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A Commercial Extract of the Brown Seaweed *Ascophyllum nodosum* Suppresses Avocado Thrips and Persea Mites in Field-Grown Hass Avocados, A Practical Field Perspective

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Abstract.

Thrips cause damage to vegetables, fruits, and flowers and are found worldwide. They directly damage crops by feeding, vectoring viruses, and may also cause respiratory and skin irritation to field workers. Effectively managing thrips and mites with non-toxic materials has proven to be one of the most challenging aspects of pest control. A commercial extract from the brown seaweed *Ascophyllum nodosum*, reduced Avocado Thrips (*Scirtothrips perseae*) numbers by 68% compared to the control, in field-grown Hass avocado trees. This reduction in thrips number was not significantly different from reduction due to abamectin treatment; the most common chemical control for thrips in avocados. In addition, there were 87% fewer colonies of Persea mites (*Oligonychus perseae*) per leaf in the *A. nodosum extract* (ANE)-treated trees compared to the control and the ANE-treatment was not significantly different from the abamectin standard. The following year there were no thrips pressure due to environmental conditions, however ANE

extract again reduced Persea mite colonies compared to the control. ANE extract applications resulted in significantly fewer thrips nymphs and Persea mite colonies on avocados under light pest pressure.

Introduction

Avocado thrips were first discovered in California in 1996. Since that time they have become a major pest with most commercial growers spraying insecticides once or twice a year to control them (Nakahara S., 1997). There are no commonly used biological products or biostimulants to reduce thrips populations or damage. Effectively managing thrips with non-toxic materials has proven to be one of the most challenging aspects of natural pest control in avocados. Although they have little effect on tree health, avocado thrips feed directly on immature fruit. Internal fruit quality is not affected, but feeding scars cause severe downgrading or culling of damaged fruit. As fruit grows, this early feeding becomes apparent as scabby or leathery brown scars that expand across the skin. In extreme cases, the fruit may not size resulting in fruit that is not marketable. Packing house data suggests that the amount of fruit downgraded due to thrips damage can be as high as 95% (California Avocado Commission, 1998). Growers experience economic loss both due to the cost of pesticide applications as well as downgraded fruit.

Persea mite (*Oligonychus perseae*) is also a key pest of California avocados. Persea mites form colonies on the underside of the avocado leaves. When enough colonies are present, infested leaves will drop off the tree. Defoliation of the trees results in both sunburn damaged fruit as well as crop loss and poor tree health due to reduced photosynthetic capacity.

Ascophyllum nodosum is a brown seaweed, a group that contains over 2000 species. It grows in the temperate zones in the intertidal areas. Brown seaweeds are the most common type of seaweed used in agriculture and ANE is the most researched (Blunden and Gordon 1986, Ugarte et al., 2006). The biostimulant properties of ANE are well established with several examples of insect suppression using *Ascophyllum nodosum* extract in published scientific literature. Extracts of ANE elicited suppression of mites and aphids in strawberries (Hankins and Hockey, 1990), as well as red mites of apples, spider mites of chrysanthemum and cucumbers, and aphids of broadbeans and sugar beets (Stephenson, 1973). The objective of this three year project was to determine the efficacy of ANE, to reduce thrips and mite populations in avocados.

Materials And Methods

Trials were conducted in 2010, 2011, and 2012 in a commercial avocado orchard near Camarillo, CA. The trials were a randomized complete block design with 4-two tree replicates. The trees were 4 years old at the beginning of the trial and planting at 4.9 x 6.1 meter spacing. All materials were applied to the trees with a Solo Backpack Sprayer simulating 935 liters per hectare. The treatments were applied foliar at petal fall for thrips (*Scirtothrips perseae*) and repeated approximately 8 weeks later for Persea mites (*Oligonychus perseae*). This is the common application timing for avocado insect management in California. The treatments in 2010 included a completely untreated control (no pesticides), abamectin applied at 10 ounces per acre (the common practice in the area), *A. nodosum* seaweed extract (Acadian Seaplants Limited, Dartmouth, NS) applied at 2 pounds per acre, and abamectin appled at 10 oz/A combined with ANE at 2 lb/A. All of the abamectin treatments included 415 spray oil applied at 1% v/v as directed by the use instructions on the label. An additional treatment of ANE applied at 2 lb/A through the drip irrigation was added in 2011 and 2012. Thrips were evaluated several times during the spring and early summer by evaluating 5 newly emerged leaves per tree and total number of immature thrips counted from the underside of the leaves. Mite colony counts were also based on 5 newly emerged leaves sampled per tree. Colonies generally house 1-4 mites per colony and 5-10 eggs. Data was analyzed using Duncan's new MRT, P=.10, ARM 7, Gylling Data Management, Inc.

Results And Discussion

The two most important insect pests of avocados in California are Avocado thrips and Persea mites, which were evaluated in this study. Although trials were conducted in 2010, 2011, and 2012, thrips pressure was only significant in 2010 with 10-15 nymphs per leaf. In 2010, abamectin, ANE, and the combination of the two products significantly reduced thrips counts compared to the control at nearly all of the rating dates. ANE alone suppressed thrips numbers similarly to abamectin (Table 1). Persea mites were present all three years with approximately 60 colonies per leaf in the untreated control in 2010 and

Table 1. Numbers of thrips juveniles per leaf, 2010

	Pretmt	6 dat	11 dat	20 dat	26 dat	34 dat	40 dat	46 dat	53 dat	Avg
UTC	2.3 a	7.3 a	12.7 a	6.1 a	7.8 a	9.5 a	13.9 a	3.9 a	5.8 a	8.4 a
abamectin	5.4 a	0.2 b	0.8 b	2.1 a	0.2 b	4.5 b	7.5 b	0.9 b	1.3 d	2.2 b
ANE	5.4 a	0.4 b	3.2 b	1.6 a	0.7 b	3.8 b	6.8 b	3.0 a	2.3 c	2.7 b
abamectin + ANE	4.8 a	0.1 b	0.2 b	1.6 a	1.3 b	3.3 b	3.8 c	1.1 b	3.6 b	1.8 b

Means followed by same letter do not significantly differ (P=.05, Duncan's New MRT)
DAT = Days after treatment, application 2 was 59 days after application 1

2011 and nearly 200 colonies per leaf in 2012. In 2010 the abamectin, ANE, and the combination of the two, all reduced numbers of mite colonies per leaf compared to the control (Table 2). In 2011, both the foliar and irrigation applied ANE treatments performed similarly. These treatments significantly reduced mite colonies compared to the control and not significantly different from the abamectin standard at the final count (Table 3). Persea mite pressure did not build to significant levels in 2012 until nearly 20 days after the second treatments were applied,

Table 2. Numbers of Persea mite colonies per leaf, 2010

	53 dat1	11 dat2	17 dat2	28 dat2
UTC	58.6 a	43.6 a	38.3 a	60.4 a
abamectin	7.5 c	5.1 c	7.1 b	7.6 b
ANE	39.5 b c	13.4 b	8.0 b	7.9 b
abamectin + ANE	14.2 c	3.4 c	7.7 b	9.6 b

Means followed by same letter do not significantly differ (P=.10, Duncan's New MRT)
DAT = Days after treatment, application 2 was 59 days after application 1

due to unusually warm weather. Around 20 days after the applications were made mite pressure increased to approximately 130 colonies per leaf in all treatments. By the final rating, the control as well as the sea-

Table 3. Numbers of Persea mite colonies per leaf, 2011

	64 dat1	5 dat2	19 dat2	33 dat2	47 dat2	62 dat2
UTC	20.0 a	4.7 a	17.4 a	40.5 a	65.2 a	53.2 a
abamectin	4.5 a	3.7 a	0.0 a	0.0 c	3.3 b	6.1 b
ANE foliar	32.1 a	5.6 a	5.7 a	24.7 ab	37.1 ab	29.0 b
ANE soil	5.9 a	2.7 a	5.6 a	18.3 bc	37.0 ab	22.7 b
abamectin + ANE	6.8 a	11.3 a	2.4 a	0.0 c	10.6 b	7.1 b

Means followed by same letter do not significantly differ (P=.10, Duncan's New MRT)
DAT = Days after treatment, application 2 was 94 days after application 1

weed extract treatments all had over 200 mite colonies per leaf while the abamectin and ANE + abamectin treatments both had less than 15 mite colonies per leaf (Table 4). The failure of ANE to manage mites in 2012 may be due to the high pressure combined with the fact that mite num-

Table 4. Numbers of Persea mite colonies per leaf, 2012

	61 dat1	7 dat2	13 dat2	19 dat2	21 dat2	26 dat2	35 dat2	41 dat2
UTC	0.6 a	1.3 a	1.7 a	3.4 b	130.8 a	14.6 c	53.7 a	206.0 a
abamectin	1.9 a	2.0 a	1.1 a	2.3 b	138.5 a	6.1 d	27.9 bc	2.4 b
ANE foliar	3.8 a	2.2 a	1.8 a	12.0 a	130.5 a	28.0 b	8.7 c	231.3 a
ANE soil	2.0 a	1.7 a	1.3 a	16.6 a	136.5 a	35.8 a	13.2 c	247.0 a
abamectin + ANE	2.4 a	1.2 a	1.2 a	3.3 b	135.3 a	5.5 d	45.2 ab	12.3 b

Means followed by same letter do not significantly differ (P=.10, Duncan's New MRT)
DAT = Days after treatment, application 2 was 63 days after application 1

bers were not significant until 3 weeks after application. Perhaps any efficacy offered by the ANE was lost by the infrequency of applications.

Prior research gives some hints as to the mode of action behind this observed insect suppression. However, none of the authors suggest that the observed efficacy is based on direct pesticidal qualities of the seaweed extract (Bergey et al. 1996, Dickie et al., 1990, Hankins and Hockey, 1990, McCon et al., 2007, Stephenson, 1973, Turlings et al., 1990, 1991, 1993, Takabayashi et al., 1991, 1994). The MSDS for Acadian's ANE that the product is non-toxic orally, non-irritating to the ocular tissue, non-toxic dermally, not irritating to dermal tissue, and not hazardous by inhalation. This indicates that the mode of action is likely not directly pesticidal and may involve a different mode of action such as eliciting the plant's natural resistance to environmental stresses. Jasmonic acid is essential for protection against insects in Arabidopsis (McCon et al., 2007), and extracts of ANE have been shown to elicit the jasmonic acid pathway in Arabidopsis (Subramanian et al., 2011). The mode of action behind the benefits seen in these trials may be that extracts of ANE elicited the jasmonic acid pathway which is essential in plant defense against insects resulting in reduced pest numbers. Bergey et al. (1996), found that jasmonic acid is involved in insect suppression of Solanaceae crops via induction of proteinase inhibitor genes. It is possible that a similar activity may be occurring in these avocado trials. Additionally, some plants that are subject to insect feeding release volatiles that attract predatory and/or beneficial insects (Turlings et al., 1990, 1991, 1993, Takabayashi et al., 1991, 1994, Dickie et al., 1990). This also may have occurred in this study, although no unusual numbers of beneficial insects were observed. Lastly, it is common knowledge among growers that mites seem to prefer weaker plants. Possibly the ANE treated trees were healthier and less attractive to the mites. Further studies may shed more light on this interesting topic.

Conclusions

Acadian's ANE reduces numbers of thrips and mites on avocados under light to medium population pressure. Insects are often problematic when the trees are stressed due to environmental conditions such as heat and drought. ANE enhances the trees ability to resist those stresses and in doing, so may reduce the occurrence and impact of these pests. Under some environmental conditions that favor high pest populations the effects may be minimal. The effects of ANE on thrips and mites may not last more than 20 days. Further field research should refine application timings as well as critical populations at which ANE is effective. Even with these unanswered questions, these studies demonstrated the potential for this non-pesticidal material to suppress insect pest populations as well as the traditional pesticide program, under some conditions.

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