Original article

Effect of pruning and chemical control on *Saissetia oleae* (Olivier) (Hemiptera, Coccidae) in olives

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Effect of pruning and chemical control on *Saissetia oleae* (Olivier) (Hemiptera, Coccidae) in olives.

Abstract – Introduction. In Morocco the olive growers rely totally on pesticides to control the black scale *Saissetia oleae*, although this technique has adverse effects on natural enemies, on product quality and on the environment. However, the pesticides are not used efficiently because of ignorance of the developmental cycle of the insect, and of the periods of vulnerable instar presence. We studied these two parameters. Next, we tested the efficacy of the pesticide and we studied the effect of pruning on the scales as an alternative to chemicals. **Materials and methods.** The seasonal trend of the black scale was studied in two olive orchards near Essaouira, in the west of Morocco, during 2005 and 2006. One of these orchards was subject to chemical treatment in 2007, while two new orchards were selected to study the effect of pruning on the scales. The evolution of crawler and nymph density on different olive tree organs was followed in order to discover their preferences for these different organs. **Results and discussion.** The seasonal trend study showed the presence of one generation of *S. oleae* per year and the tendency to colonise young organs rather than old ones. The optimum of mobile instar population coincided with the beginning and the end of July. On the organs of the chemically-treated samples, numbers of crawlers and nymphs were highly reduced. The results showed a small-scale infestation in pruned trees compared with the unpruned trees (control). **Conclusion.** Though the chemical control has good results, pruning remains very efficient and can help improve the control of the black scale populations without harming the environment.

Morocco / *Olea europaea* / insect control / *Saissetia oleae* / population dynamics / chemical control / pruning

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Effet de l'élagage et de la lutte chimique sur *Saissetia oleae* (Olivier) (Hemiptera, Coccidae) en vergers d'oliviers.

Résumé – Introduction. Au Maroc, les oléiculteurs comptent entièrement sur les pesticides pour lutter contre la cochenille noire de l'olivier *Saissetia oleae*, bien que cette technique ait des effets nocifs sur ses ennemis naturels, sur la qualité des produits et sur l'environnement. Cependant, les pesticides ne sont pas utilisés de manière efficace du fait de l'ignorance du cycle de développement de l'insecte, ainsi que du moment de présence de ses stades de développement en vergers. Nous nous sommes intéressés à ces deux facteurs. Nous avons testé ensuite l'efficacité d'un pesticide et, pour pallier l'utilisation de produits chimiques, nous avons étudié l'effet de la taille des arbres sur la cochenille. **Matériel et méthodes.** Les variations saisonnières de la cochenille noire ont été étudiées dans deux vergers d'oliviers à proximité d'Essaouira, à l'ouest du Maroc, en 2005 et 2006. L'un de ces vergers a été soumis à un traitement chimique en 2007, tandis que deux nouveaux vergers ont été choisis pour étudier l'effet de l'élagage sur la cochenille. L'évolution des densités de chenilles et de nymphes sur différents organes de l'olivier a été suivie afin d'identifier leurs préférences pour ces différents organes. **Résultats et discussion.** L'étude des tendances saisonnières a montré qu'il se créait une génération de *S. oleae* par an et qu'elle avait tendance à coloniser les organes jeunes plutôt que les anciens. L'optimum de la population de larves mobiles a coïncidé avec le début et la fin de juillet. Dans les échantillons d'organes traités chimiquement, le nombre des chenilles et des nymphes a été fortement réduit. Les résultats ont montré une faible infestation par la cochenille noire dans les arbres élagués par rapport aux arbres non taillés (arbres témoins). **Conclusion.** Bien que la lutte à l'aide de produits chimiques donne de bons résultats, l'élagage demeure très efficace et pourrait contribuer à améliorer le contrôle des populations de cochenilles noires sans nuire à l'environnement.

Maroc / *Olea europaea* / lutte anti-insecte / *Saissetia oleae* / dynamique des populations / lutte chimique / taille

the averages were calculated per linear metre. For the old branches (25 cm length), average numbers were obtained by dividing the crawlers and nymphs found on 40 branches by 1000 cm (40 × 25 cm) to have density by linear metre. This study permitted us to determine: i) the peak period when crawlers and second-instar nymphs reached their highest emergence, and ii) the preferences of these sensitive instars for different olive organs. Our focus on the above-mentioned mobile instars was justified because at these instars, nymphs do not have the impervious shell of the adult females and can be removed by pesticides.

2.3. Effect of pruning olive trees on *S. oleae* populations

Two olive sites in Ounagha and Talmest, 30 km from the Essaouira region, were selected for this study. In the first site, olive trees were pruned in 2004 and 2006, while the second site, whose olive trees were not pruned, was used as a control. Samples of branches were taken during the active period of the black scale (January to August 2007). Five trees were randomly sampled in each site by taking 8 branches from each. Monthly, a sample of 40 branches 25 cm in length per site was examined and the numbers of eggs, nymphs and adult females were recorded. The crawlers (0.4 mm length) were distinguished from the second-instar nymphs (0.8 mm length) by the size and the appearance of the H letter form on the back of the second instars. The data were analysed using a Student t-test with matched samples.

2.4. Effect of chemical treatment on the *S. oleae* population

The treatment was conducted in Talmest, in the same old orchard that was used for the seasonal trend during 2005 and 2006. Once crawlers and second-instar nymphs were completely emerged, a treatment was undertaken in July 2007. Five olive trees were treated with fenthion 50% (Lebaycid, Bayer, France), a standard product, at a dose of 1 mL·L^{-1}. Each tree received 10 L of the insecticide. In parallel, five untreated trees, 70 m away from the treated trees, were followed up. After 15 d, a sample of 40 branches was taken from the treated trees and another one from the untreated trees. The numbers of eggs, crawlers and nymphs and living adult females were counted on young and old leaves and branches in each sample to compare the two samples. We used the Abbot formula to determine the efficacy of the product by evaluating the mortality rate: [Mortality = (instar number in the control – instar number in treatment) / instar number in the control].

3. Results and discussion

3.1. Seasonal trend of the scale during 2005 and 2006

3.1.1. In the old orchard

In the old orchard, the eggs started to be laid in May 2005 and they reached their maximum (1480 eggs per linear metre) in the same month. They continued until August (4500 eggs per linear metre) and did not reappear until May of next year (*figure 1*).

The crawlers appeared between May and July or August depending on the year. There was a very high number in 2005 and a lower one in 2006. The second-instar nymphs appeared in all samples except those for January, March, April and May. Their number fluctuated between 54 and 213 per linear metre. The third-instar nymphs were found on branches from September until early April in 2005 and until May in 2006. As for adult females, they appeared from early March to July or August and their densities were relatively lower (2.4–11.3 in 2005 and 0.2–8.9 in 2006). We can note that the duration of different instars was longer in 2006 because the rainfall was abundant and so the humidity was suitable for them.

3.1.2. In the young orchard

In the young orchard, eggs appeared from May to July in 2005 and from April to June in 2006 (*figure 2*). The maximum number of eggs was about 1400 eggs per linear metre higher in 2006 because the relative humidity was higher (> 60%) (*figure 4*). The densities were maximum on the young leaves in 2005 (2.6 individuals per leaf, the equivalent of 520 nymphs per linear metre) and on the old leaves in 2006 (5.2 individuals per leaf or 2080 nymphs per linear metre). These results are similar to those of Paparatti, who indicated that, after the second moult, nymphs moved towards the leaves [10]. For others, the second instars typically migrate from the leaves back to the branches [23]. From the results of mobile instar-L1 and -L2 densities, we note that the maximum of crawlers occurred in the last part of June and the maximum of second-instar nymphs was reached in August. Consequently, chemical treatments must target both instars and thus must take place in two phases: a first treatment at the beginning of July to destroy the maximum number of crawlers and a second one a month later in order to reach the maximum number of second-instar nymphs.

In the same way, in Spain, populations peaked in July, when crawlers emerged after the egg-laying period, and decreased in summer due to mortality of crawlers [23-25]. Thus, two pesticide applications are advised. This approach seems largely questionable because of the doubling of the distribution cost.

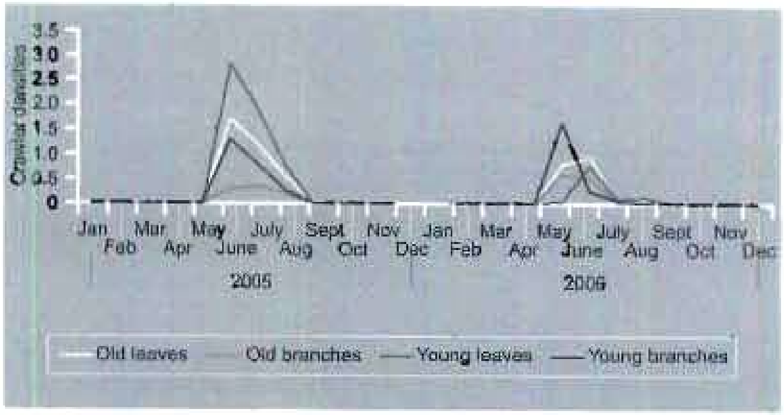

Figure 3.
Density of crawlers of the scale *Saissetia oleae* (Olivier) on old and young leaves per leaf, and on old and young branches per linear metre in two olive orchards during 2005 and 2006 (Morocco).

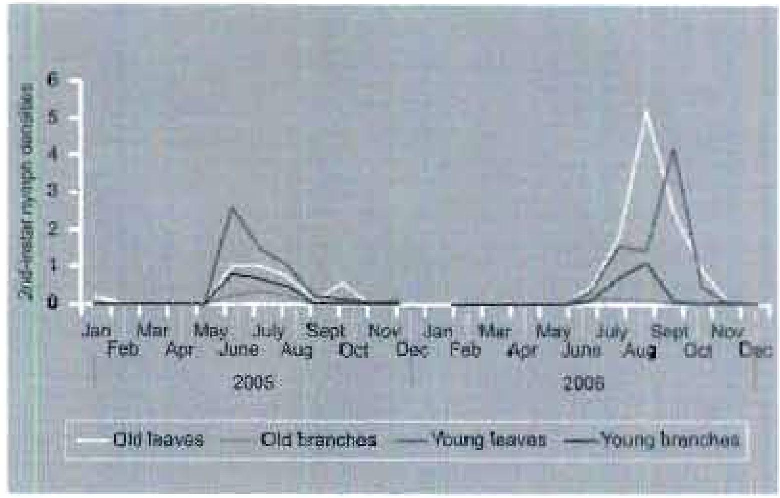

Figure 4.
Density of second-instar nymphs of *Saissetia oleae* (Olivier) on old and young leaves per leaf, and on old and young branches per linear metre in two olive orchards during 2005 and 2006 (Morocco).

3.3. Seasonal trend of *S. oleae* under pruning

Comparing the variation in the infestation of branches from pruned and unpruned olive trees (control), it appeared that the level of branches infested by eggs, nymphs and adult females was higher in the control than in all the samples from the pruned trees (*figure 5*). The pruning reduced the number of eggs from 1.6 to 2.3 times; whereas the nymph reduction due to this technique was almost two-fold less. The number of adult females also underwent a reduction of their population by half. The Student t-test used to compare the total numbers of various instars of the scale from the two orchards (pruned and the control) showed that these differences are significant for all the instars: indeed, for eggs, $t = -2.57$ with ($P = 0.021$, degree of freedom = 15); for the nymphs (including crawlers), $t = -2.426$ with ($P = 0.028$, degree of freedom = 15); and for adult females, $t = -2{,}919$ with ($P = 0.011$, degree of freedom = 15).

These results show that the level of infestation by the various instars of the scale is lower in the pruned orchard than in the control. These results are in conformity with those found by other authors. On olive trees, branches, 5.2 nymphs on the young leaves and 6.4 nymphs on the young branches. It should be noted that the larval populations were reduced 3.23, 3.70, 6.50 and 4.75 times compared with the control.

The mortality ranged from 70% to 87% on the leaves and from 75% to 85% on the branches (*figure 7*). We also noted that the death rate was higher on young organs compared with the old. The average mortality calculated on all parts of the olive tree in this orchard was about 79%.

Fenthion significantly reduced the *S. oleae* nymph population, which reached up to 87%. The Student *t*-test detected a highly significant difference between the number of nymphs of the first and second instars in the treated orchard and the control with, respectively, $t = -3.587$ ($P = 0.037$, degree of freedom = 3) and $t = -5.564$ ($P = 0.011$, degree of freedom = 3) for the first and second instars. In addition, the complete inefficiency of fenthion is explained by the spreading out of the hatching in time, which makes the application of only one treatment insufficient. Considering the variation in the density of the first and second instars (*figures 1, 2*), subject to the chemical interventions, we recommend a first treatment during the first week of July, and a second treatment after one month in order to reach the maximum of hatched crawlers. In California, pesticides are usually applied in July and August against the first and second instars, which are more susceptible to insecticides [23].

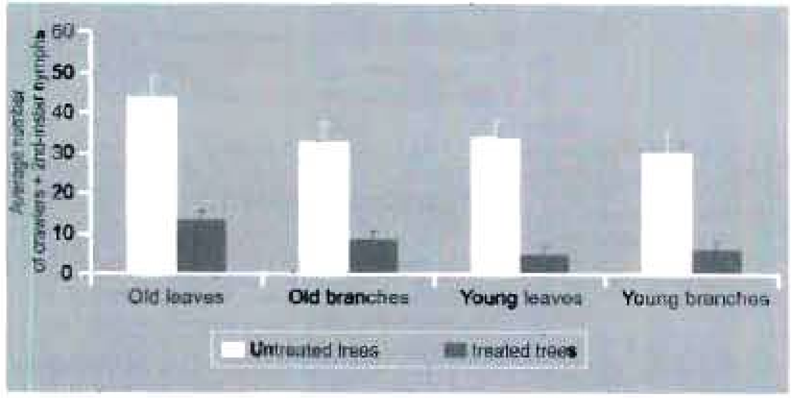

Figure 6.
Average of crawlers (L1-instars) and nymphs (L2-instars) per linear metre (*Saissetia oleae* (Olivier)) in treated and untreated (control) branches and leaves of olive trees. Samplings were taken 15 d after a treatment with fenthion 50% (Lebaycid, Bayer, France) undertaken in July 2007 (numbers should be multiplied by 100).

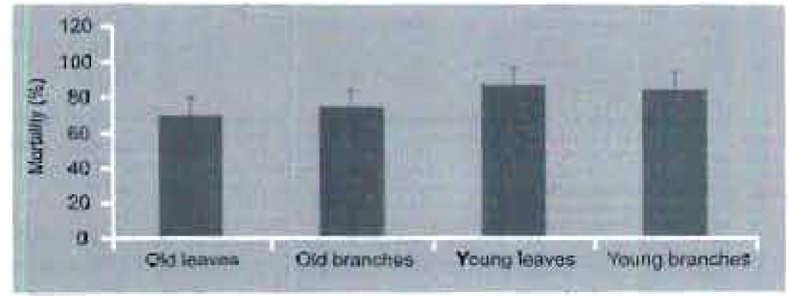

Figure 7.
Mortality rate calculated with the Abbot formula from samplings in treated and untreated (control) branches and leaves of olive trees. Samplings were taken 15 d after a treatment with fenthion 50% (Lebaycid, Bayer, France) undertaken in July 2007.

Infestations of live mature scale may need spraying with an insecticide such as Supracide or Lebaycid. Californian olive growers use oil emulsions, diazinon 50WP, methidathion and carbaryl. Greek olive growers use Supracide as an all-rounder for many olive problems. Nevertheless, resistance of this pest to several chemicals has been reported in some countries [35].

Concurrently with the fenthion used for this study, several insecticides are usually used in Moroccan olive-growing orchards to control *S. oleae*, in particular: methomyl, lamda cyalothrine, dimethoate, parathion, malathion and cypermethrine. However, these products present a lethal effect on the adults of the *Pullus mediterraneus* parasitoid which constitutes an important predator of *S. oleae* eggs [13]. In Morocco, methidaxide 40 and Ultracide 40 EC (methidathion), Promazit blanche (mineral oil) and Sevin 85 WP (carbaryl) are also certified on the black scale on olives [36].

In conclusion, agricultural practices such as pruning associated with a well-applied treatment constitute an important tool to improve the health status of olives, so their involvement in the integrated control of olive groves will be more than appreciated. In addition, monitoring of scale populations

[20] Vincent C., Goettel M.S., Lazarovits G., Biological control: A global perspective, Cabi publ., Wallingford, UK, 2007.

[21] Bailey K.L., Boyetchkoa S.M., Langleb T., Social and economic drivers shaping the future of biological control: A Canadian perspective on the factors affecting the development and use of microbial bio pesticides, Aust. N. Z. Biocontrol Conf. 52 (3) (2009) 221–229.

[22] Bedker P.J., O'Brien J.G., Mielke M.E., Arboricultural pruning methodologies, Arborist News 3 (4) (1994) 33–38.

[23] Daane K.M., Caltagirone L.E., Biological control in California olive orchards: cultural practices affect biological control of black scale, Calif. Agric. 43 (1989) 9–11.

[24] Civantos M., Développement de la lutte intégrée dans les oliveraies espagnoles, Olivae 59 (1995) 75–81.

[25] Tena A., Soto A., Vercher R., Garcia-Mari F., Density and structure of *Saissetia oleae* (Hemiptera: Coccidae) populations on citrus and olives: Relative importance of the two annual generations, Environ. Entomol. 36 (4) (2007) 700–706.

[26] Anon., Agriculture raisonnée : l'oléiculture française tournée vers la protection sanitaire raisonnée, Afidol (Assoc. Fr. Interprof. Olive), Olivae 86 (2001) 43–45.

[27] Regis S., Pour la santé de l'olivier : la lutte intégrée, une méthode plus écologique, Olivae 91 (2002) 45–51.

[28] Saunyama I.G.M., Knapp M., Effect of pruning and trellising of tomatoes on red spider mite incidence and crop yield in Zimbabwe, Afr. Crop Sci. J. 11 (4) (2003) 269–277.

[29] Liu C.Z., Yan L., Wei L.X., Zhang F., Qian X.J., Effects of cutting on the population dynamics of main insect pests on alfalfa, J. Appl. Ecol. 19 (3) (2008) 691–694.

[30] Onillon J.C., Lutte biologique et intégrée dans les vergers de citrus en zone méditerranéenne, Biocontrol 33 (4) (1987) 481–494.

[31] Pearce S., Zalucki M.P., Does the cutting of lucerne (*Medicago sativa*) encourage the movement of arthropod pests and predators into the adjacent crop? Aust. J. Entomol. 44 (3) (2005) 219–225.

[32] Chaboussou F., Sur le processus de multiplication des acariens au Maroc, Fruits 336 (1970) 1–4.

[33] Daane K.M., William L.E., Manipulating vineyard irrigation amount to reduce insect pest damage, Ecol. Appl. 13 (6) (2003) 1650–1666.

[34] Chow A., Chau A., Heinz M., Reducing fertilization for cut roses: Effect on crop productivity and twospotted spider mite abundance, distribution, and management, J. Econ. Entomol. 102 (5) (2009) 1896–1907.

[35] Civantos M., Développement de la lutte intégrée dans les oliveraies espagnoles, Olivae 59 (1995) 75–81.

[36] Anon., Index phytosanitaire Maroc, Assoc. Maroc. Prot. Plantes (Ed.), Rabat, Maroc, 2009.