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DEVELOPING AN ACTION THRESHOLD FOR THE PERSEA MITE ON AVOCADO

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Oligonychus perseae was first discovered in Israel in the autumn of 2001 in several avocado plots located in the Western Galilee and has spread since to most of the growing areas. As no damage thresholds have been developed for this pest some growers will apply up to four acaricide applications per year, while others will not spray at all, often leading to extensive foliar damage. To reduce pesticide use on the one hand and to prevent damage to fruit quality and yield on the other, we set out the development of an action threshold for this pest. Towards this aim, we attempted to create different pest levels by applying acaricides (spirodiclofen and abamectin) at 50, 100, 250 mites/leaf and a non-sprayed control in a replicated block design for three consecutive years, 2004-2006, on Hass, evaluating the leaf damage and yields of 2005-2007. Based on cumulative mite days, the plots sprayed at 50 and 100 mites/leaf were similar and differed from the two higher levels, the latter pair also being similar. Mite population levels significantly affected leaf damage and mean tri-annual yields (2005-2007). At the higher threshold levels, mean yield was reduced by 20% in comparison to the mean yield attained when plots were sprayed at a threshold of 50-100 mites per leaf.

Key words: *Oligonychus perseae*, foliage damage, yield.

ESTABLECIMIENTO DE UN UMBRAL DE ACCIÓN PARA EL ÁCARO DE LA PALTA

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Oligonychus perseae fue por primera vez descubierto en Israel en el otoño del 2001 en algunos predios localizados en el oeste de Galilea y desde entonces se ha expandido por la mayoría de las áreas de producción. Ya que no se han desarrollado los umbrales de acción en relación al daño de esta plaga, algunos agricultores aplican hasta 4 pulverizaciones anuales con acaricida, mientras que otros no lo aplican, dejando a menudo extensas áreas con daño foliar. Para disminuir el uso de pesticidas por una parte, y prevenir el daño en la calidad de la fruta y producción por otra., establecimos un umbral de daño para esta plaga. Para lograr esto, procuramos crear diferentes niveles de la plaga aplicando acaricidas (abamectina y envidor) en 50, 100, 250 ácaros/hoja y un control no pulverizado en un diseño de bloques con replicas durante tres años consecutivos (2004-2006) sobre Hass, evaluando el daño foliar y rendimientos de 2005-2007. De acuerdo con los días acumulativos de acaro, los lotes que recibieron pulverizaciones con 50 y 100 ácaros/hoja fueron similares y se diferenciaron de los más altos niveles, el ultimo par también fue similar. Estos dos marcados niveles de población estacional afectan significativamente el daño en la hoja, pero no afectan el rendimiento en los primeros dos años del estudio (la producción de 2006-07 aún está siendo evaluada). En este punto creemos que es prematuro asumir que la plaga no afecta la producción. Posiblemente es necesario que pasen más años para que el efecto a largo plazo de la plaga sea observado. Se está llevando a cabo un ensayo adicional con bloques más grandes y con sólo dos niveles de daño para continuar monitoreando el efecto multianual de esta plaga. Los niveles poblacionales de ácaros afectaron significativamente el daño en la hoja y el promedio de la producción de tres años (2005-2007). En cuanto al mayor nivel de población de ácaros, el promedio de la producción se redujo en un 20% en comparación con el promedio de producción logrado cuando las parcelas fueron asperjadas con un umbral de 50-100 ácaros por hoja.

Plabras claves: *Oligonychus perseae*, umbral de daño, daño foliar, producción.

Introduction:

Oligonychus perseae, a pest of Avocado originating from Central America, was first discovered in Israel in the autumn of 2001 in several avocado plots located in the Western Galilee and has since spread to most of the growing areas. It has recently been reported from Spain and the Canary Islands. The mite was first documented as a pest in California in 1990, thereafter numerous studies were conducted in California on the pest's biology (Aponte and McMurtry, 1997), biological control (Hoddle *et al.*, 1999; Hoddle *et al.*, 2000; Kerguelen and Hoddle, 1999a), cultivar susceptibility (Kerguelen and Hoddle, 2000) and damage (Kerguelen and Hoddle, 1999b; Kerguelen and Hoddle, 1999a). Percent of leaf area damage (PLAD) in leaf drop (in 90% of leaves sampled) was equal to or above 7.5%, suggesting that leaves were more prone to drop if leaf damage reached or exceeded this level (Kerguelen and Hoddle, 1999a). Correlations between PLAD and number of mites per leaf indicated that this level of damage was approximately equal to 120 mites/leaf (Hoddle, 1998). However it must be stated that these researchers could not define a finite action threshold to prevent leaf drop. Furthermore no follow up studies were conducted to correlate leaf damage to yield. This lack of information has led Israeli growers to adopt very different tactics for persea mite control. Growers fearing leaf drop will apply up to four acaricide applications per year, while others taking on an apathetic approach to leaf damage, may not spray at all, often resulting in extensive foliar damage. To reduce pesticide use on the one hand and prevent damage to fruit quality and yield on the other we set out to develop an action threshold for this pest.

Methods and Materials:

General experimental design:

The experiment was conducted between the years 2004-2007 at Kibbutz Kefar Masaryk, Western Galilee, Israel on ‘Hass’. To obtain different levels of mite damage and to develop an action threshold, sub plots of three trees long plus a border tree (between subplots) and 3 rows wide were sprayed with spirodiclofen (ENVIDOR®SC) or abamectin (Agrimek®EC) when mite levels exceeded a designated threshold. As a starting point we chose a threshold of 100 mites/leaf, slightly lower than 120 mites/leaf, the level that was found to be associated with leaf drop (Hoddle, 1998; Kerguelen and Hoddle, 1999a). For comparison we additionally evaluated a lower threshold of 50 mites/leaf, a high threshold of 250 mites/leaf, along with a non-treated control. Treatments were arranged in a replicated block design, blocked by row, replicated six times.

Monitoring the pest:

Pest mite populations were monitored from March 2004 through March 2007, once a month during the cooler months of December-March, and fortnightly during the rest of the year, taking a sample of 10 leaves per site. Pest mites were counted in situ with an 8X lens using the fast field counting method developed by Machlitt (1998). Mite days (of all motile stages) for two consecutive counts were calculated by multiplying the mean number of mites by the number of days between counts. Summing these mites day over a season gave the seasonal cumulative mite days (CMDs).

Foliar and fruit damage evaluation:

For assessment of foliar damage, at harvest 20 leaves were sampled from each site and their abaxial surfaces scanned with an optical bed scanner (HP Office jet 5510) at 600 dpi, 24 bit color resolution. The white back of the scanner allowed for clear separation between the background and the prominent colors of the healthy and damaged leaves. The scanned images were saved in a lossless JPG format and subsequently analyzed with proprietary software, LeafColorAnalyzer, developed at the Institute of Agricultural Engineering, Agricultural Research Organization (ARO), Israel. The color range of healthy and damaged leaves was determined in the RGB space using sample images of avocado leaves. Healthy leaf areas were characterized by RED/GREEN >1 & RED/BLUE >1, whereas damaged leaf areas were characterized by RED/GREEN <1 & GREEN/BLUE >1. These rules were then applied to separate between healthy and damaged areas allowing for the calculation of the percent of leaf area damaged (PLAD). Fruit parameters, namely, number of fruit, fruit size and total yield were obtained by harvesting once per season, picking each subplot separately into marked bins and sorting on a small automated line at the packing house of the Western Galilee.

Statistical Analysis:

As a first step we tested whether the action thresholds had a significant effect on seasonal CMDs for each year. We then evaluated the effect of the thresholds, that differed significantly, on annual, biannual and three year yields. These ANOVAs were performed using the 'Fit Model' procedure in JMP (5.0.1) taking into account the block effect of the rows. Linear regression was used to evaluate the effect of CMDs on foliar damage and annual yield using the three year data set.

Results and Discussion:

As could be expected the acaricide treatments applied at the different action thresholds significantly affected CMDs in all three years (2005-$F_{3,14}$=98.28, P<0.0001; 2006-$F_{3,14}$=4.62, P=0.0190; 2007-$F_{3,14}$=21.39, P<0.0001; 2005-2007-$F_{3,14}$=66.72, P<0.0001). However mean separations showed that the two lower thresholds, sprayed at 50 and 100 mites/leaf never differed significantly, these generally differing from the high and control plots, except for 2006 (Figure 1). To determine whether the two lower thresholds significant improved yields we conducted an additional analysis comparing the CMDs and yields of the lower mite levels (low-medium) to the higher ones (high-control). We assumed that grouping together the two higher levels was justified because mites populations rarely exceeded the 250 mites/leaf. Using this grouping, CMDs of the low-medium differed very significant from the high-control plots for all three years (2005-$F_{1,16}$ =61.42, P<0.0001; 2006-$F_{1,16}$=12.34, P=0.0029; 2007-$F_{1,16}$=35.39, P<0.0001) (Figure 2 charts a, b and c). In contrast annual yields only differed significantly in 2005 ($F_{3,14}$=5.09, P<0.0383, Figure 2 chart d) when mean CMDs for the high-control threshold almost reached 19,000. In 2006 and 2007 CMD levels in these plots did not exceed 11,500 CMDs with no significant difference in annual yields (2006-$F_{3,14}$=0.21, P=0.657, Figure 2 chart e; 2007-$F_{3,14}$=2.41, P=0.14, Figure 2 chart f).

It has been shown in the literature that spider mite CMDs of one year can affect the return yield of the following year in apples (Beers and Hull, 1990; Palevsky *et al.*, 1996). We were therefore interested to evaluate the bi-annual and tri-annual mean yields which take into account both alternate bearing and the cumulative load of multi-annual CMDs. For 2005-2006 mean bi-annual yields did not differ significantly ($F_{1,16}$ =3.07, P=0.099) but mean tri-annual yield of 2005-2007 did ($F_{1,16}$ =5.67, P=0.030) with a substantial 20% decrease in yield (53 versus 66 kg/tree).

While the Linear regressions for leaf damage vs. CMDs and yield vs. CMDs were both significant (Figure 3) the regression coefficient for leaf damage (r=0.738) was substantially higher than that of yield (r=0.254). Clearly mite infestation is only one of many factors affecting yield, having said that, it is interesting to note that beyond 16000 CMDs yields were always very low. To the best of our knowledge this is the first time that yield reductions have been correlated to *O. perseae* CMDs. This result has a number of implications. The first being that *O. perseae* is an economic pest that must be dealt with. Second an action threshold of 50-100 mites/leaf can be adopted, at least as a starting point, future refining of this action threshold can be expected. Third, the damage threshold found in this study can be used to assess the degree of success of integrated control programs, such as conservation and augmentation of mite predators.

Literature Cited:

Aponte O. and McMurtry J. A. 1997. Biology, life table and mating behavior of *Oligonychus perseae* (Acari: Tetranychidae). International Journal of Acarology 23: 199-207.

Beers E. H. and Hull L. A. 1990. Timing of mite injury affects the bloom and fruit development of apple. Journal of Economic Entomology 83: 547-551.

Hoddle M. S. 1998. Biology and management of the persea mite. California Avocado Society Yearbook 82: 75-85.

Hoddle M. S., Aponte O., Kerguelen V. and Heraty J. 1999. Biological control of *Oligonychus perseae* (Acari: Tetranychidae) on avocado: I. Evaluating release timings, recovery and efficacy of six commercially available phytoseiids. International Journal of Acarology 25: 211-219.

Hoddle M. S., Robinson L. and Virzi J. 2000. Biological control of *Oligonychus perseae* (Acari: Tetranychidae) on avocado: III. Evaluating the efficacy of varying release rates and release frequency of *Neoseiulus californicus* (Acari: Phytoseiidae). International Journal of Acarology 26: 203-214.

Kerguelen V. and Hoddle M. S. 1999a. Biological control of *Oligonychus perseae* (Acari: Tetranychidae) on avocado: II. Evaluating the efficacy of *Galendromus helveolus* and *Neoseiulus californicus* (Acari: Phytoseiidae). International Journal of Acarology 25: 221-229.

Kerguelen V. and Hoddle M. S. 1999b. Measuring mite [*Oligonychus perseae*] feeding damage on avocado leaves with automated image analysis software. Florida Entomologist 82: 119-122.

Kerguelen V. and Hoddle M. S. 2000. Comparison of the susceptibility of several cultivars of avocado to the persea mite, *Oligonychus perseae* (Acari: Tetranychidae). Scientia Horticulturae 84: 101-114.

Palevsky E., Oppenheim D., Reuveny H. and Gerson U. 1996: Impact of European red mite on Golden Delicious and Oregon Spur apples in Israel. Experimental and Applied Acarology 20: 343-354.

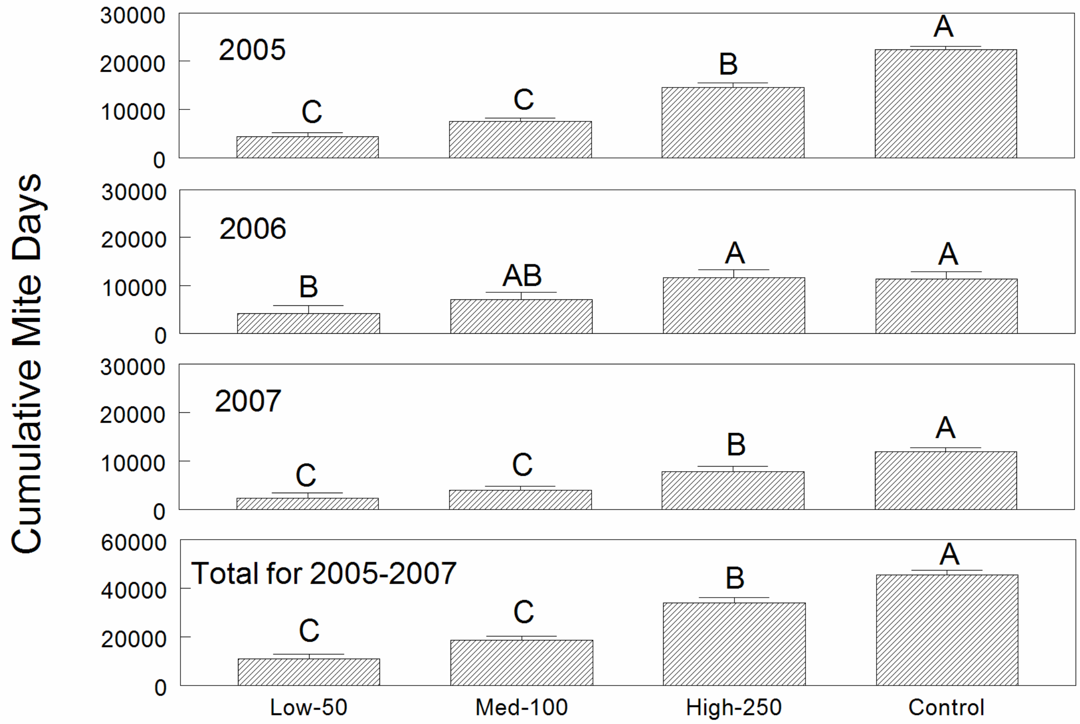

Figure 1: Cumulative mite days (CMDs) of *Oligonychus perseae* for the three action thresholds in comparison to the control. Different letter within the same season (or group of seasons) indicate a significant difference in CMDs between threshold, α=0.05.

Figure 1: Acumulación ácaros días (AADs) de *Oligonychus perseae* para tres umbrales de acción en comparación con el control. Diferentes letras dentro de la misma estación (o grupo de estaciones) indica una diferencia significativa en AADs entre umbrales, α=0.05.

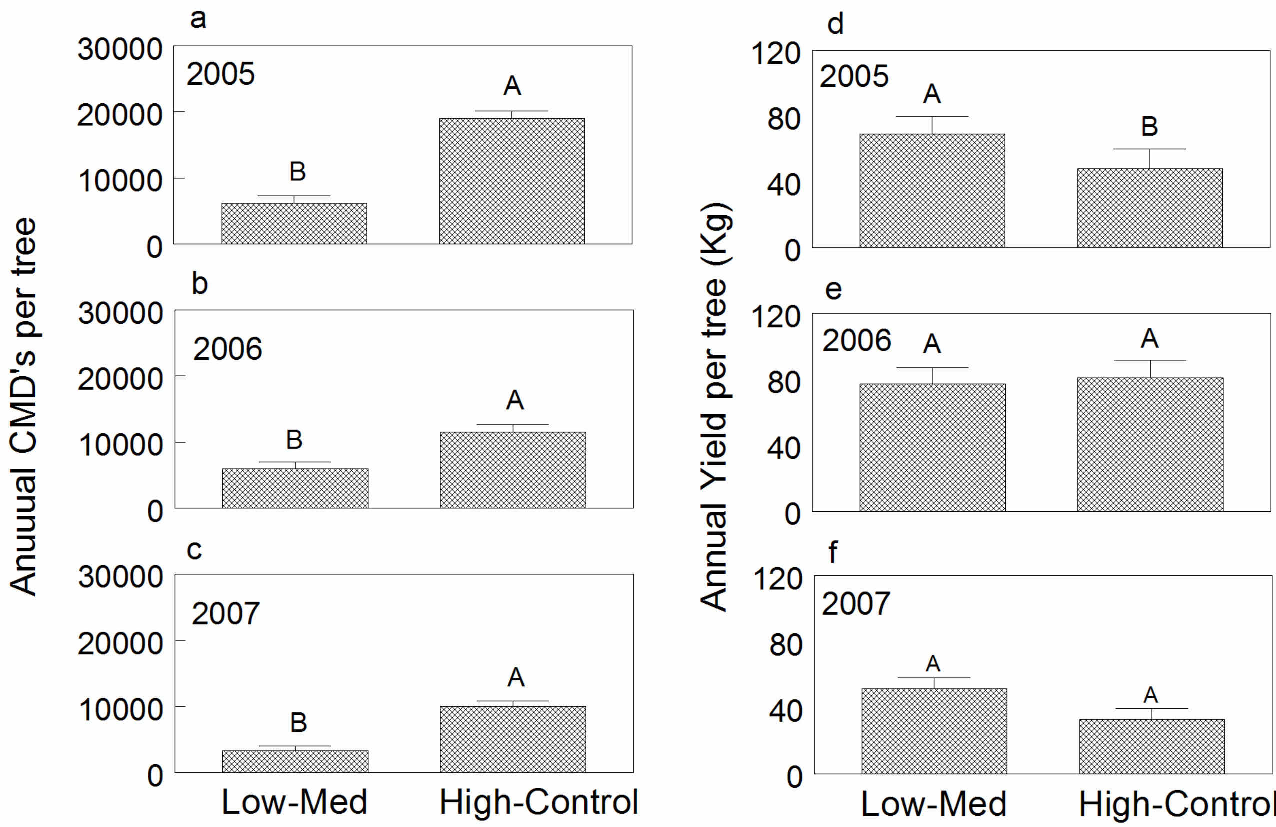

Figure 2: Charts a, b and c -Cumulative mite days (CMDs) of *Oligonychus perseae* for the Low-Med thresholds vs. the High threshold and control for 2005 through 2007, respectively. Charts d,e and f – Annual yields for the Low-Med thresholds vs. the High threshold and control for 2005 through 2007, respectively. Different letter within the same season indicate a significant difference in CMDs between threshold, α=0.05.

Figure 2: Grafico a, b y c –Acumulación ácaros días (AADs) de *Oligonychus perseae* para el umbral Bajo-Medio vs. el umbral alto y control para el 2005 hasta el 2007, respectivamente. Gráficos d, e y f – Producción anual para el umbral Bajo- Medio vs. el umbral Alto y el control para el 2005 hasta el 2007, respectivamente. Diferentes letras dentro de la misma estación (o grupo de estaciones) indica una diferencia significativa en AADs entre umbrales, α=0.05.

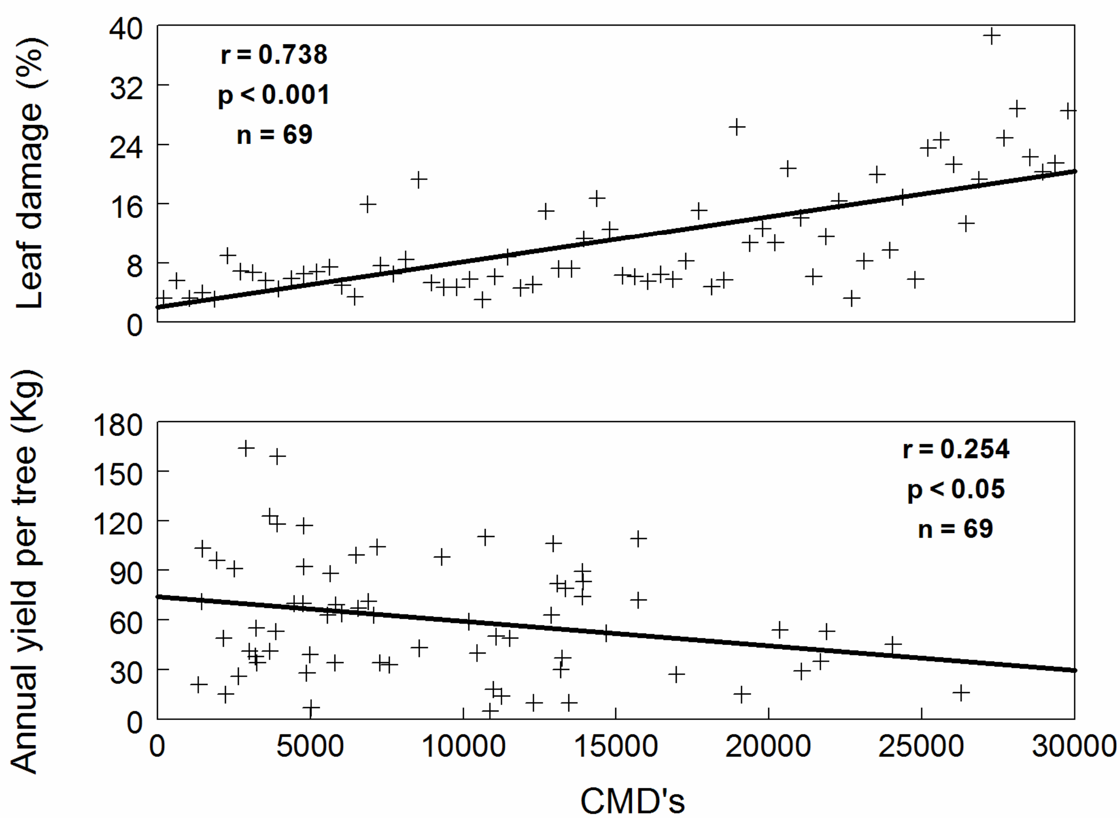

Figure 3: Linear regression for annual leaf and yield damage as a function of cumulative mite days (CMDs) of *Oligonychus perseae*.

Figure 3: Regresión lineal anual para daños en las hojas y en la producción como una función acumulativa de ácaros días (AADs) de *Oligonychus perseae*.