BioOne COMPLETE

Field Evaluation of Petroleum Spray Oil and Carbaryl Against Tetranychus marianae (Acari: Tetranichidae) on Eggplant

Authors: Reddy, Gadi V. P., and Miller, Ross H.

Source: Florida Entomologist, 97(1) : 108-113

Published By: Florida Entomological Society

URL: https://doi.org/10.1653/024.097.0115

BioOne Complete (complete.BioOne.org) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at www.bioone.org/terms-of-use.

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

Downloaded From: https://complete.bioone.org/journals/Florida-Entomologist on 28 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

FIELD EVALUATION OF PETROLEUM SPRAY OIL AND CARBARYL AGAINST *TETRANYCHUS MARIANAE* (ACARI: TETRANICHIDAE) ON EGGPLANT

GADI V. P. REDDY[1]* AND ROSS H. MILLER[2]

[1]Western Triangle Agricultural Research Center, Montana State University, 9546 Old Shelby Rd., Conrad, MT 59425, USA

[2]Western Pacific Tropical Research Center, College of Natural and Applied Sciences, University of Guam, Mangilao, Guam 96923, USA

*Corresponding author; E-mail: reddy@montana.edu

ABSTRACT

Tetranychus marianae McGregor (Acari: Tetranychidae) is a pest of several perennial crops and is widespread in the Pacific Basin, including the Mariana Islands where it was first reported. The mite is also present in the West Indies, Bahamas, southern USA, Nicaragua, Argentina, Brazil and Southeast Asia. Eggplant growers apply carbaryl 10 to 15 times against this pest during each cropping period. Some growers no longer cultivate eggplant and tomato because of uncontrollable mite infestations. Previous indoor studies have shown petroleum spray oil (PSO) to be effective against *T. marianae*. We therefore examined the comparative effectiveness of PSO (Sun-spray 6E®) at the rate of 5mL/liter, and carbaryl at the rate of 1.5 mL/liter, against *T. marianae* on eggplant at 2 locations in Guam. The mean percentages of mite infested leaves and the population densities of *T. marianae* at both the locations were significantly higher in control plots than in treatment plots. PSO treatments with 6 and 15 sprays more effectively reduced the number of *T. marianae*-infested leaves and populations of *T. marianae* than carbaryl treatments. Marketable yields of eggplant from PSO treated plots were significantly higher than from the other plots. We recommend 6 applications of PSO at 15, 25, 35, 45, 55 and 65 days of after transplanting for managing *T. marianae* on eggplant.

Key Words: integrated control, *Tetranychus marianae*, carbaryl, petroleum spray oil, eggplant

RESUMEN

Tetranychus marianae McGregor (Acari: Tetranychidae) es una plaga de varios cultivos perennes y está muy extendida en la Cuenca del Pacífico, incluyendo las Islas Marianas, desde donde se informó por primera vez. El ácaro también está presente en las Antillas, Bahamas, el sur de Estados Unidos, Nicaragua, Argentina , Brasil y el sudeste de Asia. Los productores de berenjena se aplican carbaril de 10 a 15 veces durante cada período de cultivo. Como resultado, algunos productores ya no cultivan berenjena y tomate, debido a las infestaciones por ácaros incontrolables . Los estudios anteriores han demostrado interiores aceite en aerosol de petróleo (PSO) para ser eficaz contra *T. marianae*. Tanto, nuestro estudio la efectividad comparativa de PSO (Sun -spray 6E ®), a razón de 5mL/liter y carbaril a razón de 1.5 mL / litro, frente a *T. marianae* de berenjena en dos localidades de Guam. La media del porcentaje de hojas infestadas de ácaros y la densidad de población de *T. marianae* tanto en los lugares fueron significativamente mayores en las parcelas de control que en las parcelas de tratamiento. Tratamientos PSO con seis y quince sprays de manera más eficaz el número de hojas de *T. marianae* infestadas y las poblaciones de *T. marianae* que los tratamientos carbaril . Los rendimientos negociables de berenjena de PSO parcelas tratadas fueron significativamente más altos que los de las otras parcelas. Recomendamos seis aplicaciones de PSO a los 15, 25, 35, 45, 55 y 65 días de después del trasplante de la gestión *T. marianae* en berenjena.

Palabras Clave: control integrado, *Tetranychus marianae*, carbaril, aceite en aerosol petróleo, berenjena

Downloaded From: https://complete.bioone.org/journals/Florida-Entomologist on 28 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

The red spider mite, *Tetranychus marianae* McGregor (Acari: Tetranychidae), is a severe pest on vegetables and ornamental plants in the Mariana Islands (Reddy et al. 2011) where it feeds and reproduces year round (Moraes et al. 1987; Reddy et al. 2013). The climate of the Mariana Islands is hot and humid year round, resulting in high mite populations and severe damage to eggplant (*Solanum melongena* L.; Solanales: Solanaceae) and tomato (*Solanum lycopersicum* L.; Solanales: Solanaceae) (Reddy & Tangtrakulwanich 2013). Even low numbers of mites cause visible leaf damage on vegetables and ornamentals (Reddy & Bautista 2012). Initial damage causes slight spotting on the leaves (Denmark 1970). As feeding continues, leaves become chlorotic and covered in webbing (Oatman et al. 1967). Extensive webbing may cover leaves, twigs, and fruit, with leaves eventually dropping from the plant (Noronha 2006). Leaf loss may significantly reduce yields of eggplant and tomato (Reddy et al. 2013; Reddy & Tangtrakulwanich 2013).

Some eggplant growers in the Mariana Islands apply between 10 and 15 chemical insecticide applications per cropping period, often resulting in the development of resistance in mite populations. Some eggplant growers apply the readily available carbaryl indiscriminately. Many farmers in the Western Pacific have ceased eggplant and tomato cultivation because of their inability to control mites. Extensive survey work on mites has been conducted on several crop and ornamental plants on Guam at the insistence of the Guam Department of Agriculture and with funding from multiple agencies. Subsequent surveys have confirmed the severe damage caused by *T. marianae* to vegetable crops (Reddy et al. 2011). The present study extends this work by developing an integrated approach to *T. marianae* control.

Reddy et al. (2013) reported that eggplant plots sprayed with petroleum spray oil (PSO) at a threshold of 2 or 4 mites/leaf in the dry season and at 2-8 mites/leaf during the wet season experienced significantly less leaf damage. Similarly on tomato, based on *T. marianae* infested leaves, the population density of and degree of plant damage caused by *T. marianae* on tomato was significantly reduced when experimental plots were sprayed at a threshold of 8-12 mites/leaf in the dry season and at 8-14 mites/leaf during the wet season (Reddy & Tangtrakulwanich 2013).

Reddy & Bautista (2012) reported that combining the predatory mite *Neoseiulus californicus* (Evans) (Acari: Phytoseiidae) with petroleum spray oils (Volck® oil spray) produced significant control of *T. marianae* while not affecting the survival of *N. californicus*. Further, they reported that integrating petroleum spray oil with releases of *N. californicus* resulted in better control of *T. marianae* than did utilizing *N. californicus* alone. The optimum release rate of *N. californicus* against *T. marianae* populations was 200 *N. californicus* per plant. Subsequently, *N. californicus* was successfully released and established on Guam (Reddy & Bautista 2012). However, *N. californicus* can be seen only in some parts of Guam and several more years may be required for the populations to build-up sufficiently to adequately control *T. marianae*.

Because PSO effectively controlled *T. marianae* and was not detrimental to *N. californicus*, the present study compared the effectiveness of PSO against *T. marianae* on eggplant on Guam compared to carbaryl sprays long used by Guam's farmers.

Materials and Methods

Eggplant Seedlings

Seeds of the eggplant variety 'Pingtung Long' (Known-You Seed, Co., Ltd., Kaohsiung, Taiwan) were sown in 40 × 30 cm trays and raised in a shade house (30-32 °C, 60–80% RH, 14 : 10 h L:D). The seedlings were grown in culture for 40 days.

Experimental Locations

Duplicate experiments were conducted at the University of Guam Agricultural Experiment Stations at Yigo (N 13° 31.930' E 144° 52.351') in northern Guam and at the Inarajan Experiment Station (N 13° 61.963' E 144° 45.353') in southern Guam. Treatment plots measured 6 m × 6 m and were arranged in a randomized block design and separated from other plots by 1.0 m buffer zones to prevent spray drift. Forty day-old eggplant seedlings were transplanted with 75 cm between rows and 50 cm between plants within each row. Eight spray treatments were employed and replicated 3 times for a total of 30 individual plots. Each plot consisted of 10 rows of 15 eggplant seedlings, for a total of 150 plants per plot. Fertilizer was applied according to published recommendations (Schlub & Yudin 2002). The entire experimental design was repeated from May-Aug 2012 at Yigo and from Jun-Sep 2013 at Inarajan.

Treatment Procedures

Seven chemical application treatments and a water spray and no spray control were applied to plots (Table 1). Concentrations of chemical applications were: Sun-spray 6E® (Sunoco, Inc. R&M, Philadelphia, Pennsylvania; active ingredients: refined petroleum distillate: 98.8 wt % + emulsifier: 1.2 wt %) at 5mL/liter and carbaryl (50% wettable powder, AllPro, St. Joseph, Missouri) at 1.5 mL/liter. Carbaryl spraying corresponded to the set time intervals normally practiced by Guam farmers.

The amount of solution sprayed per application was 80 L/ha for small plants (up to 45 DAT) and 185.0 L/ha for larger ones (45 DAT until har-

Downloaded From: https://complete.bioone.org/journals/Florida-Entomologist on 28 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

TABLE 1. NUMBER AND TIMING OF VARIOUS PETROLEUM OIL AND CARBARYL TREATMENTS CARRIED OUT ON EGGPLANT FIELDS AGAINST THE RED SPIDER MITE AT YIGO AND INARAJAN, GUAM.

Treatment	Timing of applications (days after transplanting)
Control (no spray)	—
Control (water spray)	—
Three sprays of petroleum spray oil (PSO)	15, 35 and 55
Six sprays of PSO	15, 25, 35, 45, 55 and 65
Fifteen sprays of PSO	15, 25, 35, 45, 55, 65, 75, 85, 95, 105, 115, 125, 135, 145 and 155 (the growers practice)
Three sprays of carbaryl	15, 35 and 55
Six sprays of carbaryl	15, 25, 35, 45, 55, and 65
Fifteen sprays of carbaryl	15, 25, 35, 45, 55, 65, 75, 85, 95, 105, 115, 125, 135, 145 and 155
Four carbaryl sprays and four PSO sprays (rotational)	15, 35, 55, 75, 25, 45, 65, and 85

vest). All chemical applications were made with motorized backpack sprayers (Solo Brand; Forestry Suppliers, Jackson, Mississippi) equipped with an adjustable, flat spray, hollow cone, and a jet stream nozzle.

Sampling Method for *Tetranychus marianae* Populations

To determine *T. marianae* population levels, 3 leaves from each of 10 plants were randomly selected in each plot beginning and ending when, especially with respect to days after transplanting. One leaf was selected each from the top, middle and bottom level of the plant (Reddy et al. 2013). The number of mites present on the underside of each leaf was counted using a magnifying lens. Counts were performed at weekly intervals. The number of leaves infested by *T. marianae* per plot was recorded out of 30 randomly selected leaves counted in each plot. At harvest, yield was recorded for each treatment plot for 12 weeks. Data were averaged and expressed as the number of mites per leaf, the percent of infested leaves and yield in tonnes per hectare.

Statistical Analysis

Data for the numbers of mites per leaf and infested leaves on 10 plants per plot and overall yield levels in different treatments were analyzed using repeated measures ANOVA ($P < 0.05$) over multiple dates, and differences between treatments means were compared using the LSD test. All statistical analyses were carried out using SAS Version 9.3 (SAS Institute 2009). The 5% levels of significance were used for all analyses.

RESULTS

Damage and Yield Assessment in the Experimental Plots

Mean percentage of mite infested leaves and the population density of *T. marianae* at both locations were higher in control plots than in the treatment plots ($F_{8, 34} = 11.21$, $P < 0.05$) (Figs. 1 and 2). PSO treated plots with 6 and 15 sprays significantly reduced the number of *T. marianae*-infested leaves ($F_{9, 18} = 12.7$, $P < 0.05$; Fig. 1) and the populations of *T. marianae* ($F_{9, 28} = 26.2$, $P < 0.05$; Fig. 2) over the carbaryl treated plots and both controls at both locations.

Control plots suffered the greatest damage from *T. marianae*. Results from all other treatments were intermediate. The marketable eggplant yield from the plots sprayed with PSO 6 or 15 times were significantly greater at both locations than those in other treatments ($F_{9, 32} = 7.64$, $P < 0.05$) (Fig. 3). The treatment combination of PSO + carbaryl was moderately effective but significantly better than the control.

DISCUSSION

Eggplant growers in the Mariana Islands usually apply carbaryl as many as 10 to 15 times during each cropping period. This is not only extremely expensive but also poses ecological and toxicological hazards. Carbaryl is also known to cause abrupt outbreaks in mite populations (Mathew et al. 1995). The current carbaryl-dependent mite management program used by growers probably causes the extreme mite pest problems on eggplant (Goyal 1982; Reddy 2001). There are no other pesticide options for Guam farmers, and carbaryl is readily available over the counter throughout the island.

Although carbaryl was more effective than control treatments, it was apparent that the number of infested leaves and populations of *T. marianae* had increased with the increase in number of carbaryl applications (Figs. 1 and 2). Because carbaryl is a broad-spectrum insecticide, it kills beneficial natural enemies of mites as well as the mites themselves (Wilkinson et al. 1975; Karban & Zalom 1998). Carbaryl overuse may lead to outbreaks of aphids and

Downloaded From: https://complete.bioone.org/journals/Florida-Entomologist on 28 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

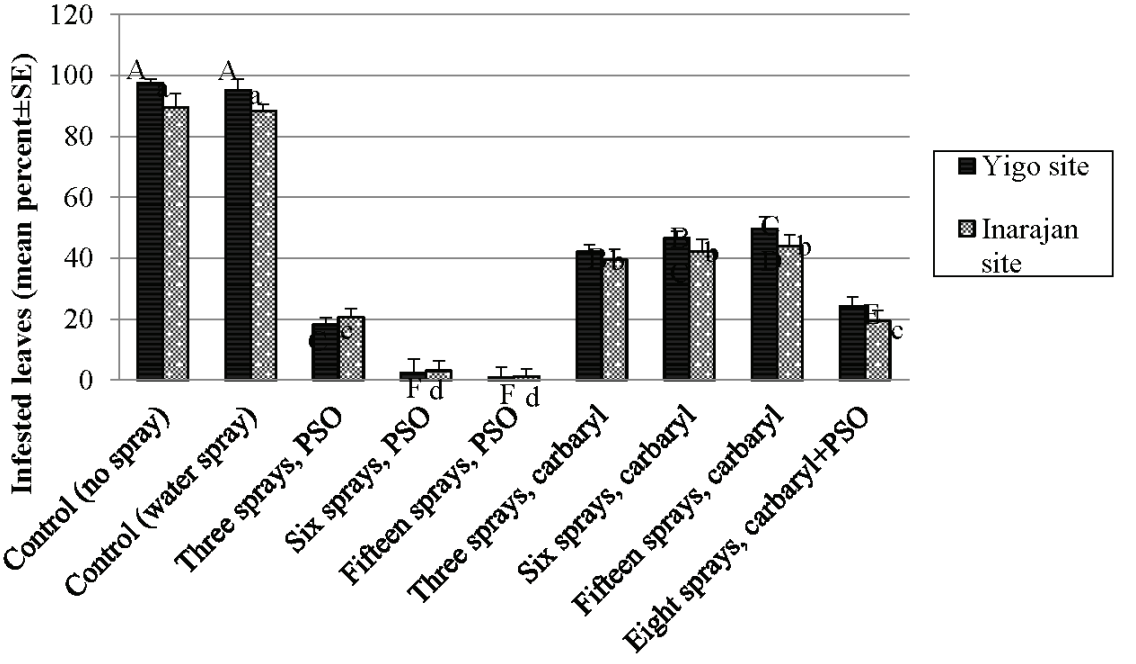


Fig. 1. Percent of *Tetranychus marianae* infested leaves in various carbaryl and petroleum spray oil treatments on eggplant fields at Yigo and Inarajan on Guam. Each bar represents the mean (± SE) of 3 replications. PSO represents petroleum spray oil.

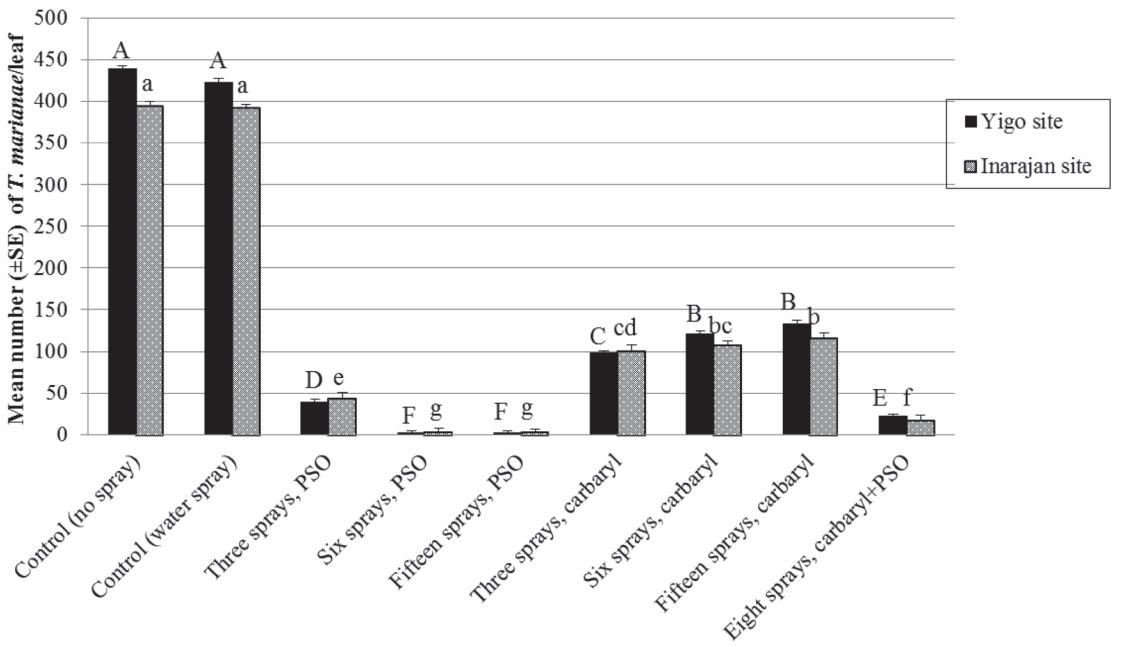


Fig. 2. Mean numbers of *Tetranychus marianae* mites per eggplant leaf in various petroleum oil and carbaryl treatments carried out on eggplant fields against this mite. From each of 10 randomly selected plants one leaf was selected from the top, middle and bottom level of the plant, and mites present on the underside of each leaf were counted at weekly intervals. PSO means petroleum spray oil.

Downloaded From: https://complete.bioone.org/journals/Florida-Entomologist on 28 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

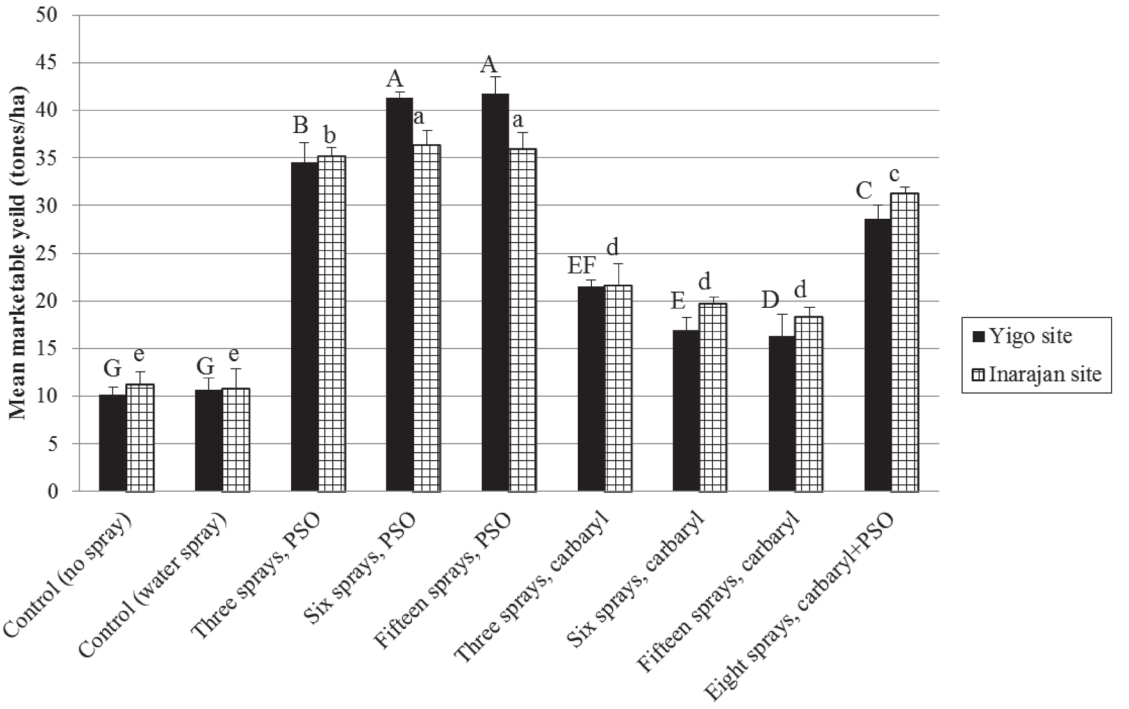


Fig. 3. Marketable yield (tonnes/ha) of eggplant in various carbaryl and petroleum spray oil treatments against *Tetranychus marianae* mites on eggplant fields at Yigo and Inarajan on Guam. Each bar represents the mean (± SE) of 3 replications. PSO represents petroleum spray oil. Different letters above the bars indicate significant differences $P > 0.05$ (Repeated measure ANOVA, LSD test). Each value represents the mean (± SE) of 3 replications.

spider mites (Shaw & Wallis 2008). Such carbaryl induced outbreaks have been reported in *Panonychus citri* (MacGregor) (Ho 1984), *Tetranychus telarious* (L.) (Patel et al. 1982) and *T. cinnabarinus* (Boisduval) (Abrol & Singh 2003). Conversely, Croft & Hoying (1975) reported carbaryl resistance in a population of the predatory mite *Amblyseius fallacis* (Garman) in Michigan. Using a carbaryl resistant natural enemy such as *A. fallacis* may assist in developing successful biological or integrated control of spider mites in other systems. Given that this observation was reported 38 years ago, more studies are needed to confirm it.

In the present study, the PSO was not shown any phytotoxic effect to eggplants. Our results agree with Mizell (1991) reported that no phytotoxicity of Sunspray Ultra-fine Spray oil was observed on ornamental plants. Also, Baxendale and Johnson (1988) stated that Sunspray oil has limited phytotoxicity on certain species of deciduous nut trees. However, there were some reports indicating that PSOs cause phytotoxicity. Cloyd et al. (2009) reported the oils such as eugenol, sodium lauryl sulfate, peppermint, and citronella oil and Sharpshooter (sodium lauryl sulfate and clove oil) were phytotoxic to the poinsettia, *Euphorbia pulcherrima* Willd. ex Klotzsch, plants. Of course, this study was the one of the first to quantitatively demonstrate that commercially available plant-derived essential oil products vary in their effectiveness against certain arthropod pests stated on the label and are phytotoxic.

Petroleum derived spray oils such as Sunspray ultra-fine oil, have potential as tools in IPM to replace conventional pesticides. Oils effectively control pests, particularly the European red mite, *Panonychus ulmi* (Koch), in commercial orchards while conserving beneficial arthropods (Jandial 2009). Knapp et al. (2001) reported that PSO is effective against citrus rust mite *Phyllocoptruta oleivora* (Ashmead) at higher doses in Florida. Oil emulsions for the control of *P. ulmi* on apple were more effective than other chemicals tested (Downing 1967). Lawson & Weires (1991) reported that of all materials they tested, sunspray 6E and Volck Supreme oil caused the most *P. ulmi* mortality.

PSO was effective against *T. marianae* on eggplant in the present study. PSO may therefore be important in developing IPM programs for mites that rely less on synthetic chemical acaricides.

Downloaded From: https://complete.bioone.org/journals/Florida-Entomologist on 28 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

Acknowledgments

This project was supported by FY 2010 Pacific Islands Area Conservation Innovation Grants (PIA-CIG) Program, Grant Agreement No. 69-9251-10-880, The Natural Resources Conservation Service (NRCS)-United States Department of Agriculture. The USDA is an equal opportunity provider and employer. We thank Mr. David M. H. Mantanona, Mr. Robert C. Mendi and Mr. Ray Gumataotao for their help in the field.

References Cited

Abrol, D. P., and Singh, J. B. 2003. Effect of insecticides on the resurgence of the red spider mite, *Tetranychus cinnabarinus* Boisdual on brinjal in Jammu, India. J. Asia-Pacific Entomol. 6: 213-219.

Baxendale, R. W. and Johnson, W. T. Evaluation of summer oil spray on amenity plants. J. Arboricul. 14: 220-225.

Cloyd, R. A., Galle, C. L., Keith, S. R., Kalscheur, N. A. and Kemp, K. E. 2009. Effect of commercially available plant-derived essential oil products on arthropod pests. J. Econ. Entomol. 102: 1567-1579.

Croft, B. A., and Hoying, S. A. 1975. Carbaryl resistance in native and released populations of *Amblyseius fallacis*. Environ. Entomol. 4: 895-894.

Denmark, H. A. 1970. The Mariana mite, *Tetranychus marianae* McGregor, in Florida (Tetranychidae). Florida Dept. Agric. Cons. Serv., DPI, Entomol. Circ. 99: 1.

Downing, R. S. 1967. Petroleum oils in orchard mite control. J. Entomol. Soc. British Columbia 64: 10-13.

Goyal, M. 1982. The spidermite *Tetranychus telarious* L. (Tetranychidae: Acarina) on glass house brinjal, *Solanum melongena*. Sci. Cult. 48: 220-221.

Ho, K. Y. 1984. Observations on the resurgence of citrus red mite following pesticide applications. Plant Prot. Bull. Taiwan 26: 99-108.

Jandial, V. K. 2009. Petroleum derived spray oils: an ecofriendly approach for the management of European red mite, *Panonychus ulmi* (Koch) on apple–a review. Indian J. Entomol. 71: 324-330.

Karban, R., and Zalom, F. 1998. Success of mite-fighting tactics evaluated. California Agric. 52: 21-24.

Knapp, J. C., Nigg, H. N., and Anderson, H. E. 2001. Update on petroleum spray oil for the citrus rust mite control. Proc. Florida State Hort. Soc. 114: 46-51.

Lawson, D. S. and Weires, R. W. 1991. Management of European red mite (Acari: Tetranychidae) and several aphid Species on apple with petroleum oils and an insecticidal soap. J. Econ. Entomol. 84: 1550-1557.

Noronha, A. C. S. 2006. Biological aspects of *Tetranychus marianae* McGregor (Acari, Tetranychidae) reared on yellow passion fruit (*Passiflora edulis* Sims f. *flavicarpa* Deg.) leaves. Rev. Brasileira Zool. 23: 404-407.

Oatman, E. R., Fleschner, O., and Mcmurtry, J. A. 1967. New spider mite poses threat to California's solanaceous crops. California Agric. 21:10-12.

Mathew, L., Reddy, M. L. P., Rao, T. P., Iyer, C. S. P., and Damodaran, A. C. 1995. Simple spectrophotometric method for the determination of carbaryl in soil and insecticide formulations. Analyst 120: 1799-1801.

Mizell III, R. F. 1991. Phytotoxicity of sunspray ultrafine spray oil and safer insecticidal concentrate soap on selected ornamental plants in summer in North Florida and South Georgia. J. Arboricul. 17: 208-210.

Moraes, G. J. De., Mcmurtry, J. A., and Baker, E. A. 1987. Redescription and distribution of the spider mites *Tetranychus evansi* and *T. marianae*. Acarologia 28: 33-343.

Patel, C. B., Shah, A. H. and Patel, S. H. 1982. Effect of insecticides on the resurgence of two spotted spider mites, *Tetranchus telarious* Linn., in brinjal. Indian J. Agric. Sci. 52: 774-776.

Reddy, G. V. P. 2001. Comparative effectiveness of an integrated pest management system and other control tactics for managing spider mite *Tetranychus ludeni* (Acari: Tetranychidae) on eggplant. Exp. Appl. Acarol. 25: 985-992.

Reddy, G. V. P., and Bautista, J. R. 2012. Integration of the predatory mite *Neoseiulus californicus* and petroleum spray oil for control of *Tetranychus marianae* on eggplant. Biocontrol Sci. Technol. 22: 1211-1220.

Reddy, G. V. P., Kikuchi, R., and Bautista, J. R. 2013. Threshold-based spraying decision programs for the red spider mite *Tetranychus marianae* on eggplant. J. Appl. Entomol. 137: 429-436.

Reddy, G. V. P., Kikuchi, R., and Remolona, J. E. 2011. New mite species associated with certain plant species from Guam. J. Entomol. Acarol. Res. Ser. II, 43, 41-46.

Reddy, G. V. P., and Tangtrakulwanich, K. 2013. Action threshold treatment regimens for red spider mite and fruit borer on tomato. Florida Entomol. 96: 1084-1096.

SAS Institute. 2009. SAS/STAT user's guide. Version 9.3th ed. SAS Institute, Cary, NC.

Schlub, R., and Yudin, L. 2002. Eggplant, Pepper, and Tomato Production Guide for Guam, Guam Cooperative Extension, University of Guam, 188 pp.

Shaw, P. W., and Wallis, D. R. 2008. Biocontrol of pests in apples under integrated fruit production. New Zealand Plant Prot. 61: 333-337.

Wilkinson, J. D., Biever, K. D., and Ignoffo, C. M. 1975. Contact toxicity of some chemical and biological pesticides to several insect parasitoids and predators. BioControl 20: 1386-6141

Downloaded From: https://complete.bioone.org/journals/Florida-Entomologist on 28 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use