2007 Utah Onion Thrips Insecticide Efficacy Trial:
Influence of Egg Hatch, Survival, and Immigration on Insecticide Performance in Dry Bulb Onion

Utah Agricultural Experiment Station, Kaysville, UT

Diane Alston, Entomologist
Department of Biology, Utah State University

Objectives and Background:

To evaluate the efficacy of different classes and modes of action of insecticides for suppression of three thrips life stages (adults, larvae, and eggs) on dry bulb onion plants. Several spray adjuvants (spreaders, stickers) were also evaluated. Two species of pest thrips were present in the study: onion thrips, *Thrips tabaci*, and western flower thrips, *Frankliniella occidentalis*.

Spirotetramat (Movento®) is a new, unregistered insecticide manufactured by Bayer CropScience. It belongs to a new chemical class, tetramic acids, and interferes with lipid synthesis. It is active via ingestion and effective against sucking insects. Spirotetramat is highly systemic; when applied to foliage it is translocated within phloem and vascular tissue. Spinetoram (Radiant®) is a new, unregistered insecticide from Dow AgroSciences that is related to spinosad (Success®). It is derived from the metabolites of the naturally occurring bacteria, *Saccharopolyspora spinosa*. Oxamyl (Vydate®) and methomyl (Lannate®) are both carbamates manufactured by DuPont. They have systemic activity and have been shown to suppress insect eggs. Formetanate hydrochloride (Carzol®) is another carbamate that currently has an EPA Section-18 registration for use on onions in some states. The mode of action of carbamates is inhibition of acetylcholinesterase, an enzyme that functions in nerve impulse transmission. The final insecticide tested, is a synthetic pyrethroid, lambda cyhalothrin (Warrior®). Pyrethroids are also neurotoxins and have been a popular insecticide class for thrips management in onions. However, resistance to pyrethroids and other insecticides has become a major issue facing onion producers.

Methods:

Onions were planted from seed in late March at the Utah State University Agricultural Experiment Station Farm in Kaysville, UT. Plot size was 12 ft (4- four-row beds spaced 3 ft apart) × 20 ft in length (with a 5 ft row-length buffer between plots). Treatments were replicated four times and plots laid out in a randomized complete block design (see plot map). The onion field was sprinkler irrigated approximately once per week to run-off (2-3 hours). Insecticide treatments were initiated when onion thrips densities increased to at least 10 motile stages per plant. The first application of treatments was made on June 26 and a second application was made on July 31. Insecticide solutions were applied with a motorized Solo® backpack mist sprayer at a rate of 50 gal per acre. The mist sprayer was able to penetrate into the onion leaf canopy and place spray droplets in the neck region of the plant where thrips predominately reside.

Treatments

1. Untreated control
2. Spirotetramat (Movento®) 240 SC @ 5 oz/acre + 0.25% v/v methylated seed oil (MSO) (not registered)
3. Spirotetramat (Movento®) 240 SC @ 8 oz/acre + 0.25% v/v MSO (not registered)
4. Spirotetramat (Movento®) 240 SC @ 5 oz/acre + 0.25% v/v Induce, a non-ionic surfactant (not registered)
5. Spinetoram (Radiant®) @ 8 oz/acre + 1.0% v/v Stylet Oil (not registered)
6. Formetanate hydrochloride (Carzol®) SP @ 0.75 lb per acre + 1.0% v/v Stylet Oil (not a registered crop use in Utah)
7. Oxamyl (Vydate®) L @ 4 pt/acre + 1.0% v/v Stylet Oil (Special Local Need 24(c) label in Utah)
8. Methomyl (Lannate®) LV @ 3 pt/acre + 1.0% v/v Stylet Oil
9. Lambda cyhalothrin (Warrior®) @ 3 fl oz per acre + 1.0% v/v Stylet Oil

Thrips sampling

Thrips were sampled pre-treatment and at weekly intervals for 3 weeks after treatment for each of the two insecticide applications: Jun 26, Jul 3, 10, and 17 for the first trial, and Jul 31, Aug 7, 13, and 21 for the second trial. Thrips densities on plants were determined by cutting and placing two whole plants per plot into jars with soapy water to wash the motile life stages (adults and larvae) from plants. The soapy water solution was poured through a 220-mesh sieve to collect the thrips for counting under a dissecting microscope at 10-20× magnification. The numbers of adults and larvae on a per plant basis were determined.

Thrips eggs were sampled within the third youngest leaf on the two sample plants per plot by collecting this leaf from washed plant samples described above. Leaves were stained with acid fuchsin and cleared with a lactic acid solution. The leaves were pressed between glass plates and the number of thrips eggs counted by viewing under a dissecting microscope at 30× magnification. At the time of this report, thrips egg counts in the stained leaves are still underway. These data will be added to the report after they are completed.

To evaluate the number of viable thrips eggs within leaves following insecticide treatments, the third youngest leaf was collected from two additional plants in each plot on each sampling date, washed with water to remove motile stages, and placed into a hatching chamber. Hatching chambers were made from Ziplock® plastic bags containing moist filter paper and placed at 25 $\pm$ 2 ºC for two weeks. The leaves and inside of the bag and filter paper were washed with water to remove larval thrips that hatched from leaves and collected on a sieve for counting under a dissecting microscope as described above. Hatching chambers and leaves were washed at each one and two weeks after collecting from the field to evaluate the influence of insecticide treatments on the rate of egg hatch.

Finally, to compare the influence of thrips survival versus immigration on thrips population densities on plants, three plants in each plot were sprayed with Safer® insecticidal soap (2.5 oz per gal) immediately after insecticide applications to kill any remaining thrips, allowed to dry, and covered with a cage to exclude immigrant thrips and natural enemies. Sleeve cages made from fine-mesh screening (No-se-um tent and

porch screen) were placed over plants and anchored with a 5" diam PVC pipe ring pushed into the soil. One caged plant was sampled in each plot on each post-treatment date (1, 2, and 3 weeks after treatment) using the whole plant wash method described above. Caged plants were set up and sampled following each of the two trials.

Densities of each life stage (adult, larva, egg, and larva hatching from leaf) were compared among insecticide treatments with analysis of variance (Proc Mixed, SAS Institute) pre-treatment, and on 1, 2, and 3 weeks after treatment. Pair-wise mean comparisons among treatments were controlled for experiment-wise Type I error and means separated, when significantly different, using the Tukey-Kramer method. Density data were square root transformed before analysis to meet normality assumptions.

Results and Discussion:

Insecticide efficacy on thrips adults and larvae

Onion thrips, *Thrips tabaci*, adults were approximately 10-100× more numerous than western flower thrips, *Frankliniella occidentalis*, adults on onion plants (Tables 1 and 2). Counts of thrips larvae from both species were combined because the species cannot be distinguished at 10-30× magnification (Table 3). Pre-treatment adult onion thrips densities were generally greater for Trial 1 (on Jun 26) than Trial 2 (on Jul 31) (Table 1), but larval densities were generally greater at the beginning of Trial 2 than 1 (Table 3). Densities of western flower thrips adults were slightly higher in Trial 2 than 1 (Table 2).

Densities of onion thrips adults generally declined during Trial 1 in all treatments, including the untreated control (Fig. 1). There were only differences among treatments on 1 week after treatment when two of the Movento treatments had higher numbers than Radiant and Lannate treatments (Table 1 and Fig. 1). There were no differences in adult onion thrips densities among treatments during Trial 2 (Table 1 and Fig. 2). There were numerically more adults in the untreated control than in all insecticide treatments up to 2 weeks after treatment, but means were not statistically different. In summary, insecticide treatments had minimal to no effect on suppressing onion thrips (OT) (*Thrips tabaci*) adults based on the whole plant wash sampling method used in this study. The whole plant wash method may be less effective in monitoring adult than larval thrips because adults fly quickly when disturbed. During sampling, plants are grasped quickly and firmly upon approach to minimize the chance of thrips escape. Regardless, OT adult densities were not influenced by the different insecticides as compared to the untreated control.

Although densities of adult western flower thrips (WFT), *Frankliniella occidentalis*, were much lower than adult onion thrips, there were more differences among insecticide treatments, especially in Trial 1 (Table 2 and Fig. 3). In Trial 1 at 1 week after treatment, Vydate, Radiant, Carzol, and Lannate had lower densities than the untreated control, several of the Movento treatments, and Warrior. At 2 weeks after treatment, Carzol, Vydate, Lannate, and Warrior had significantly fewer WFT adults than the untreated control and several of the Movento treatments. Densities in all treatments declined by 3 weeks after treatment and there were no differences among treatments. In Trial 2, there were only significant differences among treatments on the pre-treatment date (Table 1 and Fig. 4). Results from Trial 1 did influence Trial 2 because treatments

were reapplied to the same plots. Despite pre-treatment differences, all counts at the beginning of Trial 2 were $\leq$ 1.0 adult WFT per plant. Counts on 1 and 3 weeks after treatment were low across all treatments. What appeared to be an influx of WFT adults on 2 weeks after treatment showed some numeric separation of treatments with lower numbers in Radiant, Vydate, Lannate, and Warrior plots, but not significantly so.

Larval thrips densities were significantly different among treatments on most sample dates in Trials 1 and 2 (Table 3 and Figs. 5 and 6). In Trial 1, larval abundance was reduced in Radiant and Lannate treatments as compared to untreated plots on 1 and 2 weeks after treatment. The Movento treatments did not reduce larval densities initially, but by 3 weeks after treatment, larval counts were significantly less than in the untreated control. Carzol, Vydate, and Warrior were not effective in reducing thrips larval densities (Fig. 5). In Trial 2, significant effects occurred pre-treatment and on 1 and 2 weeks after treatment (Table 3 and Fig. 6). Larval densities were much higher in untreated plots in Trial 2; as high as 110 per plant on 1 week after treatment. Most insecticides significantly reduced larval counts as compared to the untreated plots on 1 and 2 week sample dates. The Movento treatments again had a delayed effect on lowering densities, and had lower counts by 2 weeks after treatment. Radiant, Vydate, and Lannate had the lowest counts on the 2 week sample date. Larval densities declined in the untreated control by 3 weeks after treatment and there were no differences among treatments.

In summary, the insecticides that most consistently suppressed larval thrips were Lannate and Radiant. Movento showed a delayed effect in both trials of 2 to 3 weeks after treatment, in lowering larval densities. It appears that there is a delay in the uptake and translocation of Movento within the plant before insect suppression is observed. Movento at 5 oz + Induce and at 8 oz + MSO suppressed larval counts more than Movento at 5 oz + MSO, but not significantly so. Vydate, Carzol, and Warrior performed relatively better compared to the untreated control in the second trial when larval densities were generally higher, but their performance was generally below that of Lannate, Radiant, and Movento in suppressing larval thrips densities.

Insecticide efficacy on thrips egg hatch

An additional challenge to insecticide performance beyond just killing motile thrips life stages on plants at the time of application is to also suppress egg hatch or kill newly hatched larvae for a period of time following application. Egg hatch suppression would reduce reinfestation of onion plants. Therefore, measurements of hatch from eggs inserted in leaves were undertaken to evaluate this aspect of insecticide efficacy.

The number of eggs that hatched per third youngest leaf over a two week period following each post-treatment sample date ranged from 1 to 54 across treatments in both trials (Figs. 7 and 8). In Trial 1, several of the Movento treatments and the untreated control plots had higher egg hatch counts on the pre-treatment sample date (Fig. 7). By 2 and 3 weeks after insecticides were applied, egg hatch was significantly reduced in the Lannate and Movento treatments as compared to the untreated control. Egg hatch reductions were moderate in Radiant and Carzol treatments and not as low or consistent in the Warrior and Vydate treatments. In Trial 2 significant differences occurred only on 1 week after treatment where all insecticides except Movento at 5 oz + MSO significantly lowered egg hatch as compared to the untreated control (Fig. 8). In general, egg hatch

results were not highly consistent between the two trials, but Lannate and Movento at 8 oz + MSO treatments had the lowest egg hatch. Both of these treatments were effective in keeping egg hatch below 14 thrips per leaf for up to three weeks after treatment.

Thrips larvae hatching from eggs in leaves were counted at each one and two weeks after the leaves were collected from the field plots to allow evaluation of the influence of insecticides on rate of egg hatch. In both Trial 1 and 2, significantly more eggs hatched within the first week after collecting onion leaves from the field as compared to two weeks for all treatments including the untreated control. Egg hatch rate relationships were similar across the post-treatment sampling dates for insecticide treatments and trials, so only data for two weeks after treatment is shown (Figs. 9 and 10). In Trial 1 there was a significant interaction between insecticide treatment and week of egg hatch ($p = 0.007$). The drop in egg hatch rate from week one to two was significantly greater for the untreated, Carzol, and Warrior treatments as compared to the others (Fig. 9). These results suggest that Carzol and Warrior did not suppress egg hatch as effectively as the other insecticides. Movento at 5 oz + Induce, Radiant, and Vydate were intermediate in their suppression of egg hatch. The two Movento treatments with MSO and Lannate were the most effective is suppressing egg hatch. In Trial 2, there was no treatment by week interaction ($p > 0.05$) (Fig. 10). Radiant and Carzol treatments had the lowest egg hatch rates at two weeks after treatment in Trial 2; a different result than observed in Trial 1.

In summary, Lannate and Movento at 8 oz + MSO were the most effective treatments in suppressing thrips egg hatch. Egg hatch results were not as consistent between trials as were effects on other life stages. Larger sample sizes would likely improve the ability to sort out treatment differences. The sample size in this study was 8 leaves per treatment per sample date. Despite the variability, egg hatch results are still interesting and shed new light onto potential effects of different types of insecticides in exhibiting longer-term effects on the egg life stage which may hatch up to two weeks after insecticides are applied to plants in the field.

Influence of exclusion (caging) on thrips densities on plants

A third critical aspect of insecticide performance is prevention of re-infestation of plants from new immigrant adult thrips for a period of time after application. The use of exclusion cages allowed comparison of thrips populations with and without immigration. The cages also excluded natural enemies; however, densities of predaceous insects (black hunter thrips, spiders, minute pirate bug, lacewing, and ladybeetle) were low in this study (data not shown) and so did not appear to be an important factor. However, cumulative predation effects over time are likely to be greater than a single snap shot obtained on each sampling date. Also, the whole plant sampling method used may have allowed predators to escape as discussed previously for adult thrips. The results from the exclusion experiments are complex, but interesting and consistent between the two trials.

In both trials, the comparison of motile thrips densities (adults and larvae) on plants at one week after treatment found significantly more thrips on open than caged plants ($p = 0.02$ and 0.008 for Trials 1 and 2, respectively; data not shown). There were no interactions between presence of cages and insecticide treatments. These results suggest that at one week after treatment, more immigrant thrips are colonizing plants than

survived or hatched from the reservoir of eggs in leaves. Considering the previous information on egg hatch rates, that most eggs hatched within the first week (albeit under laboratory conditions at 25 $\pm$ 2ºC), this would suggest that immigration of new thrips is more important than survival and egg hatch. This is surprising given that insecticide residues should be the greatest within the first week after application and thus most repellent to immigrants.

By two weeks after treatment the relationship between thrips populations on open and caged plants had changed. Overall there was no difference between counts on open versus caged plants in either trial ($p > 0.05$); however, there was a significant interaction between presence of cages and insecticide treatments in Trial 1 only ($p = 0.007$) (Fig. 11). Thrips counts were greater on caged than open plants for untreated control, Carzol, Vydate, and Warrior treatments, but not for other treatments. These results suggest that these treatments were not as suppressive to egg hatch and thrips survival on plants during the second week after treatments. These results are generally supported by the egg hatch results presented above. In Trial 2, thrips counts were higher on caged than open plants only for the untreated control, and were higher on open than caged plants for all the insecticide treatments. The interaction between presence of cage and treatment was not significant ($p > 0.05$; data not shown).

Finally, at 3 weeks after treatment the effect of thrips exclusion was yet again different than at 1 and 2 weeks. In both trials, more thrips were present on caged than open plants ($p = 0.05$ for both Trial 1 and 2) and there was no interaction between presence of cage and insecticide treatments (data shown for Trial 1 only; Fig. 12). These results suggest that by 3 weeks after insecticides have been applied, more thrips had come from egg hatch and survival within the plant than from new immigrants. The residues of insecticides would have diminished by this time.

The low sample size of caged plants (4 plants per treatment per sample date) likely contributed to the inability to assuredly sort out the effects of thrips exclusion; however, although exclusion results are not clear-cut and uniformly consistent, they do reveal that adequate suppression of thrips populations on onion plants requires not only short-term suppression of motile life stages (adults and larvae), but also longer-term suppression of immigration, and egg hatch (and/or larval mortality upon hatch). Egg hatch rates of up to 54 larvae per 3rd youngest leaf on a plant over a 2 week period are impressive and suggest that the thrips egg reservoir in leaves is an important factor in re-infestation of onion plants. More studies and larger sample sizes are needed to more fully evaluate the contribution of all life stages, including the non-feeding 3rd and 4th instar larvae not considered in this study, to longer-term onion thrips population suppression in dry bulb onion fields.

Fig. 1. Insecticide efficacy – Trial 1
Adult Onion Thrips (*Thrips tabaci*)

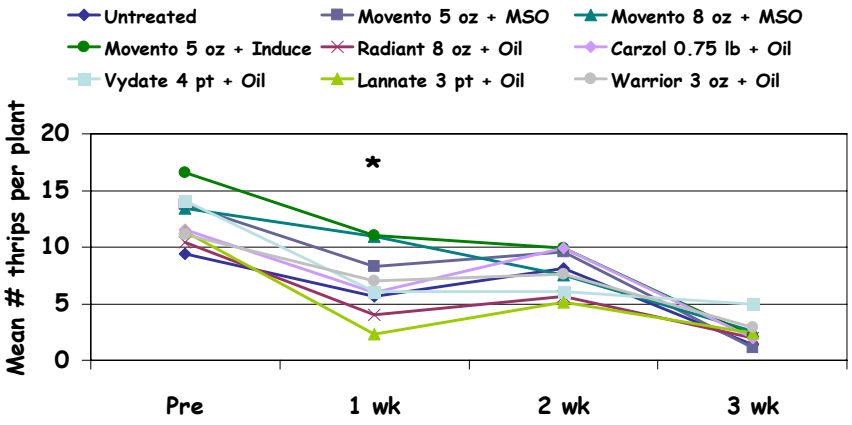


Fig. 2. Insecticide efficacy – Trial 2
Adult Onion Thrips (*Thrips tabaci*)

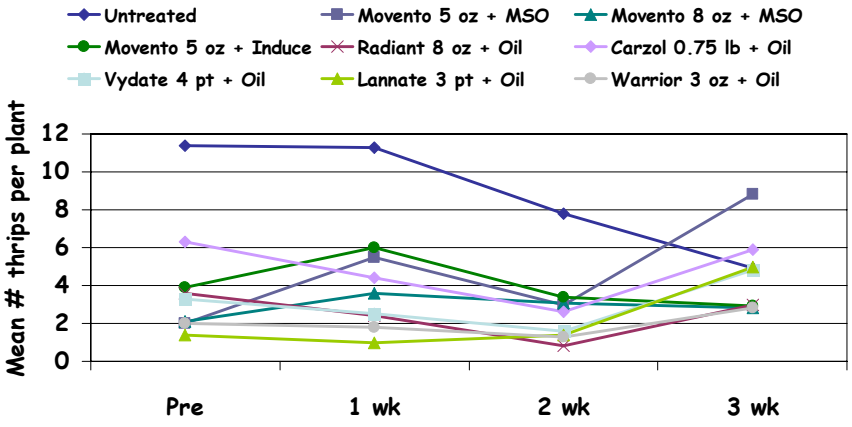


Fig. 3. Insecticide efficacy – Trial 1
Adult Western Flower Thrips (*Frankliniella occidentalis*)

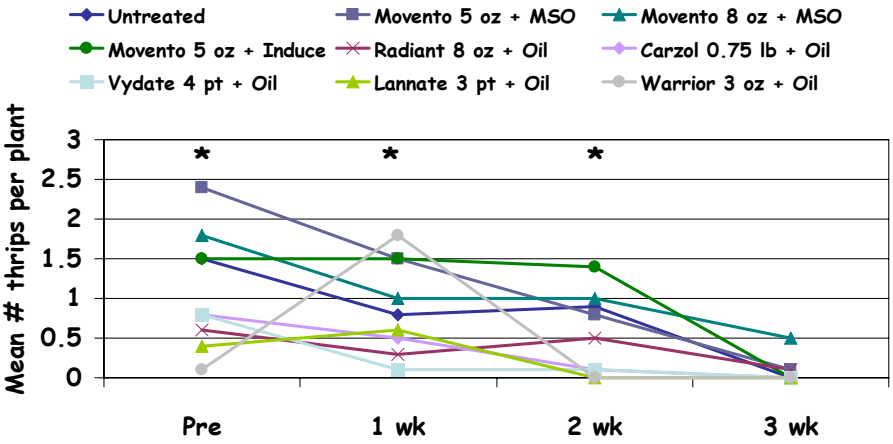


Fig. 4. Insecticide efficacy – Trial 2
Adult Western Flower Thrips (*Frankliniella occidentalis*)

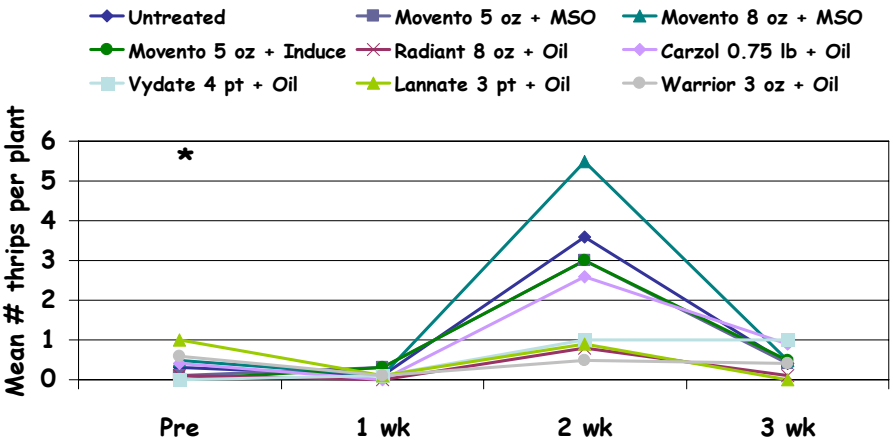


Fig. 5. Insecticide efficacy – Trial 1
Thrips Larvae

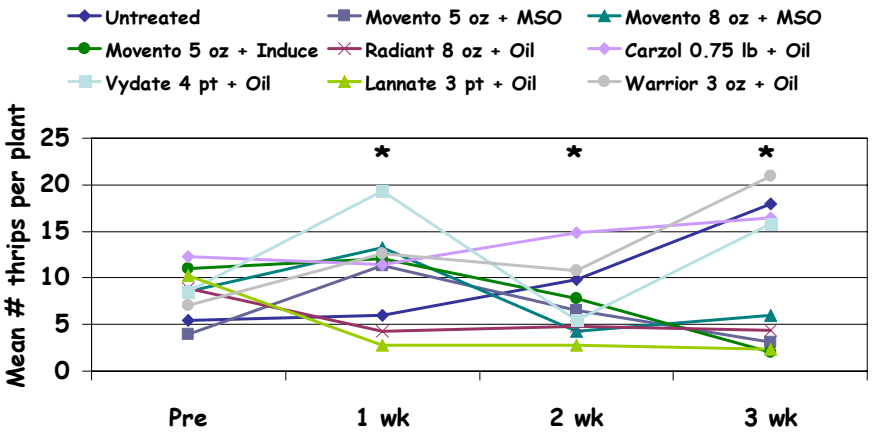


Fig. 6. Insecticide efficacy – Trial 2
Thrips Larvae

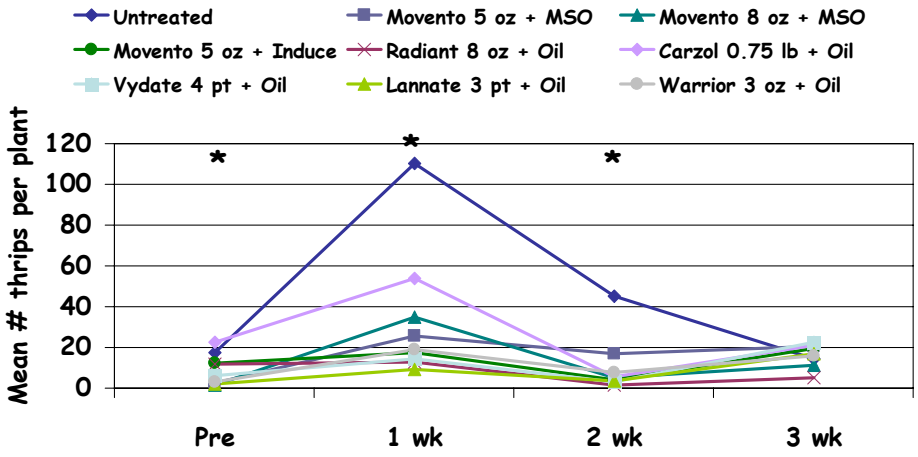


Fig. 7. Insecticide efficacy on egg hatch of onion thrips - Trial 1

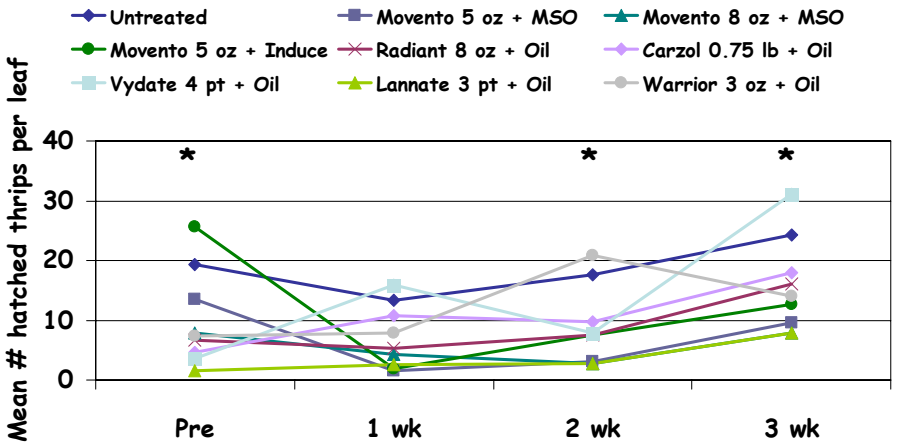


Fig. 8. Insecticide efficacy on egg hatch of onion thrips - Trial 2

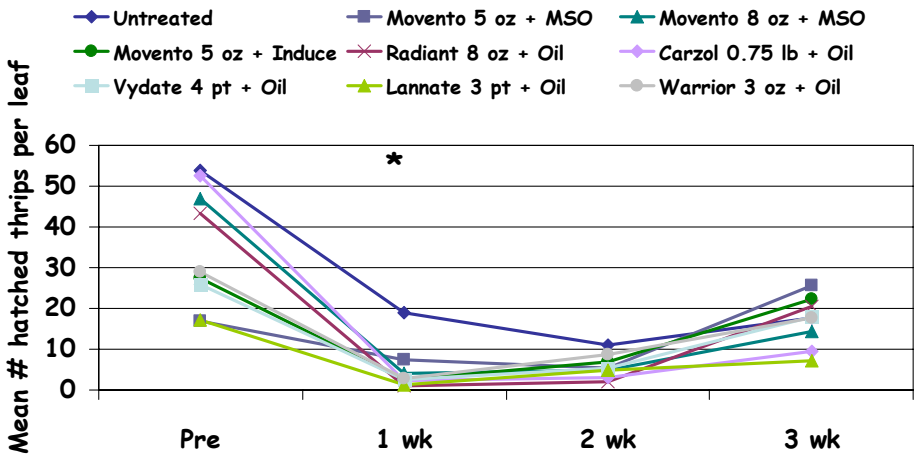
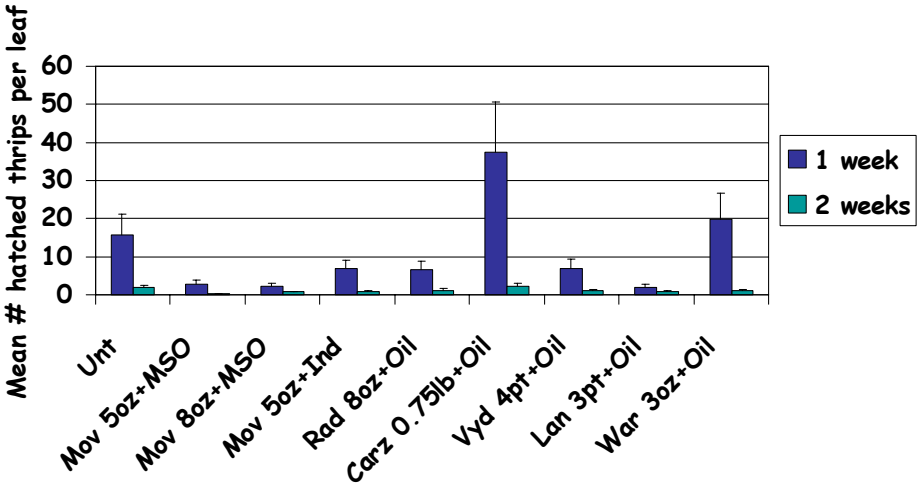
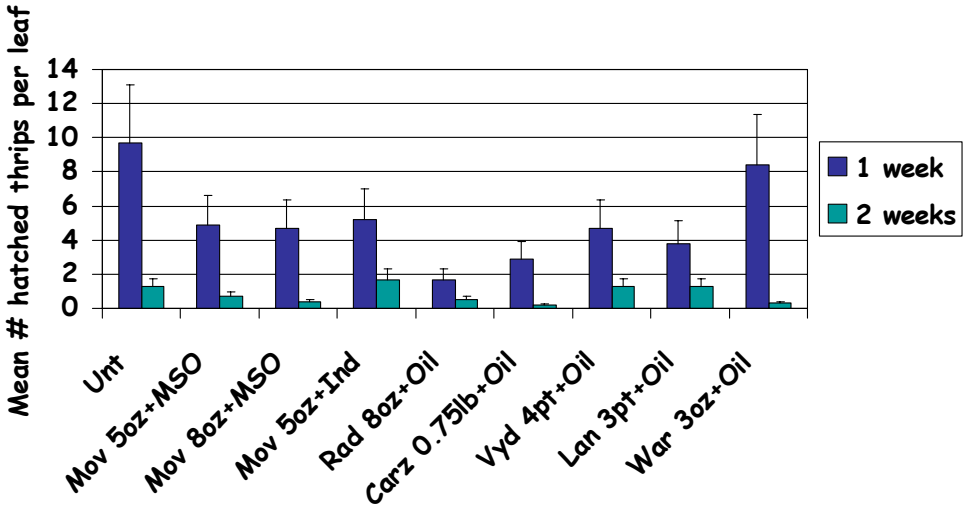


Fig. 9. Influence of insecticides on rate of thrips egg hatch – 2 weeks after treatment, Jul 10
Trial 1



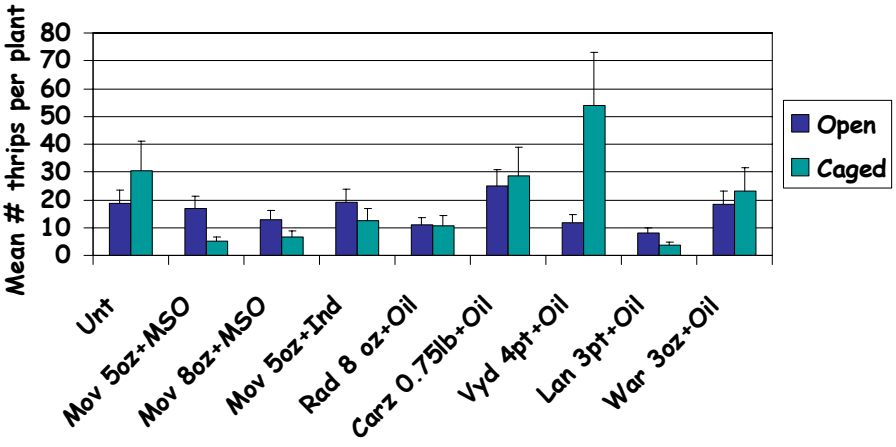
Week 1 > Week 2: $p < 0.001$

Fig. 10. Influence of insecticides on rate of onion thrips egg hatch – 2 weeks after treatment, Aug 13
Trial 2



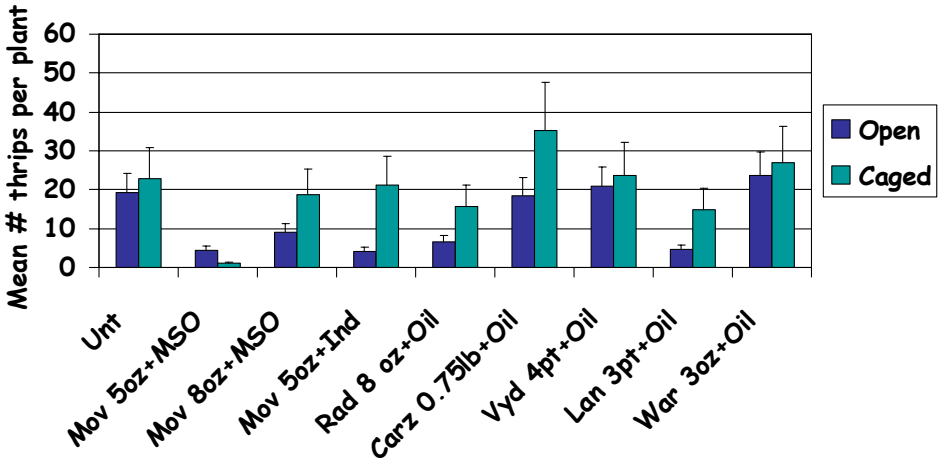
Week 1 > Week 2: $p < 0.001$

Fig. 11. Influence of exclusion (caging) on onion thrips densities (adults and larvae) on plants 2 wks after treatment, Jul 10 -Trial 1



Open is not different from Caged: $p = 0.86$
Presence of cage X insecticide interaction: $p = 0.007$

Fig. 12. Influence of exclusion (caging) on onion thrips densities (adults and larvae) on plants 3 wks after treatment, Jul 17 - Trial 1



Caged > Open: $p = 0.05$

Table 1. Influence of insecticide treatments on mean densities of onion thrips (OT) adults per plant from pre-treatment through three weeks after treatment for two trials conducted at the Utah Agricultural Experiment Station in Kaysville, UT in 2007.

Trial 1 (Jun 26-Jul 17)

Insecticide and formulation	Rates	Mean densities of OT adults per plant			
		Pre-trt.[+]	1 WAT*	2 WAT	3 WAT
1. Untreated		9.4	5.6 ab	8.1	1.4
2. Movento 240SC + MSO	5 oz/acre + 0.25% v/v	13.8	8.3 ab	9.6	1.1
3. Movento 240SC + MSO	8 oz/acre + 0.25% v/v	12.4	10.9 a	7.5	2.6
4. Movento 240SC + Induce	5 oz/acre + 0.25% v/v	16.6	11.0 a	9.9	2.1
5. Radiant 120SC + Stylet Oil	8 oz/acre + 1.0% v/v	10.4	4.0 b	5.6	2.0
6. Carzol SP + Stylet Oil	0.75 lb/acre + 1.0% v/v	11.5	6.0 ab	9.9	2.0
7. Vydate L + Stylet Oil	4 pt/acre + 1.0% v/v	14.1	6.1 ab	6.1	5.0
8. Lannate LV + Stylet Oil	3 pt/acre + 1.0% v/v	11.4	2.3 bc	5.1	2.4
9. Warrior + Stylet Oil	3 oz/acre + 1.0% v/v	11.1	7.0 ab	7.6	2.9
P>F		*0.68*	*0.03*	*0.51*	*0.32*
Trial 2 (Jul 31-Aug 21)					
1. Untreated		11.4	11.3	7.8	4.9
2. Movento 240SC + MSO	5 oz/acre + 0.25% v/v	2.0	5.5	3.0	8.8
3. Movento 240SC + MSO	8 oz/acre + 0.25% v/v	2.1	3.6	3.1	2.8
4. Movento 240SC + Induce	5 oz/acre + 0.25% v/v	3.9	6.0	3.4	2.9
5. Radiant 120SC + Stylet Oil	8 oz/acre + 1.0% v/v	3.6	2.4	0.8	3.0
6. Carzol SP + Stylet Oil	0.75 lb/acre + 1.0% v/v	6.3	4.4	2.6	5.9
7. Vydate L + Stylet Oil	4 pt/acre + 1.0% v/v	3.3	2.5	1.6	4.8
8. Lannate LV + Stylet Oil	3 pt/acre + 1.0% v/v	1.4	1.0	1.4	5.0
9. Warrior + Stylet Oil	3 oz/acre + 1.0% v/v	2.0	1.8	1.3	2.8
P>F		*0.08*	*0.06*	*0.25*	*0.32*

[+]Densities were assessed immediately before application of insecticides on Jun 26 and Jul 31 for Trials 1 and 2, respectively.

*Densities were assessed on 1, 2, and 3 weeks after treatment (WAT).

N=36 observations per date.

Data were square-root transformed (x+0.1) before analysis to meet normality assumptions.

Treatment means were separated with Tukey-Kramer pair-wise comparisons when significantly different in analysis of variance (Proc Mixed; $p \leq 0.05$).

Table 2. Influence of insecticide treatments on mean densities of western flower thrips (WFT) adults per plant from pre-treatment through three weeks after treatment for two trials conducted at the Utah Agricultural Experiment Station in Kaysville, UT in 2007.

Trial 1 (Jun 26-Jul 17)

Insecticide and formulation	Rates	Mean densities of WFT adults per plant			
		Pre-trt.[+]	1 WAT*	2 WAT	3 WAT
1. Untreated		1.5 ab	0.8 a	0.9 ab	0
2. Movento 240SC + MSO	5 oz/acre + 0.25% v/v	2.4 a	1.5 a	0.8 abc	0.1
3. Movento 240SC + MSO	8 oz/acre + 0.25% v/v	1.8 ab	1.0 ab	1.0 ab	0.5
4. Movento 240SC + Induce	5 oz/acre + 0.25% v/v	1.5 ab	1.5 a	1.4 a	0
5. Radiant 120SC + Stylet Oil	8 oz/acre + 1.0% v/v	0.6 bc	0.3 bc	0.5 b	0.1
6. Carzol SP + Stylet Oil	0.75 lb/acre + 1.0% v/v	0.8 bc	0.5 bc	0.1 c	0
7. Vydate L + Stylet Oil	4 pt/acre + 1.0% v/v	0.8 bc	0.1 c	0.1 c	0
8. Lannate LV + Stylet Oil	3 pt/acre + 1.0% v/v	0.4 c	0.6 bc	0 d	0
9. Warrior + Stylet Oil	3 oz/acre + 1.0% v/v	0.1 c	1.8 a	0 d	0
P>F		*0.008*	*0.003*	*0.005*	*0.32*
Trial 2 (Jul 31-Aug 21)					
1. Untreated		0.3 b	0.1	3.6	0.4
2. Movento 240SC + MSO	5 oz/acre + 0.25% v/v	0.1 bc	0.3	3.0	0.4
3. Movento 240SC + MSO	8 oz/acre + 0.25% v/v	0.5 ab	0.1	5.5	0.5
4. Movento 240SC + Induce	5 oz/acre + 0.25% v/v	0 c	0.3	3.0	0.5
5. Radiant 120SC + Stylet Oil	8 oz/acre + 1.0% v/v	0.1 bc	0	0.8	0.1
6. Carzol SP + Stylet Oil	0.75 lb/acre + 1.0% v/v	0.4 ab	0	2.6	0.9
7. Vydate L + Stylet Oil	4 pt/acre + 1.0% v/v	0 c	0.1	1.0	1.0
8. Lannate LV + Stylet Oil	3 pt/acre + 1.0% v/v	1.0 a	0.1	0.9	0
9. Warrior + Stylet Oil	3 oz/acre + 1.0% v/v	0.6 ab	0.1	0.5	0.4
P>F		*0.01*	*0.96*	*0.23*	*0.47*

[+]Densities were assessed immediately before application of insecticides on Jun 26 and Jul 31 for Trials 1 and 2, respectively.

*Densities were assessed on 1, 2, and 3 weeks after treatment (WAT).

N=36 observations per date.

Data were square-root transformed (x+0.1) before analysis to meet normality assumptions.

Treatment means were separated with Tukey-Kramer pair-wise comparisons when significantly different in analysis of variance (Proc Mixed; $p \leq 0.05$).

Table 3. Influence of insecticide treatments on mean densities of onion thrips (OT) larvae per plant from pre-treatment through three weeks after treatment for two trials conducted at the Utah Agricultural Experiment Station in Kaysville, UT in 2007.

Insecticide and formulation	Rates	Mean densities of OT larvae per plant			
		Pre-trt.[+]	1 WAT*	2 WAT	3 WAT
Trial 1 (Jun 26-Jul 17)					
1. Untreated		5.4	6.0 b	9.8 ab	17.9 a
2. Movento 240SC + MSO	5 oz/acre + 0.25% v/v	3.9	11.3 ab	6.5 abc	3.1 bc
3. Movento 240SC + MSO	8 oz/acre + 0.25% v/v	8.6	13.3 ab	4.3 bc	6.0 b
4. Movento 240SC + Induce	5 oz/acre + 0.25% v/v	11.0	12.1 a	7.8 abc	2.0 c
5. Radiant 120SC + Stylet Oil	8 oz/acre + 1.0% v/v	8.9	4.3 c	4.8 bc	4.4 bc
6. Carzol SP + Stylet Oil	0.75 lb/acre + 1.0% v/v	12.3	11.4 ab	14.8 a	16.5 a
7. Vydate L + Stylet Oil	4 pt/acre + 1.0% v/v	8.6	19.3 a	5.4 bc	15.8 ab
8. Lannate LV + Stylet Oil	3 pt/acre + 1.0% v/v	10.3	2.8 c	2.8 c	2.3 c
9. Warrior + Stylet Oil	3 oz/acre + 1.0% v/v	7.0	12.6 ab	10.8 ab	20.9 a
P>F		*0.40*	*0.03*	*0.05*	*0.04*
Trial 2 (Jul 31-Aug 21)					
1. Untreated		17.5 ab	110.4 a	45.0 a	14.6
2. Movento 240SC + MSO	5 oz/acre + 0.25% v/v	2.6 d	25.4 bcd	17.0 ab	20.5
3. Movento 240SC + MSO	8 oz/acre + 0.25% v/v	1.3 d	34.9 bc	5.0 bc	11.3
4. Movento 240SC + Induce	5 oz/acre + 0.25% v/v	12.4 ab	17.3 cd	4.3 bc	19.6
5. Radiant 120SC + Stylet Oil	8 oz/acre + 1.0% v/v	11.6 bc	12.8 d	1.4 c	5.0
6. Carzol SP + Stylet Oil	0.75 lb/acre + 1.0% v/v	22.8 a	53.9 b	5.6 bc	21.1
7. Vydate L + Stylet Oil	4 pt/acre + 1.0% v/v	6.3 bcd	14.5 cd	2.9 c	22.5
8. Lannate LV + Stylet Oil	3 pt/acre + 1.0% v/v	2.3 d	9.0 d	3.4 c	16.9
9. Warrior + Stylet Oil	3 oz/acre + 1.0% v/v	3.1 cd	18.9 cd	7.6 bc	16.1
P>F		*<0.001*	*<0.001*	*0.05*	*0.24*

[+]Densities were assessed immediately before application of insecticides on Jun 26 and Jul 31 for Trials 1 and 2, respectively.

*Densities were assessed on 1, 2, and 3 weeks after treatment (WAT).

N=36 observations per date.

Data were square-root transformed (x+0.1) before analysis to meet normality assumptions.

Treatment means were separated with Tukey-Kramer pair-wise comparisons when significantly different in analysis of variance (Proc Mixed; $p \leq 0.05$).

2007 Kaysville Onion Thrips Biology and Control Trial

North ↓

Block 4	**4**	**7**	**1**	**2**	**9**	**6**	**3**	**5**	**8**
Block 3	**6**	**5**	**9**	**3**	**7**	**2**	**8**	**4**	**1**
Block 2	**1**	**8**	**6**	**4**	**3**	**9**	**5**	**7**	**2**
Block 1	**3**	**2**	**5**	**9**	**1**	**8**	**6**	**4**	**7**

Treatments (flag colors):

1. Untreated control (white)
2. Movento 5 oz + MSO (orange)
3. Movento 8 oz + MSO ((orange stripe)
4. Movento 5 oz + Induce (yellow)
5. Radiant 8 oz + Oil (yellow stripe)
6. Carzol 0.75 lb + Oil (pink)
7. Vydate 4 pt + Oil (pink stripe)
8. Lannate 3 pt + Oil (green)
9. Warrior 3 oz + Oil (blue)

9 treatments x 4 blocks = 36 plots
Onions are planted in raised beds with 4 rows per bed; spacing between beds is 3 ft
Plot size:
12 ft (4 beds) x 20 ft
5 ft open buffer in front and behind each plot

Dirt Road and Irrigation Line