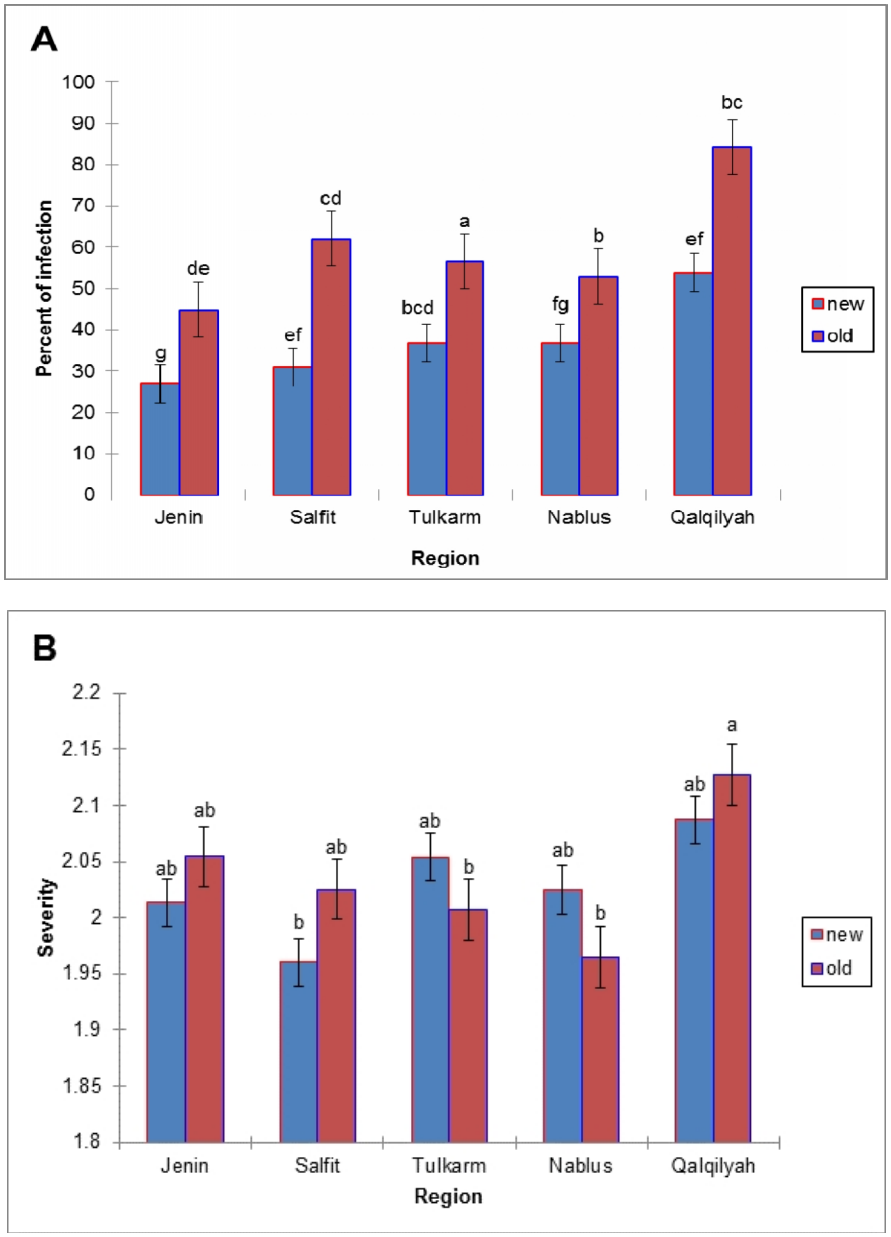

Fig. 4. Latent Incident (A) and severity (B) of infection with OLS on new and old leaves. Data is pooled across all dates

Main infection period occur during winter. A positive correlation between weather condition and disease epidemics was found by Salman et al. [5]. Observations also indicated that young leaves were highly susceptible to infection in spring. In addition, measurements on quiescent infections are provided in this survey.

Our study, showed that OLS disease is a serious problem in the northern Palestinian districts, the key olive growing areas, and this is in agreement with an earlier studies carried out by Salman et al. [5]. The current study is the first to report the variation in disease latent incident and severity, during a complete growing season, in different Palestinian olive groves and under field conditions. The results showed that the highest latent incident and severity occurred during winter. The rate of visible incident and severity (70% and grade 4, respectively) in old leaves, were higher than that in the new leaves (40% and grade 3). These results might provide reliable information on the prevalence of OLS disease in Palestinian groves.

Unfortunately, farmers and Palestinian extension services do not pay much attention to control the disease, due to the lack of information about the disease epidemiology. In addition to that our work might be helpful for planning control strategies. Currently the only control mechanism for the disease is the application of chemical fungicides. Several fungicides are available in the Palestinian market [18]. Treatment of the disease in Palestine starts usually after olive harvesting season [6]. It is obvious from this work that additional application of fungicides is needed which might be done late in February before the peak of the disease.

4. CONCLUSION

The observed symptoms and epidemiology, together with the widespread occurrence of peacock spot of olives, suggested that the disease has potential to be an important disease of olives in Palestine. According to our observations, disease management could be started late in autumn and continued during winter and early spring.

The present study has elucidated new information on the infection development in Palestinian olive groves. The results should help pest managers and researchers to predict the risk of OLS disease in different Palestinian districts. More observation and studies are needed to develop forecasting system for the proper timing of intervention.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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