

**Research Abstract for the
CALIFORNIA LEAFY GREENS RESEARCH BOARD
April 1, 2010 – March 31, 2011**

Project Title: Thrips Management In Lettuce

Project Investigator: Eric Natwick
University of California Cooperative Extension - Imperial County

Summary: Western flower thrips, *Frankliniella occidentalis* (Pergande), is a common pest in California leafy green vegetable crops. Western flower thrips is a damaging, cosmopolitan pest, resistant to many insecticides worldwide and causes serious economic losses to California lettuce growers annually. Two trials were conducted to evaluate the efficacy of commercial and experimental insecticides for thrips control in iceberg lettuce and romaine lettuce. Although several efficacious insecticides are registered for thrips control on both types of lettuce, new and efficacious insecticidal chemicals with novel modes of action are needed to slow the development of thrips-resistance to insecticides. New chemistries are needed to help maintain insecticide susceptibility in western flower thrips populations; insecticide resistance management (IRM). There is also a need to explore use patterns of insecticides that are safe and efficacious against thrips in leafy greens.

All insecticide treatments were effective in reducing western flower thrips populations compared to the water treated check plots in both experiments. Standard insecticides (Radiant, Lannate, and Hero) were among the best thrips control treatments. Aza-Direct and Agri-Mek 0.15 EC when used alone or in combination were also efficacious against western flower thrips. Assail used alone or in rotation showed efficacy against thrips. Voliam Flexi and Foliam Xpress used in rotations with Lannate were efficacious against thrips. All of the aforementioned products are important because they represent seven different chemical class modes of action (MOA) according to the Insecticide Resistance Action Committee (IRAC). They can be used in rotation to help maintain western flower thrips susceptibility in California. Radiant is a Spinosyn (Group 5), nicotinic acetylcholine receptor agonists. Lannate is a carbamate (Group 1A) and Voliam Flexi and Voliam Xpress both contain chlorantraniliprole an anthranilic diamide (Group 28), stimulating ryanodine receptor activation causing release of stored calcium from the sarcoendoplasmic reticulum causing impaired regulation of muscle contraction. Hero contained two pyrethroid insecticides; (Group 3) is a sodium channel modulator. Aza-Direct is azadirachtin (Group 18B) an ecdysone agonist molting disruptor. Assail is in another IRAC mode of action chemical class, the neonicotinoids (Group 4A) that are nicotinic acetylcholine agonist/antagonists. Abamectin (Group 6) is a chloride channel modulators. In addition to the aforementioned insecticides representing seven different MOAs, two new insecticides under development representing two additional MOAs were evaluated. Cyazypyr is a (Group 28) diamide, cyantraniliprole, under development by DuPont. Cyazypyr, applied as multiple foliar applications showed efficacy against thrips. Tolfenpyrad (Group 21), a mitochondrial complex I electron transport inhibitors under development by Nichino America, also shows promise as a thrips control insecticide that could be used in rotation with insecticides in other IRAC groups for IRM. All of the aforementioned insecticidal formulated products have a potential use for protecting leaf greens from thrips and for IRM of Western flower thrips.

**PROJECT REPORT TO THE
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Project Title: Thrips Management In Lettuce

Project Investigator: Eric Natwick
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Cooperating Personnel: Martin Lopez
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Introduction:

The western flower thrips, *Frankliniella occidentalis* (Pergande), is a common pest in lettuce grown in the low desert region, and can cause serious economic losses to lettuce growers. Two trials were conducted to evaluate the efficacy of commercial and experimental insecticides for thrips control in iceberg lettuce and romaine lettuce.

Objectives:

The immediate objectives were to assess the efficacy of insecticides for management of western flower thrips in lettuce crops.

Materials and Methods:

Site location: Univ. of California Desert Research and Extension Center
1004 Holton Road, El Centro, CA 92243

Host Crop: Iceberg Lettuce and Romaine Lettuce

Variety: EBLIN and Fresh/Heart, respectively

Planting date: 11 October for romaine and 13 October for iceberg

First irrigation: 12 October for romaine and 14 October for iceberg

Soil type: Holtville silty clay, wet

Cultural practices: 40" raised beds with 2 seed-lines / bed
Sprinkler irrigated to emergence; furrow irrigated thereafter
Herbicide: Kerb 50W via sprinkler chemigation

Experimental Design: Randomized complete block

Replication and Units: 4 replicates of 50' x 13.3' (4 beds/plot)

Ground Applications: Lee Spider Spray TracTractor 4-row sprayer with
three nozzles per row delivering 52.9 gpa at 30 psi

Insecticide application rates and application dates for each experiment are listed in Tables 1 & 2.

Table 1. List of Treatments and Rates for Thrips Control in Iceberg Lettuce 2010/11.

Treatment	Oz/acre	Treatment date	Plot numbers
1. Tolfenpyrad 15 EC	17.0	4 Jan and 14 Jan 2011	2, 22, 33, 37
2. Tolfenpyrad 15 EC	21.0	4 Jan and 14 Jan 2011	3, 16, 29, 47
3. Tolfenpyrad 15 EC + Lannate LV	21.0 + 40.0	4 Jan and 14 Jan 2011	4, 13, 30, 48
4. Lannate LV + Warrior	21.0 + 1.9	4 Jan and 14 Jan 2011	11, 14, 34, 40
5. Lannate LV	40.0	4 Jan and 14 Jan 2011	10, 20, 35, 41
6. Radiant	7.0	4 Jan and 14 Jan 2011	12, 21, 27, 46
7. MustangMax f/b Lannate LV	4.0 40.0	4 Jan 14 Jan	5, 18, 36, 43
8. Hero f/b Lannate LV	11.2 40.0	4 Jan 14 Jan	7, 24, 26, 42
9. Assail 30 SG f/b Lannate LV	4.0 40.0	4 Jan 14 Jan	9, 19, 32, 39
10. Voliam Flexi f/b Lannate LV	4.66 40.0	4 Jan 14 Jan	1, 17, 28, 44
11. Voliam Xpress f/b Lannate LV	9.0 40.0	4 Jan 14 Jan	8, 15, 25, 45
12. Water Check	-----	-----	6, 23, 31, 38

f/b = followed by

Dyne-Amic @ 0.25% volume / volume added to foliar spray mixture.

Table 2. List of Treatments[†] and Rates for Thrips Control in Romaine Lettuce 2010/11.

Treatment	Oz/acre	Treatment date	Plot numbers
1. Aza-Direct*	16.0	10 and 19 Jan 2011	2, 22, 33, 37
2. Agri-Mek 0.15 EC	8.0	10 and 19 Jan 2011	3, 16, 29, 47
3. Aza-Direct* + Agri-Mek 0.15 EC	8.0 + 4.0	10 and 19 Jan 2011	4, 13, 30, 48
4. Movento	5.0	10 and 19 Jan 2011	11, 14, 34, 40
5. A16901B 40 WG	7.2	10 and 19 Jan 2011	10, 20, 35, 41
6. Radiant	10.0	10 and 19 Jan 2011	12, 21, 27, 46
7. MustangMax	4.0	10 and 19 Jan 2011	5, 18, 36, 43
8. Hero	11.2	10 and 19 Jan 2011	7, 24, 26, 42
9. Assail 30 SG	4.0	10 and 19 Jan 2011	9, 19, 32, 39
10. Voliam Flexi	7.0	10 and 19 Jan 2011	1, 17, 28, 44
11. Tolfenpyrad 15EC	21.0	10 and 19 Jan 2011	8, 15, 25, 45
12. Water Check	-----	-----	6, 23, 31, 38

[†]All plots were treated with Lannate LV @ 24.0 fl oz/acre on 4 Jan and 25 Jan 2011.

* Buffer to pH 6.0.

Dyne-Amic @ 0.25% volume / volume added to foliar spray mixture.

Evaluations:

Iceberg lettuce evaluations were conducted on 3, 7, 11, 18, and 21 January 2011 and for romaine lettuce on 3, 7, 13, 18, 21, 28 and 31 January 2011. During each evaluation, 10 lettuce plants were examined and the number of western flower thrips found, was recorded (Tables 3 - 6).

Harvest data was collected from 13.1 row feet of each plot (0.001 acre) for each experiment; on 24 January for iceberg lettuce and on 3 February for romaine lettuce. The numbers of marketable naked iceberg lettuce heads and the numbers of whole romaine heads and romaine hearts were recorded, as well as the number of culls caused by extensive thrips damage for both the iceberg lettuce and romaine lettuce experiments. The total numbers and weight of marketable heads was recorded for each experiment. The percent of heads considered marketable due to lack thrips damage was also determined for each experiment (Tables 7 - 9).

Statistical analysis:

Raw data for each experiment were analyzed using ANOVA. Differences among means on each sampling date and in each experiment were determined using Least Significant Difference Test ($P=0.05$).

Results and Discussion:

All of the test products were effective in significantly reducing ($P=0.05$) populations of western flower thrips adults and larvae, compared to the water check plots for both the iceberg and romaine lettuce experiments on at least some of the sampling dates (Tables 3 - 6). In the iceberg lettuce experiment, Lannate LV was the most efficacious treatment for control of both adult and larval thrips on iceberg lettuce (Tables 3 and 4). Radiant used alone was the second most efficacious treatment against adult thrips in iceberg lettuce; however, the rotation of Lannate and Radiant was more efficacious against larval thrips. The Tolfenpyrad treatments and Voliam Flexi were among the least efficacious with significantly more thrips than the aforementioned treatments for the overall experiment averages for adults and larvae (Tables 3 and 4). In the romaine experiment, Hero was the most efficacious for control of both adult and larval thrips followed by MustangMax (Tables 5 and 6). Voliam Flexi was the least efficacious treatment for control of adult western flower thrips, with significantly more than all other insecticide treatments except Aza-Direct and Assail for the average numbers of adults (Table 5). Voliam Flexi was the least efficacious treatment for control of western flower thrips larvae, with significantly more than Hero, MustangMax, Radiant, Cyazapyr and Assail for the average numbers of larvae (Table 6).

None of insecticide treatments had more market quality heads, higher percentages of marketable heads and fewer thrips damaged heads than the water check plots for iceberg lettuce (Table 7). In the romaine lettuce experiment, none of insecticide treatments had more market quality heads, higher percentages of marketable heads and fewer thrips damaged heads than the water check (Table 8). In the romaine experiment, all of the insecticide treatments had significantly ($P=0.05$) more romaine hearts and higher percentages of marketable romaine hearts than the water check (Table 9). In the romaine lettuce experiment, all insecticide treatments except Voliam Flexi had fewer thrips damaged romaine hearts compared to the water check.

Not surprisingly, treatment that included industry standards such as Radiant, pyrethroid insecticides or Lannate performed well against western flower thrips as they have in earlier experiments in 2005, 2006 and 2009. All of the insecticides tested have a fit in a lettuce IPM and IRM program. It is vitally important that rotation of insecticide groups by IRAC group numbers be practiced to slow the development of insecticide-resistant western flower thrips. Two experimental compounds are promising new chemistries that would be helpful to growers in California if they were registered on lettuce, Tolfenpyrad (under development by Nichino) and Cyazapyr (under development by DuPont).

Table 3. Western Flower Thrips Adults per Iceberg Lettuce Plant at Holtville, CA 2010/11.

Treatment	Oz/acre	1PT	3DAT1	7DAT1	4DAT2	7DAT2	Avg
Tolfenpyrad 15 EC	17.0	3.88	3.03 bc	5.28 cd	3.30 b	3.85 bc	3.87 cd
Tolfenpyrad 15 EC	21.0	3.40	2.98 bc	8.30 ab	1.93 c	6.50 a	4.62 b
Tolfenpyrad 15 EC + Lannate LV	21.0 + 40.0	3.73	2.43 c	4.10 de	0.63 d	5.00 b	3.18 de
Lannate LV + Warrior	21.0 + 1.9	3.55	2.13 cde	2.93 e	0.58 d	2.13 de	2.26 gh
Lannate LV	40.0	2.70	1.50 de	3.00 e	0.03 d	2.73 cd	1.99 h
Radiant	7.0	3.13	1.38 e	4.08 de	1.85 c	1.63 de	2.41 fgh
MustangMax f/b Lannate LV	4.0 40.0	3.78	2.78 bc	4.28 de	0.10 d	4.08 b	3.00 ef
Hero f/b Lannate LV	11.2 40.0	4.23	2.43 c	4.48 de	0.65 d	0.93 e	2.54 efgh
Assail 30 SG f/b Lannate LV	4.0 40.0	3.48	2.33 cd	6.75 bc	0.03 d	1.70 de	2.86 efg
Voliam Flexi f/b Lannate LV	4.66 40.0	3.50	3.45 b	8.68 a	2.13 c	4.78 b	4.51 bc
Voliam Xpress f/b Lannate LV	9.0 24.0	2.93	2.28 cde	5.15 cd	0.10 d	1.85 de	2.46 efgh
Water Check	-----	3.08	7.58 a	9.45 a	6.10 a	6.38 a	6.52 a
LDS, $P= 0.05$		NS	0.92	1.81	0.70	1.23	0.73

f/b = followed by

Means within columns followed by the same letter are not significantly different LSD; $P = 0.05$

Table 4. Western Flower Thrips Larvae per Iceberg Lettuce Plant at Holtville, CA 2010/11

Treatment	Oz/acre	1PT	3DAT1	7DAT1	4DAT2	7DAT2	Avg
Tolfenpyrad 15 EC	17.0	0.23	0.25 b	1.90 ab	0.73 b	1.13 ab	0.85 b
Tolfenpyrad 15 EC	21.0	0.18	0.33 b	1.85 abc	0.55 b	1.05 abc	0.79 bc
Tolfenpyrad 15 EC + Lannate LV	21.0 + 40.0	0.23	0.40 b	0.73 e	0.13 c	0.50 bcde	0.40 ef
Lannate LV + Warrior	21.0 + 1.9	0.30	0.35 b	0.60 e	0.15 c	0.43 cde	0.37 ef
Lannate LV	40.0	0.15	0.13 b	0.68 e	0.00 c	0.23 de	0.24 f
Radiant	7.0	0.08	0.28 b	1.18 bcde	0.55 b	0.30 de	0.48 def
MustangMax f/b Lannate LV	4.0 40.0	0.40	0.58 b	1.08 cde	0.00 c	0.88 abcd	0.59 cde
Hero f/b Lannate LV	11.2 40.0	0.20	0.38 b	0.75 de	0.13 c	0.05 e	0.30 f
Assail 30 SG f/b Lannate LV	4.0 40.0	0.15	0.50 b	0.83 de	0.00 c	0.08 e	0.31 f
Voliam Flexi f/b Lannate LV	4.66 40.0	0.75	0.55 b	1.53 bcd	0.55 b	0.65 abcde	0.67 bcd
Voliam Xpressf/b Lannate LV	9.0 24.0	0.25	0.33 b	1.20 bcde	0.00 c	0.38 de	0.39 ef
Water Check	-----	0.50	1.85 a	2.50 a	14.25 a	1.18 a	1.40 a
LDS, $P= 0.05$		NS	0.57	0.79	0.26	0.66	0.25

f/b = followed by

Means within columns followed by the same letter are not significantly different LSD; $P = 0.05$

Table 5. Western Flower Thrips Adults per Romaine Lettuce Plant at Holtville, CA 2010/11.

Treatment	Oz/a	3 Jan	7 Jan	13 Jan	18 Jan	21 Jan	28 Jan	31 Jan	Avg
Aza-Direct	16.0	8.20	3.28 bc	2.03 d	9.10 bc	12.13 c	8.85 b	4.65 cde	6.89 bc
Agri-Mek	8.0	7.45	2.65 bcde	2.05 d	6.60 de	13.63 bc	8.03 bc	5.75 bc	6.59 cde
Aza-Direct + Agri-Mek	8.0 + 4.0	5.53	2.48 cde	1.78 d	8.88 bc	12.33 c	9.08 b	3.95 de	6.29 ef
Movento	5.0	7.03	2.85 bcd	3.58 bc	10.28 b	12.63 c	6.18 cd	4.65 cde	6.74 cde
Cyazypyr	7.2	7.10	2.20 de	4.68 b	9.45 b	8.73 d	4.63 de	3.33 e	5.73 gh
Radiant	10.0	8.08	1.95 e	2.53 cd	8.65 bcd	11.70 c	6.50 cd	3.20 e	6.09 fg
MustangMax	4.0	7.85	1.95 e	20.3 d	7.03 cde	8.75 d	3.73 e	5.55 bcd	5.27 hi
Hero	11.2	7.30	2.60 cde	2.80 cd	5.80 e	7.25 d	5.08 de	4.18 cde	5.00 i
Assail	4.0	7.80	2.38 de	4.375 b	8.65 bcd	13.15 bc	7.35 bc	3.50 e	6.67 bcd
Voliam Flexi	7.0	7.75	3.48 b	1.90 d	8.15 bcd	14.90 ab	7.83 bc	6.78 b	7.25 b
Tolfenpyrad	21.0	6.93	3.05 bcd	4.33 b	8.28 bcd	13.10 bc	4.88 de	4.33 cde	6.41 def
Water Check	-----	7.30	7.88 a	9.18 a	14.30 a	16.40 a	13.45 a	12.75 a	11.61 a
LDS, $P= 0.05$		NS	0.87	1.41	2.23	1.96	1.95	1.60	0.48

Means within columns followed by the same letter are not significantly different LSD; $P = 0.05$

Table 6. Western Flower Thrips Larvae per Romaine Lettuce Plant at Holtville, CA 2010/11.

Treatment	Oz/a	3 Jan	7 Jan	13 Jan	18 Jan	21 Jan	28 Jan	31 Jan	Avg
Aza-Direct	16.0	1.18	0.85 b	0.45 bc	3.30 bcd	4.28 bc	1.50 bcd	0.43 bc	1.71 bc
Agri-Mek	8.0	1.03	0.53 bcd	0.60 bc	0.31 cd	4.80 b	1.25 cd	0.75 bc	1.72 bc
Aza-Direct + Agri-Mek	8.0 + 4.0	0.88	0.20 de	0.65 bc	0.43 bc	2.73 cde	1.95 bc	1.05 b	1.68 bcd
Movento	5.0	1.13	0.43 bcde	0.85 bc	0.49 b	3.98 bcd	1.28 cd	0.85 bc	1.91 b
Cyazypyr	7.2	1.13	0.45 bcde	0.53 bc	0.41 bc	2.33 de	1.20 d	0.70 bc	1.49 cde
Radiant	10.0	1.30	0.30 de	0.78 bc	0.40 bc	2.78 cde	0.88 d	0.30 c	1.47 cde
MustangMax	4.0	1.60	0.15 e	0.38 c	0.31 cd	2.45 de	0.88 d	0.90 bc	1.35 de
Hero	11.2	1.05	0.33 cde	0.70 bc	0.22 d	2.30 e	1.00 d	0.93 bc	1.21 e
Assail	4.0	0.75	0.18 de	1.08 b	0.41 bc	3.18 bcde	0.03 d	0.60 bc	1.56 cd
Voliam Flexi	7.0	1.20	0.80 bc	0.43 bc	0.32 bcd	4.55 b	2.23 b	1.05 b	1.92 b
Tolfenpyrad	21.0	6.25	0.65 bcd	1.05 bc	0.41 bc	3.60 bcde	1.00 d	0.55 bc	1.65 bcd
Water Check	-----	9.75	1.65 a	2.88 a	0.68 a	7.28 a	3.33 a	2.25 a	3.59 a
LDS, $P= 0.05$		NS	0.49	0.70	1.76	1.66	0.74	0.67	0.34

Means within columns followed by the same letter are not significantly different LSD; $P = 0.05$

Table 7. Numbers of Thrips Damaged, Market, and kg Market Heads per 0.001 acre, and Percentages of Market Heads for Plants in Iceberg Lettuce, 2010/11.

Treatment	Oz/acre	Total heads	Thrips damage	Market heads	Kg market heads	% Market heads
Tolfenpyrad 15 EC	17.0	26.50	6.50	20.00	14.08	75.60
Tolfenpyrad 15 EC	21.0	26.75	6.00	20.75	15.68	78.80
Tolfenpyrad 15 EC + Lannate LV	21.0 + 40.0	29.00	8.25	20.75	12.56	71.50
Lannate LV + Warrior	21.0 + 1.9	27.25	8.00	19.25	14.04	71.30
Lannate LV	40.0	26.50	4.00	22.50	17.31	85.30
Radiant	7.0	28.50	5.75	22.75	16.81	79.60
MustangMax f/b Lannate LV	4.0 40.0	29.00	5.00	24.00	17.31	83.40
Hero f/b Lannate LV	11.2 40.0	26.50	6.50	20.00	15.51	75.50
Assail 30 SG f/b Lannate LV	4.0 40.0	26.50	4.00	22.50	16.05	84.80
Voliam Flexi f/b Lannate LV	4.66 40.0	27.50	11.25	16.25	12.44	60.80
Voliam Xpress f/b Lannate LV	9.0 24.0	29.25	10.25	19.00	13.44	66.10
Water Check	-----	26.25	8.75	17.50	14.20	68.10
LDS, $P= 0.05$		NS	NS	NS	NS	NS

f/b = followed by

Means within columns followed by the same letter are not significantly different LSD; $P = 0.05$.

Table 8. Whole Romaine Heads: Numbers of Thrips Damaged, Market, and kg Market Heads per 0.001 acre, and Percentages of Market Heads, 2010/11.

Treatment	Oz/acre	Thrips damage	Market heads	Total Heads	% Market heads	Kg market heads
Aza-Direct	16.0	26.00	3.00	29.00	9.8	213
Agri-Mek	8.0	23.75	5.50	29.25	18.7	4.15
Aza-Direct + Agri-Mek	8.0 + 4.0	24.25	5.00	29.25	17.2	4.33
Movento	5.0	25.75	4.00	29.75	13.0	3.09
Cyazypyr	7.2	25.75	3.50	29.25	11.9	2.64
Radiant	10.0	26.00	5.25	31.25	16.9	4.40
MustangMax	4.0	24.00	5.75	29.75	19.8	4.69
Hero	11.2	24.00	3.50	27.50	13.0	2.78
Assail	4.0	24.25	5.25	29.50	17.8	3.54
Voliam Flexi	7.0	28.50	3.25	31.75	10.1	2.24
Tolfenpyrad	21.0	24.00	3.00	27.00	10.8	2.36
Water Check	-----	27.75	1.75	29.50	5.8	1.36
LDS, $P= 0.05$		NS	NS	NS	NS	NS

Means within columns followed by the same letter are not significantly different LSD; $P = 0.05$.

Table 9. Romaine Hearts: Numbers of Thrips Damaged, Market, and kg Market Heads per 0.001 acre, and Percentages of Market Heads, 2010/11.

Treatment	Oz/acre	Thrips damage	Market heads	Total Heads	% Market heads	Kg market heads
Aza-Direct	16.0	6.50 bcd	22.50 b	29.00	75.60 bc	8.08 cde
Agri-Mek	8.0	2.25 d	26.75 ab	29.25	92.29 a	11.67 ab
Aza-Direct + Agri-Mek	8.0 + 4.0	3.25 cd	26.00 ab	29.25	88.96 ab	10.78 abc
Movento	5.0	5.25 cd	24.50 ab	29.75	82.93 abc	9.97 abcd
Cyazypyr	7.2	6.50 bcd	22.75 ab	29.25	78.50 abc	9.89 abcd
Radiant	10.0	3.25 cd	28.00 a	31.25	89.81 ab	12.63 a
MustangMax	4.0	3.50 cd	26.25 ab	29.75	88.30 ab	11.51 ab
Hero	11.2	4.00 cd	23.25 ab	27.50	85.49 ab	8.33 cde
Assail	4.0	7.25 bc	22.00 b	29.50	75.16 bc	9.21 bcde
Voliam Flexi	7.0	10.00 ab	21.75 b	31.75	68.71 c	7.50 de
Tolfenpyrad	21.0	3.50 cd	23.50 ab	27.00	87.24 ab	8.73 bcde
Water Check	-----	13.75 a	16.00 c	29.50	53.45 d	6.21 e
LDS, $P= 0.05$		4.33	5.34	NS	0.15	3.02

Means within columns followed by the same letter are not significantly different LSD; $P = 0.05$.