THRIPS AND IRIS YELLOW SPOT VIRUS MANAGEMENT IN THE TREASURE VALLEY

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Objective

Evaluate different treatment sequences of insecticides for thrips and Iris yellow spot virus management.

Introduction

Onion thrips and Iris yellow spot virus (IYSV), which is transmitted by onion thrips, are major limiting factors for onion production in the Treasure Valley. The high concentration of onion fields, and the long, hot growing season in the valley makes management of onion thrips and IYSV particularly challenging.

Insecticides remain the primary tool for thrips management. However, insecticide-based management faces difficulties because there is a limited set of registered insecticides with efficacy against onion thrips, and thrips are able to rapidly develop resistance to various classes of insecticides. Therefore, it is important to assess the effectiveness of currently registered insecticides and to determine when during the season different insecticides may be used most effectively. It is also important to determine the effectiveness of new products and how they may be integrated into an overall thrips management program.

Therefore, we conducted two field trials to evaluate different insecticide management programs, with products applied in various sequences over the growing season. The foliar application trial consisted of 20 different treatment regimens (including experimental/unregistered insecticides, which are not shown) (Tables 2 and 3). A second trial was designed to compare treatment regimens in which products were applied by drip application versus corresponding foliar application. This trial included 12 different treatment regimens (Tables 2 and 5).

Materials and Methods

Cultural Practices

Onion seed (cv 'Vaquero') was planted at 143,000 seeds/acre on March 28, 2018.

The field was drip irrigated with drip tape laid at 4-inch depth between two onion beds during planting. The drip tape had emitters spaced 12 inches apart and an emitter flow rate of 0.22 gal/min/100 ft (T-Tape, Rivulis USA, San Diego, CA). The distance between the tape and the center of each double row of onions was 11 inches.

Onions were irrigated automatically to maintain the soil water tension (SWT) in the onion root zone below 20 cb. Soil water tension was measured with six granular matrix sensors (GMS, Watermark Soil Moisture Sensors Model 200SS, Irrometer Co., Riverside, CA) installed at 8-inch depth in the center of the double row. Sensors had been calibrated to SWT. Irrigations were run by a controller programmed to irrigate twice a day applying 0.48 inch of water per irrigation. A Watermark Electronic Module (WEM, Irrometer Co.) was adjusted to override controller irrigations if the SWT was below 20 cb. Four Watermark sensors were connected to the WEM.

Weed management included an application of Roundup® on April 13, just before onion emergence; and GoalTender® at 4 oz/acre, Brox® 2EC at 16 oz/acre, and Shadow® 3EC at 5.3 oz/acre on May 8; Prowl® H2O at 2 pt/acre on May 19; GoalTender® at 8 oz/acre, Brox 2EC at 20 oz/acre, and Shadow 3EC at 5.3 oz/acre on May 30.

Foliar Insecticide Trial Applications

Insecticides were applied weekly from May 25 to July 13, according to the schedule and rates listed in Tables 2 and 3. Insecticides were applied with a CO_2 backpack sprayer using a 4-nozzle boom with 11004 nozzles at 30 psi and 35 gal/acre. Each treatment plot was 4 double rows wide by 23 ft long.

Drip Insecticide Trial Applications

In the drip application trial, insecticide applications were made on approximately 10-day intervals from May 25 to August 6 (Tables 2 and 5). The drip trial included the standard foliar applications of Movento®, Agri-Mek®, Radiant®, and Lannate® for comparison (Treatment 4 in this trial).

Drip applications were made by injecting insecticide solutions for 6 hours. Solutions were mixed and buffered in 60 gal of water. Injections were made with Ozawa pumps running at 10 gal/hour. Water was applied for 1 hour before applications began and for 1 hour after insecticide injections were completed.

Foliar applications were made with a CO_2 backpack sprayer using a 4-nozzle boom with 11004 nozzles at 30 psi and 35 gal/acre. Each treatment plot was 4 double rows wide by 23 ft long.

Data Collection

Weekly thrips counts were made, starting on May 7 (before insecticide applications began). After insecticide applications began, thrips were counted 3-4 days following an application. Thrips counts were made by counting the number of thrips on 10 consecutive plants in one of the middle two rows of each plot. Adult and larval (immature) thrips were counted separately.

Onions in each plot were evaluated visually for severity of symptoms of IYSV and thrips feeding damage after insecticide treatments had been completed. Assessments were made on July 30 for the foliar trial and on August 8 for the drip trial. Ten consecutive plants in one of the middle two rows of each plot were rated on a scale of 0 to 4 of increasing severity of symptoms or feeding damage. Separate ratings were made for the inner, middle, and outer leaves of each plant to estimate damage occurrence over the course of the growing season.

The rating scale was as follow (Table 1):

Table 1. Rating scales used to assess severity of Iris yellow spot and thrips feeding damage on onions.

Rating	IYSV lesions (% foliage with lesions)	Feeding damage (% foliage with scarring)
0	0	0
1	1–25	1–25
2	26–50	26–50
3	51–75	51–75
4	76–100	76–100

Onions from the middle two double rows in each plot were lifted on September 13. They were topped by hand, bagged on September 18 and placed in storage. The onions from each plot were graded on November 5 and 6. During grading, bulbs were separated according to quality: bulbs without blemishes (No. 1s), split bulbs (No. 2s), neck rot (bulbs infected with the fungus *Botrytis allii* in the neck or side), plate rot (bulbs infected with the fungus *Fusarium oxysporum*), and black mold (bulbs infected with the fungus *Aspergillus niger*). The No. 1 bulbs were graded according to diameter: small, medium, jumbo, colossal, and supercolossal. Bulb counts per 50 lb of supercolossal onions were determined for each plot of every variety by weighing and counting all supercolossal bulbs during grading. Marketable yield consisted of No.1 bulbs in the medium or larger size classes (larger than 2¼ inches).

Results and Conclusions

Foliar Application Trial

Thrips began to colonize onions in early May and reached the threshold level for the trial (4 thrips/plant) by May 22. Applications in both trials began on May 25 (Figs. 1 and 4). Thrips populations began to peak in late June, which has been the typical pattern in the Ontario/Cairo Junction area. However, populations rapidly collapsed soon after that, which has not been typical. In the untreated control, populations began to decline after the first week of July. Overall, thrips pressure in the trial was lower than in recent years, with the greatest average in the control reaching only about 26 per plant (Fig. 1). Thrips feeding damage and IYSV severity were relatively low for the season (Table 4).

As is typical, most thrips on onions were immatures (~75%). Because of the ability of adults to move from plant to plant, we typically do not see large differences in adult populations among insecticide treatments. The largest treatment effects are a result of the effect on immature thrips.

The standard reference program of two applications of Movento, followed by two of Agri-Mek, two of Radiant, and two of Lannate still performed well under this season's conditions (Treatment program 2). Thrips numbers increased late in the season with the final Lannate applications, which was a pattern seen in other treatment programs with late season use of Lannate (Fig. 4). Figure 4(A) shows the percentage difference in thrips between treatment 19 and the untreated control after the first 2 of 8 Lannate applications, and then the percentage difference after the last 2 of 8 Lannate applications. The increase in thrips numbers at the end of

the Lannate applications indicates it may become less effective with more applications within a season.

The effect of Movento was enhanced by combining it with an adulticide (e.g., Treatment 17, the first application of Movento with Radiant).

In situations where applications need to begin earlier in the spring than late May, applying Movento later in the season (by 1–2 weeks) rather than at the start may also make better use of its activity against immature thrips when thrips populations reach their peak in late June. For example, Treatment 3, which started Aza-Direct plus M-Pede®, followed by Movento mixed with Aza-Direct and then M-Pede, reduced the number of larval thrips at the population peak (Figs. 1 and 2).

This year's trial included a number of programs with Minecto® Pro, which combines the active ingredients of Agri-Mek and Exirel®. It performed well whether used early or late in the season but not dramatically better than Agri-Mek (Figs. 1 and 2).

Treatment program 3 had the numerically highest yield and a favorable size profile. This pattern is similar to previous year's results with this program (Fig. 3). In part, it delays Movento applications until later in the season, which helps to control peak populations of immature thrips. In addition, it does not use Lannate late in the season, which may help avoid later season spikes in thrips numbers (Figs. 1, 2, 4).

Table 2. Characteristics of insecticides tested for efficacy against onion thrips. Sequences with unregistered products are not listed. **Please consult the label to determine appropriate uses for all pesticides.** Malheur Experiment Station, Oregon State University, Ontario, OR, 2018.

Product	Company	Rate (product per acre)	Adjuvant	Active ingredient	pH	Mode of action group
Agri-Mek SC	Syngenta	3.5 fl oz	MSO 0.5% v/v	abamectin	6.5	6
Aza-Direct	Gowan	16 fl oz	-	azadirachtin	6.0	unknown
Captiva	Gowan	7/11 fl oz		capsacin oleoresin, garlic oil, soybean oil	7.0	Unknown
Exirel	FMC	13.5 fl oz	MSO 0.5% v/v	Cyantraniliprole	5.0	28
Lannate LV	DuPont	3 pt	NIS 0.25% v/v	methomyl	5.0	1A
M-Pede	Gowan	5.6 pt	-	potassium salts of fatty acids	6.0	unknown
Minecto Pro	Syngenta	10 fl oz	MSO 0.5% v/v NIS 0.25% v/v	Abamectin / Cyantraniliprole	6.0	6 / 28
Movento HL	Bayer	2.5 fl oz	MSO 0.5% v/v Dyne-Amic 0.25% v/v	spirotretramat	6.5	23
Radiant	Dow	8 fl oz	Dyne-Amic 0.25% v/v	spinetoram	7.0	5
Venerate	Marrone	8 qt	-	*Burkholderia strain A396*	6.0	Heat-killed bacteria
Verimark	FMC	10.3 fl oz	-	Cyantraniliprole	5.0	28

Table 3. Insecticide regimens and application dates in the standard insecticide treatment program. Only treatment regimens with registered products are listed. Applications were made once per week. Malheur Experiment Station, Oregon State University, Ontario, OR.

Date	25-May	1-Jun	8-Jun	15-Jun	22-Jun	29-Jun	6-Jul	13-Jul
Treatment	**1st**	**2nd**	**3rd**	**4th**	**5th**	**6th**	**7th**	**8th**
1	Control	-	-	-	-	-	-	-
2	Movento (old form)	Movento (old form)	Agri-Mek	Agri-Mek	Radiant	Radiant	Lannate	Lannate
3	M-Pede+ Aza-Direct	M-Pede+ Aza-Direct	Movento HL + Aza-Direct	M-Pede + Movento HL	Minecto	Minecto	Radiant + M-Pede	Radiant + M-Pede
6	Movento HL	Movento HL	Minecto	Minecto	Radiant	Radiant	Lannate	Lannate
7	Movento HL	Movento HL	Radiant	Radiant	Minecto	Minecto	Lannate	Lannate
8	Movento HL	Movento HL	Radiant	Radiant	Lannate	Lannate	Minecto	Minecto
9	Movento HL	Movento HL	Radiant	Radiant	Exirel	Exirel	Lannate	Lannate
10	Movento HL	Movento HL	Radiant	Radiant	Lannate	Lannate	Exirel	Exirel
15	Movento HL	Movento HL	Agri-Mek	Agri-Mek	Radiant	Radiant	Lannate	Lannate
16	Movento HL	Movento HL	Agri-Mek	Agri-Mek	Radiant	Radiant	Lannate	Lannate
17	Movento HL + Radiant	Movento HL	Minecto	Minecto	Radiant	Radiant	Lannate	Lannate
18	Lannate	Lannate	Lannate	Lannate	Lannate	Lannate	Lannate	Lannate
19	Exirel	Exirel	Movento HL	Movento HL	Radiant	Radiant	Lannate	Lannate

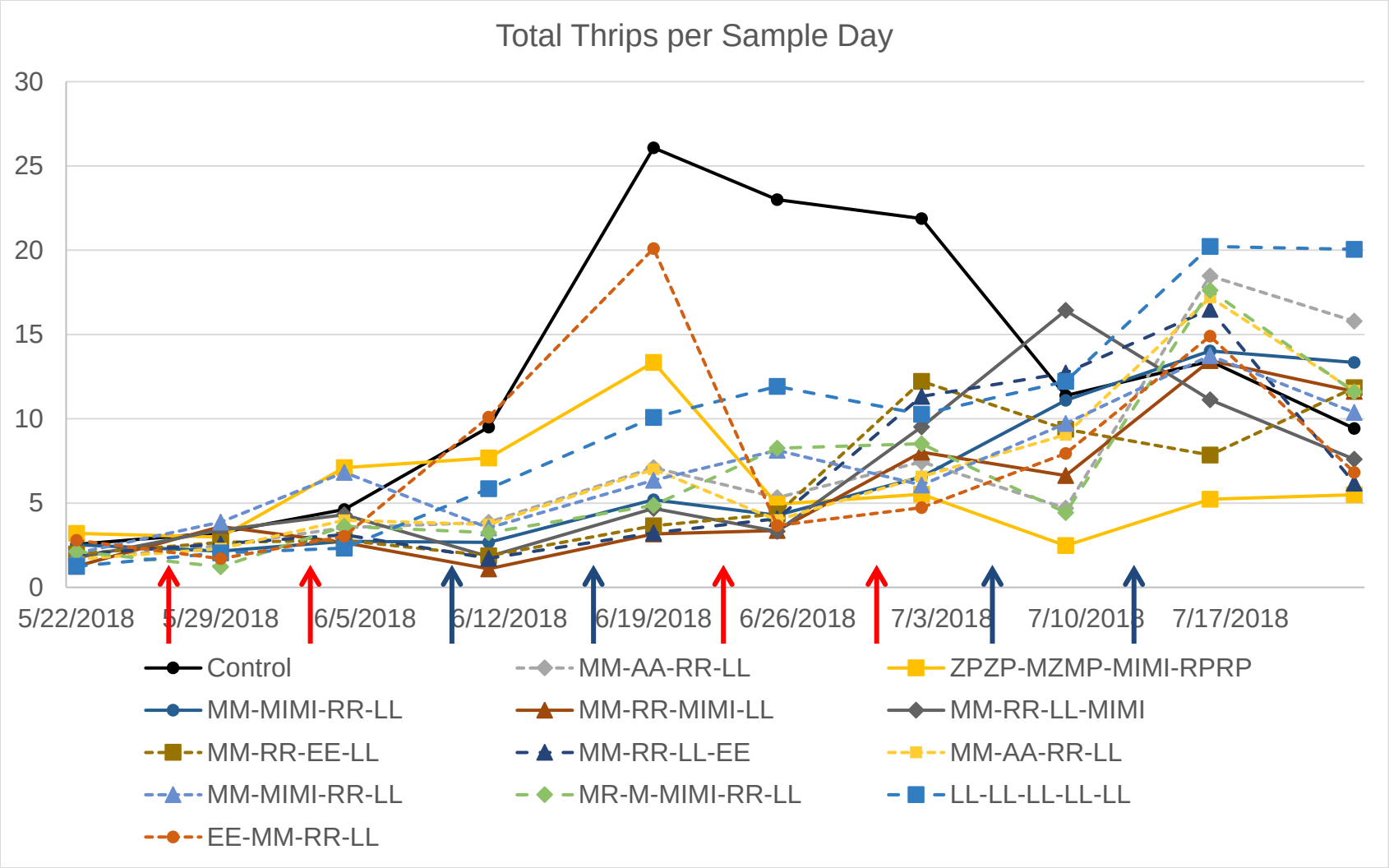


Figure 1. Average total thrips per plant in the foliar insecticide trial at the Malheur Experiment Station, 2018. Insecticide abbreviations: A = Agri-Mek, L = Lannate, M = Movento, MI = Minecto Pro, P = M-Pede, R = Radiant, Z = Aza-Direct. See Tables 1 and 2 for additional information on applications.

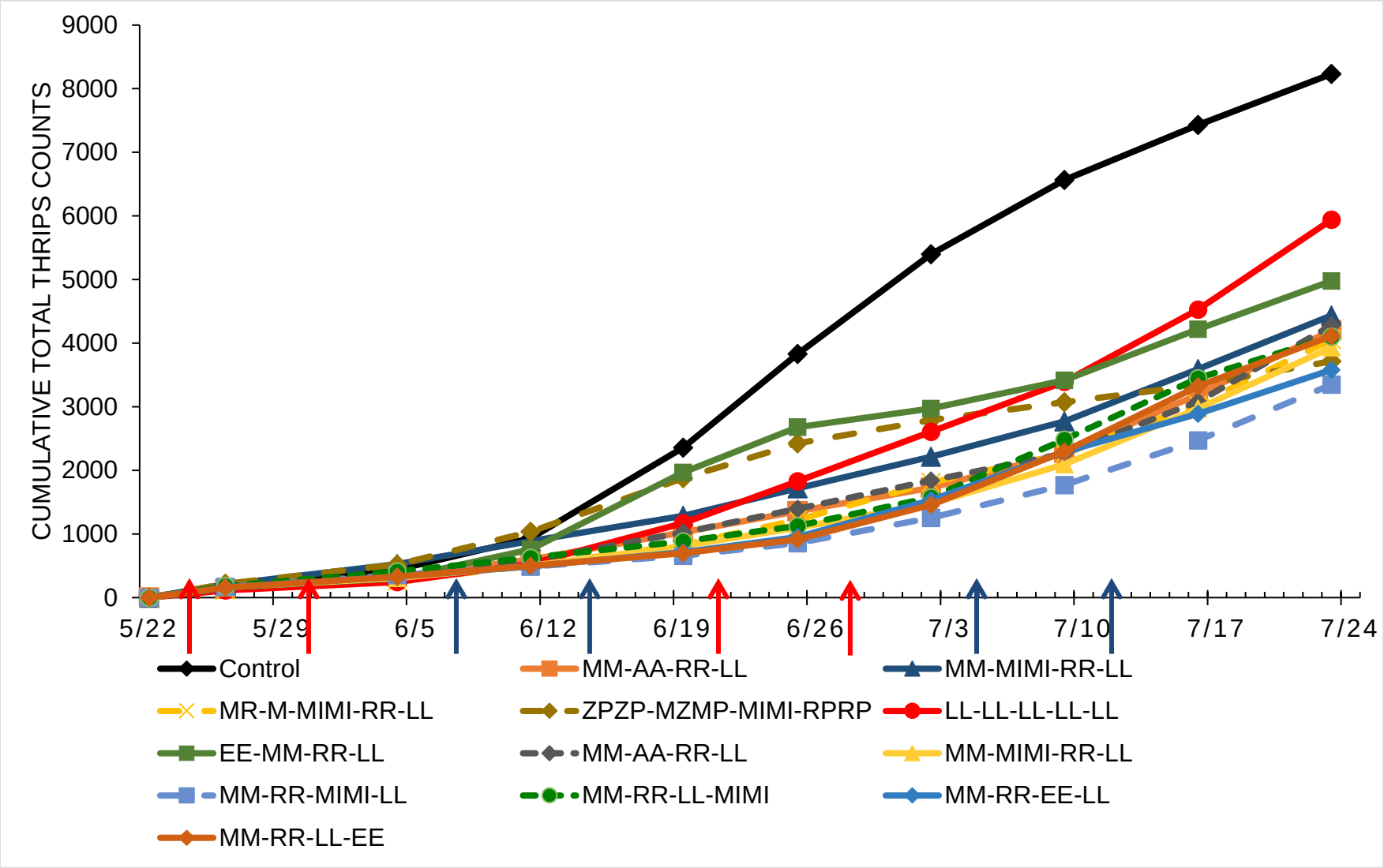


Figure 2. Cumulative thrips counts for the standard foliar insecticide trial in which applications were made weekly, Malheur Experiment Station, Oregon State University, Ontario, OR. Arrows along the date axis show when applications were made. Insecticide abbreviations: A = Agri-Mek, L = Lannate, M = Movento, MI = Minecto Pro, P = M-Pede, R = Radiant, Z = Aza-Direct. See Tables 1 and 2 for additional information on applications.

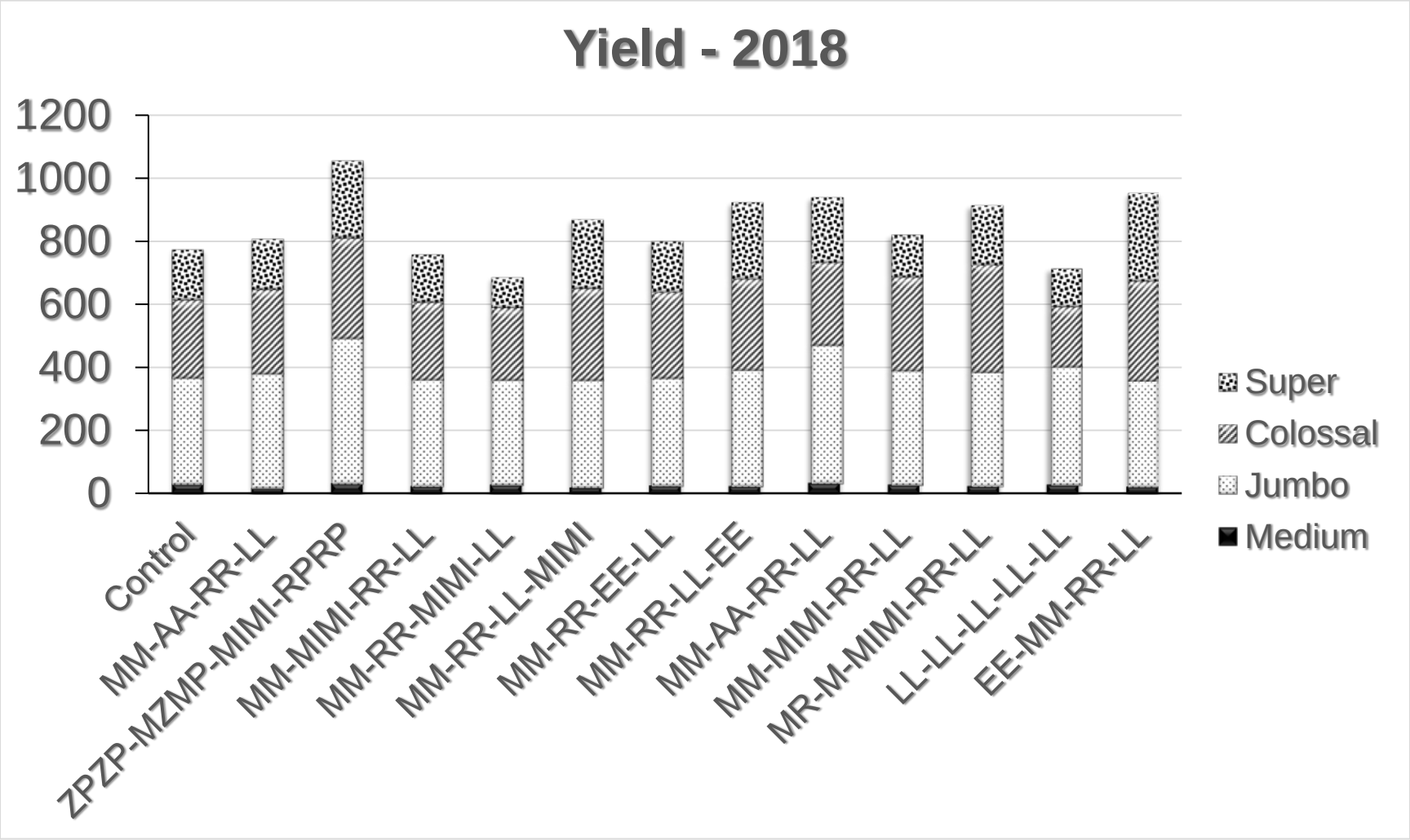
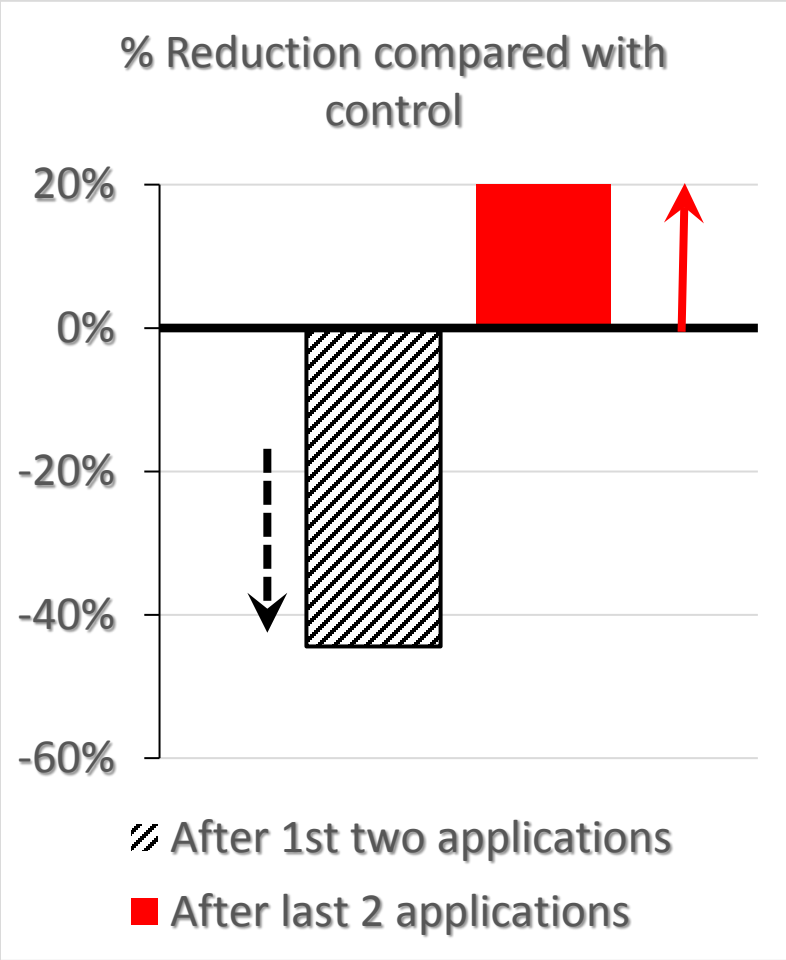


Figure 3. Marketable onion yield (cwt/acre) results by size category for the drip application trial, Malheur Experiment Station, Oregon State University, Ontario, OR. Insecticide abbreviations: A = Agri-Mek, E = Exirel, L = Lannate, M = Movento, MI = Minecto Pro, P = M-Pede, R = Radiant, Z = Aza-Direct. See Tables 1 and 2 for additional information on applications. Note Program 2 (MM-AA-RR-LL uses the old Movento formulation; all others use the new Movento HL formulation).

Table 4. Severity of Iris yellow spot virus and thrips damage to onions in 2018 in the standard foliar application trial, Malheur Experiment Station, Oregon State University, Ontario, OR. Ratings are the mean rating for 10 plants per plot taken on July 30, 2018 after insecticide applications had been completed. Ratings are on a 0-4 scale. See Tables 1 and 2 for descriptions of treatments.

Treatment	Mean virus damage rating	Mean thrips damage rating
1 - Control	0.80	0.98
2 - MM-AA-RR-LL	0.45	0.55
3 - ZPZP-MZMP-MIMI-RPRP	0.73	0.58
6 - MM-MIMI-RR-LL	0.55	0.65
7 - MM-RR-MIMI-LL	0.53	0.63
8 - MM-RR-LL-MIMI	0.58	0.65
9 - MM-RR-EE-LL	0.63	0.63
10 - MM-RR-LL-EE	0.58	0.83
15 - MM-AA-RR-LL	0.60	0.45
16 - MM-AA-RR-LL	0.65	0.78
17 - MR-M-MIMI-RR-LL	0.73	0.85
18 - LL-LL-LL-LL	0.48	0.68
19 - EE-MM-RR-LL	0.53	0.83
	LSD = 0.25	LSD = 0.27



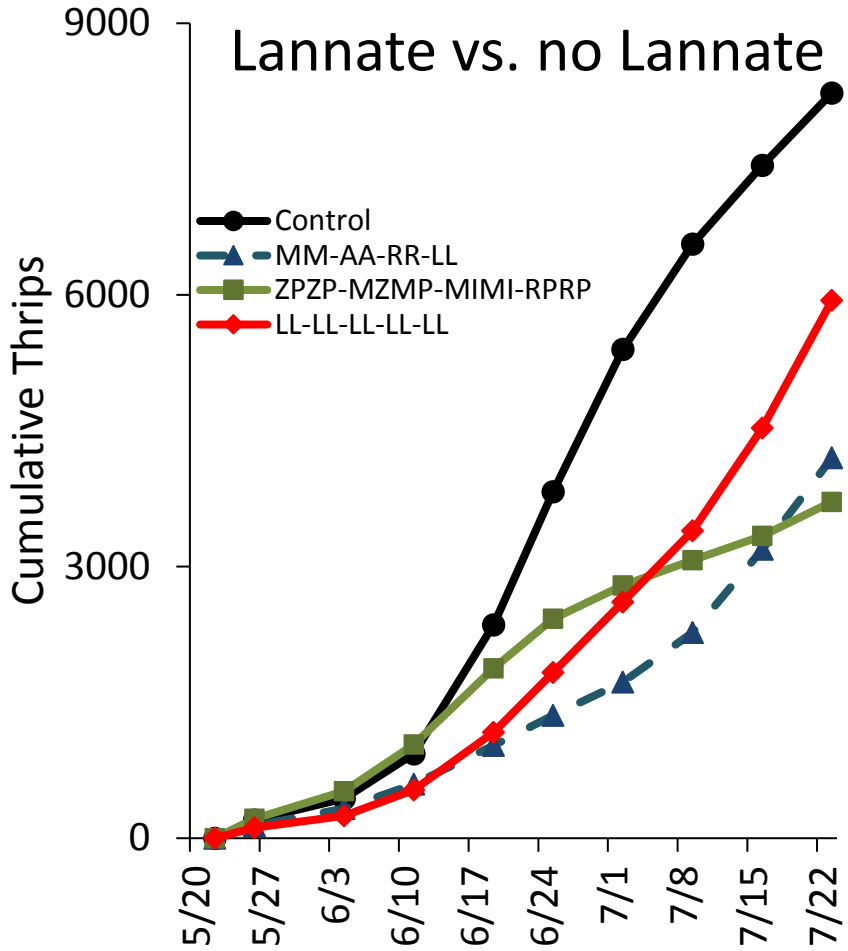


Figure 4. The effect of repeated applications of Lannate on thrips populations. (A) Bar on the left shows the percent reduction in thrips in plots that received two consecutive applications of Lannate compared with thrips in untreated plots. (B) Bar on the right shows the percent increase in thrips in plots that had received 8 applications of Lannate compared with thrips in the untreated plots. Treatment abbreviations in the legand: A = Agri-Mek, L = Lannate, M = Movento, MI = Minecto Pro, P = M-Pede, R = Radiant, Z = Aza-Direct.

Drip Application Trial

Thrips populations remained above the trial threshold of four per plant through the application schedule (August 8), indicating the need to continue thrips treatments into August for later maturing varieties, such as Vaquero. Although thrips populations persisted through the growing season, pressure was relatively low compared with other seasons (Table 6). Iris yellow spot virus did become more prevalent late in the season, as evidenced by the higher severity scores in the drip trial (Table 6) compared with the foliar trial (Table 4), in which ratings were taken 2 weeks earlier.

The best performing programs (Treatments 7 and 11) delayed applications of Movento to the third and fourth application intervals so that Movento remained active through the peak abundance of thrips in late June to mid-July. These programs did not combine an adulticide with Movento, which may have further enhanced control.

The use of Exirel, the foliar version of cyantraniliprole, or Verimark®, the drip version of cyantraniliprole at the beginning of the insecticide program gave comparable results for thrips control as the standard program with Movento at the beginning of the program (Figs. 5 and 6).

Exirel provided better control later in the season (5^{th} and 6^{th} application intervals) than did corresponding drip applications of Verimark (Treatment 11 with Exirel vs. Treatment 10 with Verimark).

It is important to note that Exirel and Verimark act as antifeedants, so thrips may still be alive on plants, but they cease feeding and causing damage.

Foliar applications of Aza-Direct (12 fl oz/acre) gave comparable control of thrips as drip applications of Aza-Direct (32 fl oz/acre).

In terms of yield, the programs with delayed applications of Movento (Treatments 7, 11, 12) had the highest yields. These programs averaged more than 15% greater marketable yields than programs with delayed applications of Movento and 21% greater yields of colossal and supercolossal onions.

Acknowledgments

We appreciate the technical assistance of Kelsey Alexander, Brooke Bezona, Mary Phipps, Hannah Rose, and Allison Simmons. The project was supported by the Idaho-Eastern Onion Committee, Bayer, Gowan, Syngenta, and FMC.

Table 5. Insecticide regimens and application dates in the drip (D) insecticide treatment program (F = foliar). Only treatment regimens with registered products are listed. See Table 1 for more information on insecticides. Malheur Experiment Station, Oregon State University, Ontario, OR.

Application Date	**5/25**	**6/5**	**6/15**	**6/25**	**7/5**	**7/16**	**7/26**	**8/6**
			Application Number					
Treatment	1st	2nd	3rd	4th	5th	6th	7th	8th
1	Control	-	-	-	-	-		
2	Verimark (D) 10.3 fl oz	Verimark (D) 10.3 fl oz	Agri-Mek (F) 3.5 fl oz	Agri-Mek (F) 3.5 fl oz	Radiant (F) 8 fl oz	Radiant (F) 8 fl oz	Lannate (F) 3 pt	Lannate (F) 3 pt
3	Movento HL (F) 2.5 oz	Movento HL (F) 2.5 oz	Verimark (D) 10.3 oz	Verimark (D) 10.3 oz	Radiant (F) 8 fl oz	Radiant (F) 8 fl oz	Agri-Mek (F) 3.5 fl/oz	Agri-Mek (F) 3.5 fl/oz
4	Movento HL (F) 2.5 oz	Movento HL (F) 2.5 oz	Agri-Mek (F) 3.5 fl oz	Agri-Mek (F) 3.5 fl oz	Radiant (F) 8 fl oz	Radiant (F) 8 fl oz	Lannate (F) 3 pt	Lannate (F) 3 pt
5	Exirel (F) 13.4 oz	Exirel (F) 13.4 oz	Agri-Mek (F) 3.5 fl oz	Agri-Mek (F) 3.5 fl oz	Radiant (F) 8 fl oz	Radiant (F) 8 fl oz	Lannate (F) 3 pt	Lannate (F) 3 pt
6	Verimark (D) 10.3 oz	Verimark (D) 10.3 oz	Agri-Mek (F) 3.5 fl oz	Agri-Mek (F) 3.5 fl oz	Radiant (F) 8 fl oz	Radiant (F) 8 fl oz	Lannate (F) 3 pt	Lannate (F) 3 pt

Application Date	**5/25**	**6/5**	**6/15**	**6/25**	**7/5**	**7/16**	**7/26**	**8/6**
			Application Number					
Treatment	1st	2nd	3rd	4th	5th	6th	7th	8th
7	Aza-Direct (D) 32 fl oz	Aza-Direct (D) 32 fl oz	Movento HL (F) 2.5 oz	Movento HL (F) 2.5 oz	Radiant (F) 8 fl oz	Radiant (F) 8 fl oz	Lannate (F) 3 pt	Lannate (F) 3 pt
8	Movento HL (F) 2.5 oz	Movento HL (F) 2.5 oz	Exirel (F) 13.4 fl oz	Exirel (F) 13.4 fl oz	Radiant (F) 8 fl oz	Radiant (F) 8 fl oz	Agri-Mek (F) 3.5 fl oz	Agri-Mek (F) 3.5 fl oz
10	Aza-Direct (D) 32 fl oz	Aza-Direct (D) 32 fl oz	Movento HL (F) 2.5 oz	Movento HL (F) 2.5 oz	Verimark (D) 10.3 oz	Verimark (D) 10.3 oz	Agri-Mek (F) 3.5 fl oz	Agri-Mek (F) 3.5 fl oz
11	Aza-Direct 12 fl oz + M-Pede (2%) (F)	Aza-Direct 12 fl oz + M-Pede (2%) (F)	Movento HL (F) 2.5 oz	Movento HL (F) 2.5 oz	Exirel (F) 13.4 fl oz	Exirel (F) 13.4 fl oz	Agri-Mek (F) 3.5 fl oz	Agri-Mek (F) 3.5 fl oz
12	Aza-Direct (D) 32 fl oz	Aza-Direct (D) 32 fl oz	Verimark (D) 10.3 oz	Verimark (D) 10.3 oz	Radiant (F) 8 fl oz	Radiant (F) 8 fl oz	Agri-Mek (F) 3.5 fl oz	Agri-Mek (F) 3.5 fl oz

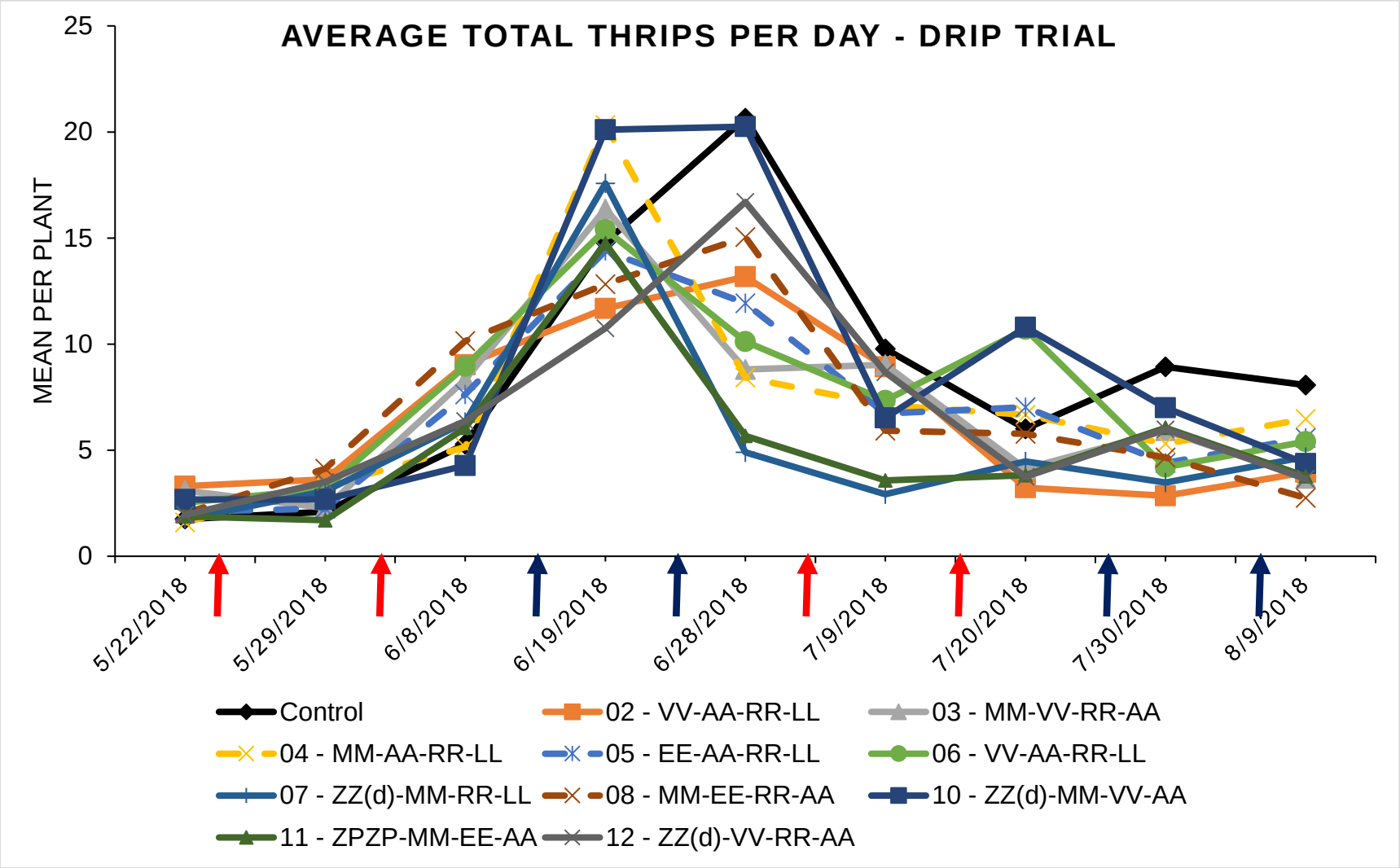


Figure 5. Average total thrips per plant in the foliar insecticide trial, Malheur Experiment Station, Oregon State University, Ontario, OR, 2018. Insecticide abbreviations: A = Agri-Mek, L = Lannate, M = Movento, MI = Minecto Pro, P = M-Pede, R = Radiant, Z = Aza-Direct. See Tables 1 and 4 for additional information on applications.

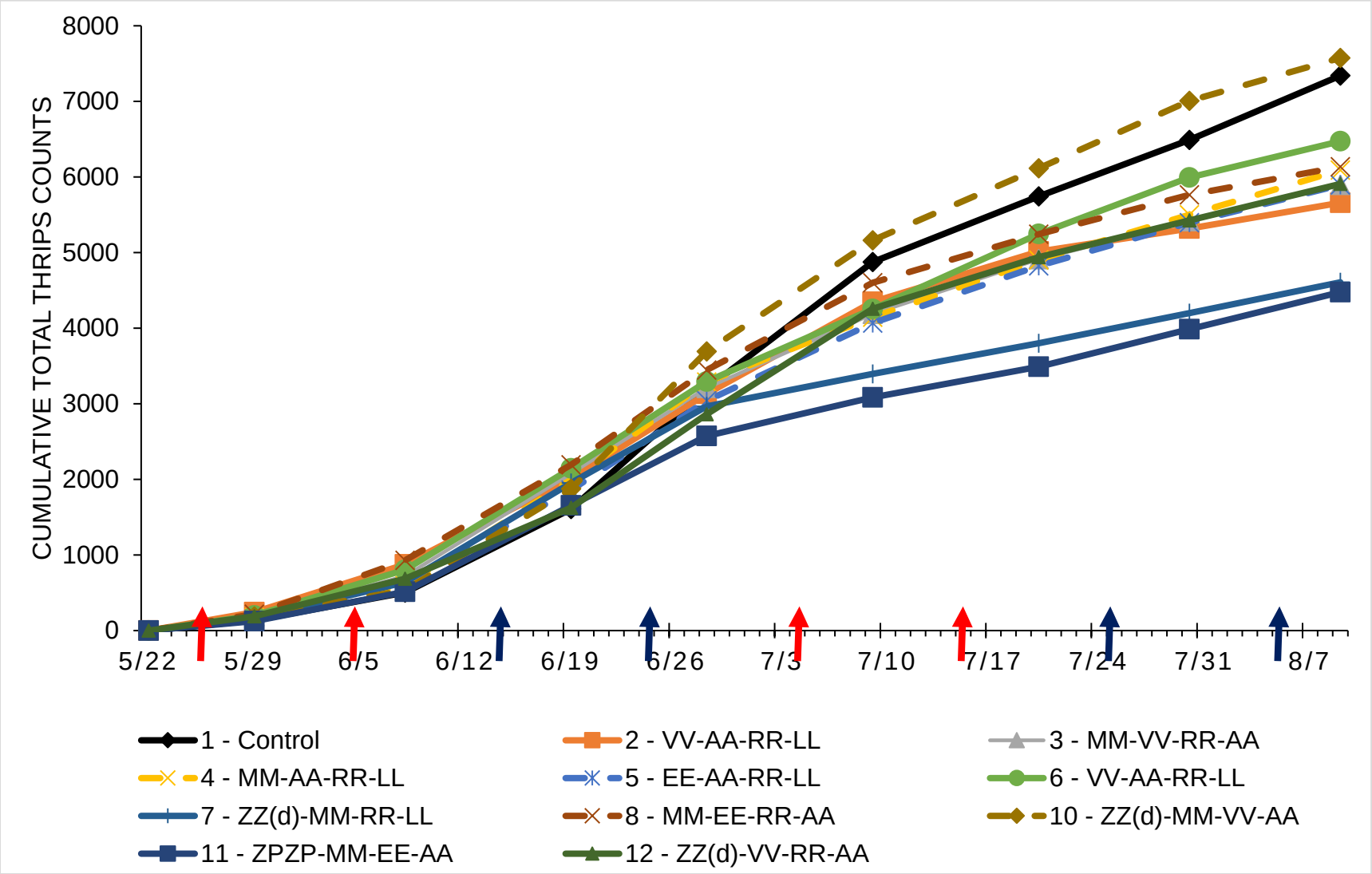


Figure 6. Cumulative thrips counts for the drip insecticide trial in which applications were approximately 10 days apart, Malheur Experiment Station, Oregon State University, Ontario, OR. Arrows along the date axis show when applications were made. Insecticide abbreviations: A = Agri-Mek, E = Exirel, L = Lannate, M = Movento, MI = Minecto Pro, P = M-Pede, V = Verimark.

Table 6. Severity of Iris yellow spot virus and thrips damage to onions in 2018, Malheur Experiment Station, Oregon State University, Ontario, OR. Ratings are the mean rating for 10 plants per plot taken on July 30, 2018 after insecticide applications had been completed. Ratings are on a 0-4 scale. See Tables 1 and 4 for description of the treatments.

Treatment	Mean virus damage rating	Mean thrips damage rating
1 - Control	1.83	1.90
2 - VV-AA-RR-LL	1.53	1.65
3 - MM-VV-RR-AA	1.50	1.45
4 - MM-AA-RR-LL	1.58	1.68
5 - EE-AA-RR-LL	1.68	1.63
6 - VV-AA-RR-LL	1.55	1.73
7 - ZZ(d)-MM-RR-LL	1.68	1.90
8 - MM-EE-RR-AA	1.48	1.45
10 - ZZ(d)-MM-VV-AA	1.68	1.88
11 - ZPZP-MM-EE-AA	1.48	1.70
12 - ZZ(d)-VV-RR-AA	1.53	1.58
	LSD = 0.25	LSD = 0.27

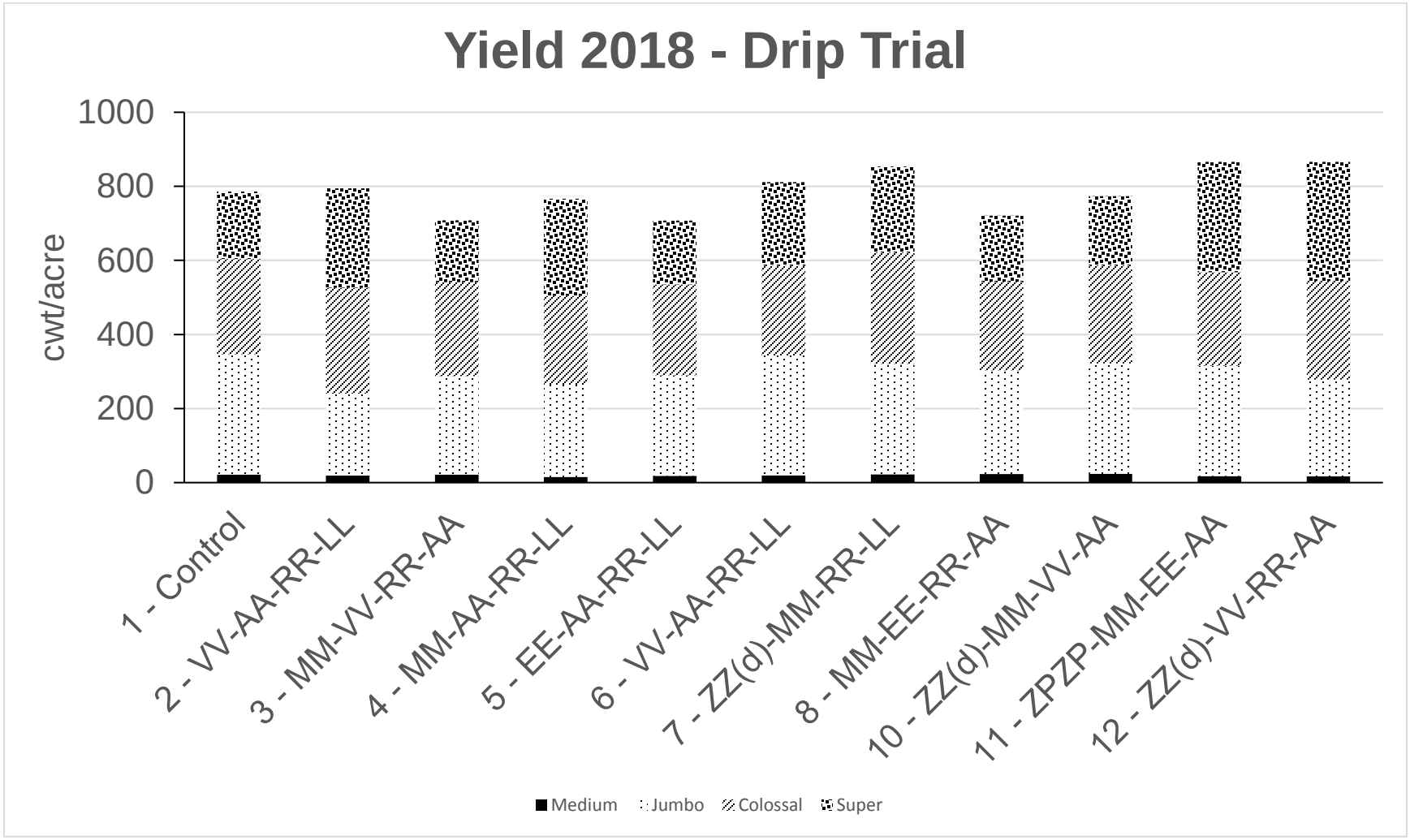


Figure 7. Marketable onion yield results by size category for the drip application trial, Malheur Experiment Station, Oregon State University, Ontario, OR. Insecticide abbreviations: A = Agri-Mek, E = Exirel, L = Lannate, M = Movento, MI = Minecto Pro, P = M-Pede, R = Radiant, V = Verimark, Z = Aza-Direct, (d) = drip application. See Tables 1 and 4 for additional information on applications.