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Authors: Manrique, Veronica, Montemayor, Cecil O., Cave, Ronald D., Skvarch, Edward A., and Smith, Bradley W.

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EFFECT OF STRAW MULCH ON POPULATIONS OF MICROTHECA OCHROLOMA (COLEOPTERA: CHRYSOMELIDAE) AND GROUND PREDATORS IN TURNIP BRASSICA RAPA IN FLORIDA

VERONICA MANRIQUE1, CECIL O. MONTEMAYOR2, RONALD D. CAVE1, EDWARD A. SKVARCH1 AND BRADLEY W. SMITH1
1University of Florida, Indian River Research and Education Center, 2199 South Rock Road, Fort Pierce, FL 34945
2St. Lucie Co. Cooperative Extension Service, University of Florida, 8400 Picos Rd., Fort Pierce, FL 34945

ABSTRACT

Microtheca ochroloma Stål (Coleoptera: Chrysomelidae), the yellow-margined leaf beetle, is a serious pest of crucifer crops in the southeastern USA. The objective of this study was to investigate the effect of straw mulch on the abundance of M. ochroloma and ground predators in turnips in Florida, and subsequent influence on crop damage and yield. Eight plots (5 m long × 9 m wide) were established, and each plot consisted of 5 beds with 10 turnip plants each (50 turnips per plot). An 8-10-cm layer of straw mulch was applied by hand 2 d after planting to half of the plots in a complete randomized block design. The abundance of M. ochroloma and other insect herbivores were recorded twice weekly from Mar 13 to Apr 24, 2009. In addition, 3 pitfall traps per plot were used for sampling predatory arthropods during each sampling period. Higher numbers of M. ochroloma were found in plots with mulch compared to plots with no mulch, whereas greater numbers of ground predators were obtained in the no mulch treatment. The most abundant predators found in pitfall traps were ants, earwigs, and spiders, while lower numbers of predatory beetles were recorded. At the end of the experiment, greater leaf biomass (dry weight) was obtained from turnip plants grown in plots with straw mulch, but those plants suffered greater herbivory since the leaf area removed was greater in that treatment. Mean weight of tubers did not vary significantly between treatments. In conclusion, the use of straw mulch as a pest management option for M. ochroloma in crucifer crops on organic farms is not recommended.

Key Words: organic mulch, insect populations, cultural control, yellow-margined leaf beetle, pitfall traps

RESUMEN

El escarabajo de la hoja, Microtheca ochroloma Stål (Coleoptera: Chrysomelidae), es una plaga importante de cultivos de crucíferas en el sudéste de los Estados Unidos. El objetivo de este estudio fue investigar el efecto de la cobertura de heno en la abundancia de M. ochroloma y los depredadores de suelo en cultivos de nabo en Florida, y el subsecuente daño foliar y el rendimiento del cultivo. Se establecieron 8 parcelas (5 m de largo × 9 m de ancho) y cada parcela estuvo compuesta de 5 camas con 10 plantas de nabo cada una (50 plantas por parcela). Dos días luego de haberse plantado el cultivo, se agregó una cobertura muerta de heno de 8-10 cm de ancho a la mitad de las parcelas siguiendo un modelo de bloques aleatorizados. La abundancia de M. ochroloma y de otros insectos herbívoros fueron evaluadas 2 veces por semana desde marzo 13 hasta abril 24 de 2004. También se utilizaron trampas de intercepción o "pitfall traps" (3 por parcela) para la captura de artrópodos depredadores durante cada muestreo. Se encontró mayor número de M. ochroloma en las parcelas con cobertura de heno en comparación con las parcelas sin cobertura; mientras que los depredadores de suelo fueron más abundantes en las parcelas sin cobertura. Hormigas, tijeretas, y arañas fueron los depredadores más abundantes capturados en las trampas de intercepción. Al final del experimento, se obtuvo mayor biomasa foliar (peso seco) en las plantas de nabo provenientes de las parcelas con cobertura de heno. Sin embargo, éstas plantas sufrieron un mayor daño dado que el área de la hoja removida fue mayor en ese tratamiento. El promedio de peso de los tubérculos no varió significativamente entre tratamientos. En conclusión, no se recomienda el uso de la cobertura de heno para el manejo de M. ochroloma en cultivos de crucíferas en granjas orgánicas.

Translation provided by the authors.
M. ochroloma was studied by Ameen & Story (1997a, b). Larvae and adults are defoliators that feed only on plants in the family Brassicaceae. Preferred hosts are turnips, mustard, radish, watercress, and Chinese cabbage, while less preferred hosts include cabbage and cauliflower (Chamberlin & Tippins 1949; Ameen & Story 1997b).

There are at least 497 organic farms in Florida involved in the production of crucifer vegetables (Florida Organic Grower 2008). However, many growers have reduced the proportion of crucifer crops as a consequence of damage by M. ochroloma (Bowers 2003). This pest is a serious problem from Oct to Apr, which corresponds to the primary growing season for organic farmers in many parts of Florida (Capinera 2001). Damage caused by M. ochroloma prevents the growers from selling high quality products, thus resulting in significant economic losses. Management of M. ochroloma is usually achieved with foliar insecticides (Capinera 2001), which are not an option for organic farmers. Management by cultural control has received limited study. According to Bowers (2003), intercropping mizuna (Brassica rapa rapifera, Seven Top) (2 weeks old) were transplanted to the field on Mar 10, and an 8-10-cm thick layer of dried straw mulch was applied by hand 2 d later to half of the plots. The straw mulch (Bahia hay, Fair-Us Tractor Service, Okeechobee, FL) was 3 months old when the experiment started. Eight plots (5 m long × 9 m wide) separated by at least 10 m were arranged in a complete randomized block design. Each plot consisted of 5 beds separated by 1 m. Ten turnip plants were planted with a spacing of 50 cm in each bed (50 turnips per plot).

Sampling Ground Predators

A pitfall trap consisting of a plastic cup (9 cm diameter at soil surface, 12 cm depth) was placed in each of the 3 inner beds of each plot (3 traps per plot). Traps were half-filled with soapy water and checked twice weekly from Mar 13 to Apr 24. The arthropods from each trap were preserved in separate vials with 75% EtOH. All predators were counted and identified to order or family.

Foliar Damage and Yield

At the end of the experiment (Apr 24), 6 randomly selected turnip plants from each plot were collected and brought to the laboratory. One new leaf and 1 older leaf were selected randomly from each plant and the leaf area consumed per leaf was determined by scanning each leaf and measuring the total area removed by herbivory with the software Image-J (http://rsb.info.nih.gov). New leaves were those that ranged from 10 to 15 cm in length, and older leaves were those ranging from 30 to 35 cm. Fresh weight of the tuber and dry weight of all leaves were recorded for each plant.
Data Analysis

Repeated measure analysis of variance was used to compare the abundance of *M. ochroloma*, total herbivores, predators per taxon, and total predators between treatments (mulch versus no mulch) over time. Data for each predator were combined for all dates because there were no interactions (treatment × time effect), except for earwigs and spiders, which were analyzed by single factor analysis of variance for each date. Leaf area consumed and yield were compared between treatments by single factor analysis of variance. Means were separated with the Student–Newman–Keuls (SNK) test (SAS Institute, 1999). A significance level of \( \alpha = 0.05 \) was used for all statistical analyses. Means are reported with their standard error.

**RESULTS**

**Insect Herbivores**

Differences were detected in the number of *M. ochroloma* found between treatments over time, with a significant interaction between treatment and time (\( F = 3.65, df = 11, 95, P = 0.0005 \)). When analyses were conducted separately for each date, higher numbers of *M. ochroloma* were found in plots with mulch compared to plots with no mulch (Fig. 1). Other insect herbivores found on turnip plants included aphids, several lepidopteran species, and other leaf beetles. However, no significant differences between treatments were detected for total number of herbivores per plant (~28 per plant) (treatment × time: \( F = 1.24, df = 11, 95, P = 0.27 \); treatment: \( F = 1.48, df = 1, 95, P = 0.22 \)). Aphids were the most abundant insect herbivore in Mar, whereas *M. ochroloma* was the most abundant herbivore in Apr. The high numbers of *M. ochroloma* (20-28 per plant) recorded in Apr may not correspond to natural infestations since adults were released in each plot at the beginning of the experiment.

**Ground Predators**

Higher numbers of predators (each predator taxon and total predators) were recorded in the no-mulch treatment compared with the mulch treatment (Table 1). Fewer predatory beetles (ground beetles, Carabidae; rove beetles, Staphylinidae; and lady beetles, Coccinellidae) were captured compared with the higher numbers of ants (Formicidae), earwigs (Dermaptera), and spiders (Araneae). Overall, significantly more ground beetles and rove beetles were captured in traps in the no mulch treatment versus the mulch treatment. No significant difference in abundance of lady beetles between treatments was detected on any date. Significant treatment × time effect interactions were observed for earwigs and spiders; therefore, data were analyzed separately for each date. Significantly more earwigs were recorded in the no-mulch treatment on all but 2 of the 13 sampling dates (\( P < 0.05 \)). For spiders, significantly higher numbers were recorded from the traps in the no-mulch treatment on 5 of the sampling dates (\( P < 0.05 \)); on all but 2 dates for which there was no significant difference between treatments, more spiders were noted in the no-mulch treatment.

**Foliar Damage and Yield**

Leaf area consumed from new turnip leaves was greater in plants from plots with straw mulch (mean = 4.1 ± 0.4 cm²) compared to those from plots without mulch (mean = 2.0 ± 0.5 cm²) (\( F = 9.09; df = 1, 7; P = 0.02 \)). However, no differences were detected between treatments for damage to older leaves (no-mulch treatment mean = 5.6 ± 1.5 cm², mulch treatment mean = 8.4 ± 1.4 cm²) (\( F = 1.88; df = 1, 7; P = 0.22 \)). Similar mean tuber weights were recorded for turnips in the no-mulch (mean = 130.7 ± 24.9 g) and the straw mulch (mean = 145.9 ± 18.1 g) treatments (\( F = 0.25; df = 1, 47; P = 0.62 \)). However, greater dry leaf weight was obtained for turnips in the straw mulch treatment (mean = 142.9 ± 16.4 g) compared with the no-mulch treatment (mean = 97.8 ± 9.5 g) (\( F = 5.66; df = 1, 47; P = 0.02 \)).

**DISCUSSION**

Our study shows that the use of straw mulch does not provide a means for adequately controlling populations of *M. ochroloma* in turnips. Moreover, greater pest populations occur in plots with straw mulch compared to plots without mulch during Mar and Apr 2009. These data suggest that adults of *M. ochroloma* are able to suc-
cessfully locate and recognize their host plants growing in straw mulch and that the pest population increases following colonization. Similarly, other pests, for example the squash bug, Anasa tristis (DeGeer), and the American palm cixiid, Myndus crudus Van Duze, are favored by the use of organic mulches (Howard & Oropeza 1998; Cranshaw et al. 2001). In contrast, the use of organic mulches in other cropping systems has resulted in a decrease in pest populations. This has been observed for the onion thrips, Thrips tabaci Lindeman, in onions (Larentzaki et al. 2008), the onion thrips, Thrips tabaci, and spiders, while lower numbers of predatory predators in pitfall traps were ants, earwigs, lady beetles, rove beetles, and ground beetles. Other factors that may affect pest and predator populations are differences in plant quality and soil moisture. For example, turnip plants in the plots with straw mulch were larger (more leaf biomass), thus presenting higher quality host plants to the pest.

The commercially valuable part of a turnip crop is the tubers and leaves that are sold in fresh markets. Although greater leaf biomass was obtained from turnip plants grown in plots with straw mulch, those plants suffered greater damage since the leaf area removed by herbivory was greater in plots with straw mulch compared to plots without mulch. Thus, the damaged leaves cannot be marketed and must be discarded, thereby resulting in lower yield from a turnip crop grown in straw mulch. The increase in leaf damage was correlated with the increase of M. ochroloma population in the straw mulch treatment, which highlights the importance of this pest as an economically important defoliator of turnips and other leafy green crucifer crops. Although our study was conducted during 1 growing season in 2009, the trends observed in the abundance of insect populations between treatment plots were quite significant. For example, there was a two-fold increase in M. ochroloma populations in the plots with straw mulch compared to the plots without mulch.

In conclusion, the use of straw mulch as a pest management option for M. ochroloma in crucifer crops on organic farms is not recommended. More appropriate management tactics that are environmentally-friendly and effective in reducing susceptible to predation by ground predators, whereas in plots with the structurally complex straw mulch the larvae and adults can easily hide and escape predation from the fewer ground predators. Other factors that may affect pest and predator populations are differences in plant quality and soil moisture. For example, turnip plants in the plots with straw mulch were larger (more leaf biomass), thus presenting higher quality host plants to the pest.

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pest populations (e.g., biological control) should be evaluated to help organic farmers in Florida and elsewhere.

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