THRIPS AND IRIS YELLOW SPOT VIRUS MANAGEMENT IN THE TREASURE VALLEY

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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, use of furrow and drip irrigation, 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 number 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.

Production practices for onions continue to evolve in the Treasure Valley. Today, most onions are grown under drip irrigation. With the expanding use of drip irrigation for onion production, it is important to evaluate insecticides that can be applied through drip systems. There has also been interest in comparing how different adjuvants may affect the performance of different insecticides.

Our objectives were to: 1) evaluate different treatment sequences of insecticides for thrips and IYSV management, and 2) evaluate new application methods for thrips and IYSV management.

Therefore, we conducted three field trials to evaluate different insecticide management programs, with products applied in various sequences over the growing season. The foliar application trial consisted of 22 different treatment regimens (including experimental/unregistered insecticides, which are not shown) (Tables 2 and 3). The second trial was conducted to compare the efficacy of different adjuvants when applied with a set of standard foliar-applied insecticides (Table 4). A third 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 (Table 5).

Materials and Methods

Cultural Practices

Onion seed (cv 'Vaquero') was planted at 150,000 seeds/acre on March 24, 2016.

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. Inc., 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.

Foliar Insecticide and Adjuvant Trial Applications

Insecticides were applied weekly from May 26 to July 14, (see Tables 3 and 4 for schedule and rates). Insecticides were applied with a CO_2 backpack sprayer using a 4-nozzle boom with 11004 nozzles at 30 psi and 35 gal/acre.

Drip Insecticide Trial Applications

Drip applications began after 1 hour of water was applied at the beginning of an 8-hour set (1 hour water, 6 hour insecticide injection, 1 hour water). Foliar applications of insecticides for this trial were made with a CO_2 backpack sprayer, as described above. Applications in this trial were made on a 10-day schedule, beginning on May 26 and continuing until August 4, as listed in Table 5.

Data Collection

Weekly thrips counts were made, starting on May 4 (before applications began). Thrips counts were made by counting the number of thrips on 10 consecutive plants in 1 of the middle 2 rows of each plot. Adult and larval (immature) thrips were counted separately. Each treatment plot was 4 double rows wide by 23 ft long.

Onions in each plot were evaluated visually for severity of symptoms of IYSV and thrips feeding damage on August 8. 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 (Table 1). 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.

Table 1. Thrips feeding damage rating scale.

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 7, topped by hand, bagged on September 16 and placed in storage. The onions from each plot were graded on October 12 and 13. 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 (>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 23. Applications in the foliar trial began on May 26. 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. Generally, peak populations continue for 2-3 weeks into the middle of July.

As is typical, most thrips on onions are immatures (~75%). Because adults can move from plant to plant, we typically do not see large differences in adult populations among insecticide treatments.

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 in Figs. 1-5).

The effect of Movento was enhanced by combining it with an adulticide (e.g., Treatment 19, the first application of Movento with Lannate). 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.

It is important to combine Movento with an adulticide with this type of use pattern so that dispersing adults do not cause excessive damage. Movento does provide approximately 2-3 weeks of activity against immature thrips after a second application (see Treatment 22, in which no insecticides were applied after a second Movento application).

Treatment 20 had Admire® applied April 23 followed by the standard insecticide program (treatment 2). The Admire application did not provide additional thrips control over the standard program.

Treatment 10 substituted Gladiator® for Agri-Mek in the standard treatment program. Although Gladiator has performed well in trials at the Experiment Station, it must be used with caution as it contains a synthetic pyrethroid. Onion thrips readily develop resistance to pyrethroids (e.g., Warrior®) and overuse will likely cause new resistance problems to develop rapidly.

Although there were no significant differences in virus and thrips damage ratings among the treatments, treatment 5 had the lowest virus damage ratings of all treatments. Treatment 4 had the lowest thrips damage ratings of all treatments.

There were no significant differences in marketable yields among the treatments (Fig. 5). However, treatments 5 and 10 had the most favorable size profiles. Treatment 5 included the use of Aza-Direct and M-Pede as complements to Movento in the two initial applications and excluded an application during the final (eighth) treatment week. Treatment 10 included Gladiator as a substitute for Agri-Mek. These two treatment programs had significantly higher yields of colossal and supercolossal size bulbs than the other treatments.

Adjuvant Trial

We compared three rates of WETCIT® used for all insecticide applications with the adjuvants typically used with the standard insecticides used in the standard reference insecticide program. That program consists of Movento mixed with methylated seed oil (MSO), Agri-Mek mixed with MSO, Radiant mixed with Dyne-Amic®, and Lannate® mixed with a non-ionic surfactant (NIS) (Table 4). WETCIT is an alcohol ethoxylate-based adjuvant with spreading and penetrating properties. MSO adjuvants have penetrating properties that enable systemic insecticides to move throughout the plant. Dyne-Amic is an organosilicone and MSO blend with spreading and penetrating properties. NIS adjuvants also have spreading and penetrating properties to aid in moving materials across the leaf surface and into the leaf tissue so thrips will ingest toxicants.

In this trial, all of the treatments had fewer thrips and greater yields than the untreated control (Figs. 6-8). Overall, there were no statistically significant differences among the adjuvant treatments. However, the intermediate rate of WETCIT (0.40% v:v) did provide slight improvements in the performance of Lannate compared with NIS and the other WETCIT rates (Fig. 7).

There were no significant differences in yield among the adjuvant treatments (Fig. 8). However, the standard adjuvant program (treatment 2 in this trial) had the most favorable size profile, based on having the highest proportion of colossal and supercolossal bulbs.

Drip Application Trial

In the drip application trial, applications were made on a 10-day interval from May 23 to August 4. The drip trial included the standard foliar applications of Movento, Agri-Mek, Radiant, and Lannate for comparison (treatment 4 in this trial).

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. 9 and 10). 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 standard program (treatment 4) and treatments 2 and 3, which started with drip applications of Verimark, had significantly higher yields of colossal and supercolossal bulbs compared with the other treatments (Fig. 11). Treatment 6, which also started with Verimark, had lower yields of large size classes, possibly because of the use of Agri-Mek at the peak of thrips abundance rather than Radiant (application numbers 5 and 6).

Acknowledgments

We appreciate the technical assistance of Ian Trenkel, Nicole Drake, Darvee Stevens, Katelyn Nelson, Megan Travis, and Kelsey Alexander. The project was supported by the Idaho-Eastern Onion Committee, Bayer, Gowan, Syngenta, FMC, Dow, and DuPont.

Table 2. Characteristics of insecticides tested for efficacy against onion thrips. Sequences with unregistered products are not listed. **<u>Please consult the label to determine appropriate uses for all pesticides</u>**. Malheur Experiment Station, Oregon State University, Ontario, OR, 2016.

Product	Company	Rate (product per acre)	Adjuvant	Active ingredient	pH	Mode of action group
Admire Pro	Bayer	14 fl oz		imidacloprid	6.5	4A
Agri-Mek SC	Syngenta	3.5 fl oz	MSO 0.5% v/v	abamectin	7.0	6
Aza-Direct	Gowan	12 fl oz	-	azadirachtin		unknown
Captiva	Gowan	7/11 fl oz		capsacin oleoresin, garlic oil, soybean oil	7.0	Unknown
Exirel	DuPont	13.5 fl oz	MSO 0.5% v/v	Cyantraniliprole	5.0	28
Gladiator	FMC	19 fl oz		Avermectin / Zeta-cypermethrin	7.0	6 / 3
Lannate LV	DuPont	3 pt	Preference 0.25% v/v	methomyl	5.0	1A
M-Pede	Gowan	5.6 pt	-	potassium salts of fatty acids		unknown
Movento	Bayer	5 fl oz	MSO 0.5% v/v	spirotetramat	6.5	23
Radiant	Dow	8 fl oz	Dyne-Amic 3.75% v/v	spinetoram	7.0	5
Verimark	DuPont	13.5 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. Malheur Experiment Station, Oregon State University, Ontario, OR, 2016.

Date	26-May	2-Jun	9-Jun	16-Jun	22-Jun	30-Jun	7-Jul	14-Jul
Treatment	**1st**	**2nd**	**3rd**	**4th**	**5th**	**6th**	**7th**	**8th**
1	Control	-	-	-	-	-	-	-
2	Movento	Movento	Agri-Mek	Agri-Mek	Radiant	Radiant	Lannate	Lannate
3	M-Pede+ Aza-Direct	M-Pede+ Aza-Direct	Movento + Aza-Direct	M-Pede + Movento	Captiva (11)	Captiva(7) + Agri-Mek	Radiant + M-Pede	Radiant + M-Pede
4	M-Pede+ Aza-Direct	Aza-Direct + Movento	M-Pede + Movento	Captiva(11)	Captiva(7) + Agri-Mek	Captiva(7) + Agri-Mek	Radiant	Radiant
5	Aza-Direct + Movento	M-Pede + Movento	Captiva(11)	Captiva(7) + Agri-Mek	Captiva(7) + Agri-Mek	Radiant + M-Pede	Radiant + M-Pede	
10	Movento	Movento	Gladiator	Gladiator	Radiant	Radiant	Lannate	Lannate
11	Movento	Movento	Radiant	Radiant	Lannate	Lannate	Agri-Mek	Agri-Mek
19	Movento + Lannate	Movento	Agri-Mek	Agri-Mek	Radiant	Radiant	Lannate	Lannate
20	Movento (Admire)	Movento	Agri-Mek	Agri-Mek	Radiant	Radiant	Lannate	Lannate
22	Aza-Direct + M-Pede	Aza-Direct + M-Pede	Movento + Aza-Direct	Movento	None	None	None	None

Table 4. Adjuvants used in the trial comparing different rates of WETCIT and other adjuvants, Malheur Experiment Station, Oregon State University, Ontario, OR, 2016.

Insecticide	**Standard**	**WETCIT Low**	**WETCIT Intermediate**	**WETCIT High**
Movento	MSO 0.5%	WETCIT 0.25%	WETCIT 0.40%	WETCIT 0.80%
Agri-Mek	MSO 0.5%	WETCIT 0.25%	WETCIT 0.40%	WETCIT 0.80%
Radiant	Dyne-Amic 0.25%	WETCIT 0.25%	WETCIT 0.40%	WETCIT 0.80%
Lannate	Preference 0.25%	WETCIT 0.25%	WETCIT 0.40%	WETCIT 0.80%

Table 5. Insecticide regimens and application dates in the drip insecticide treatment program, Malheur Experiment Station, Oregon State University, Ontario, OR, 2016. (D = drip, F = foliar)

Application Date	May 27	Jun 3	Jun 14	Jun 23	Jul 5	Jul 15	Jul 25	Aug 4
			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 (F) 5 oz	Movento (F) 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 (F) 5 oz	Movento (F) 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	Movento (F) 5 oz	Movento (F) 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

Application Date	May 27	Jun 3	Jun 14	Jun 23	Jul 5	Jul 15	Jul 25	Aug 4
			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 (F) 5 oz	Movento (F) 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
8	Movento (F) 5 oz	Movento (F) 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	Radiant (F) 8 fl oz	Radiant (F) 8 fl oz
9	Aza-Direct (F) 12 fl oz	Aza-Direct (F) 12 fl oz	Movento (F) 5 oz	Movento (F) 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
10	Aza-Direct (D) 32 fl oz	Aza-Direct (D) 32 fl oz	Movento (F) 5 oz	Movento (F) 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 + M-Pede (F) 12 fl oz	Aza-Direct + M-Pede (F) 12 fl oz	Movento (F) 5 oz	Movento (F) 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

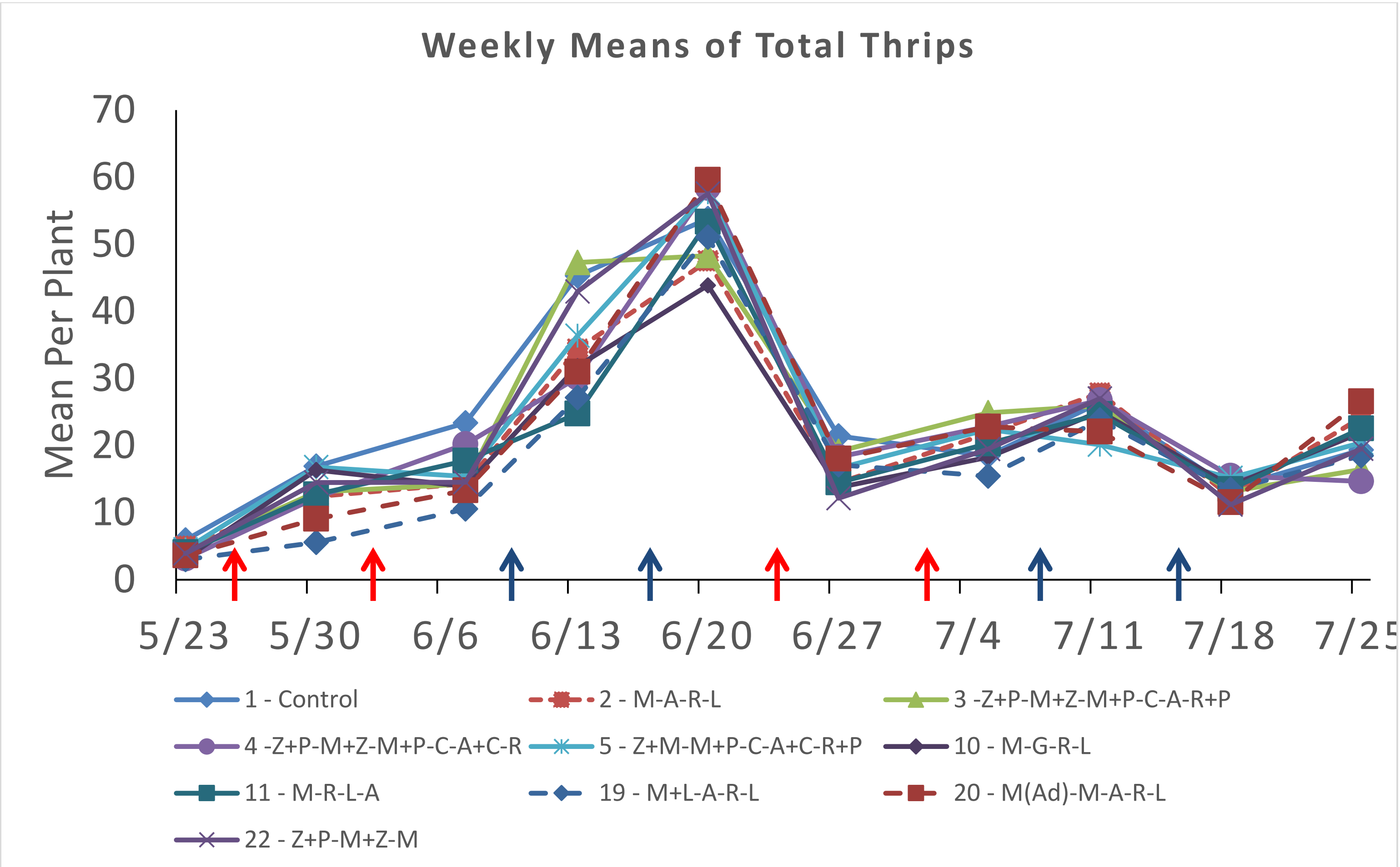

Figure 1. Weekly means of total number of thrips per plant in the foliar application trial. Arrows along the x- axis indicate spray dates. See tables 2 and 3 for further explanation of treatment applications. Thrips colonized the field in early May and reached treatment threshold (4 per plant) by May 23. Most thrips (~75%) are immatures. Malheur Experiment Station, Oregon State University, Ontario, OR, 2016.

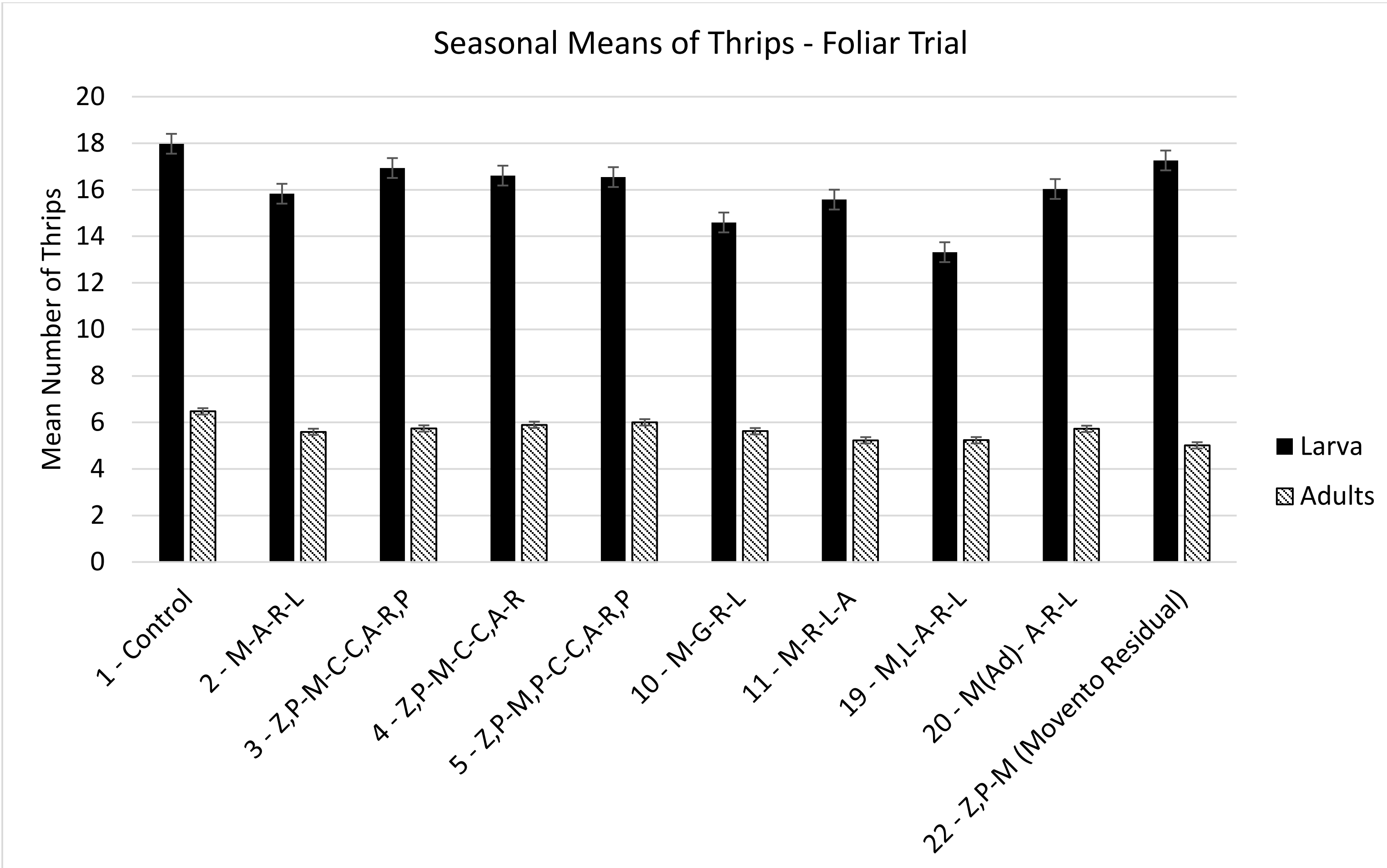

Figure 2. Seasonal means of immature (larval) and adult thrips in the foliar application trial. Abbreviations for insecticides: A=Agri-Mek, Ad=Admire, C=Captiva, G=Gladiator, L=Lannate, M=Movento, P=M-Pede, R=Radiant, Z=Aza-Direct. See Tables 2 and 3 for additional information on applications. Malheur Experiment Station, Oregon State University, Ontario, OR, 2016.

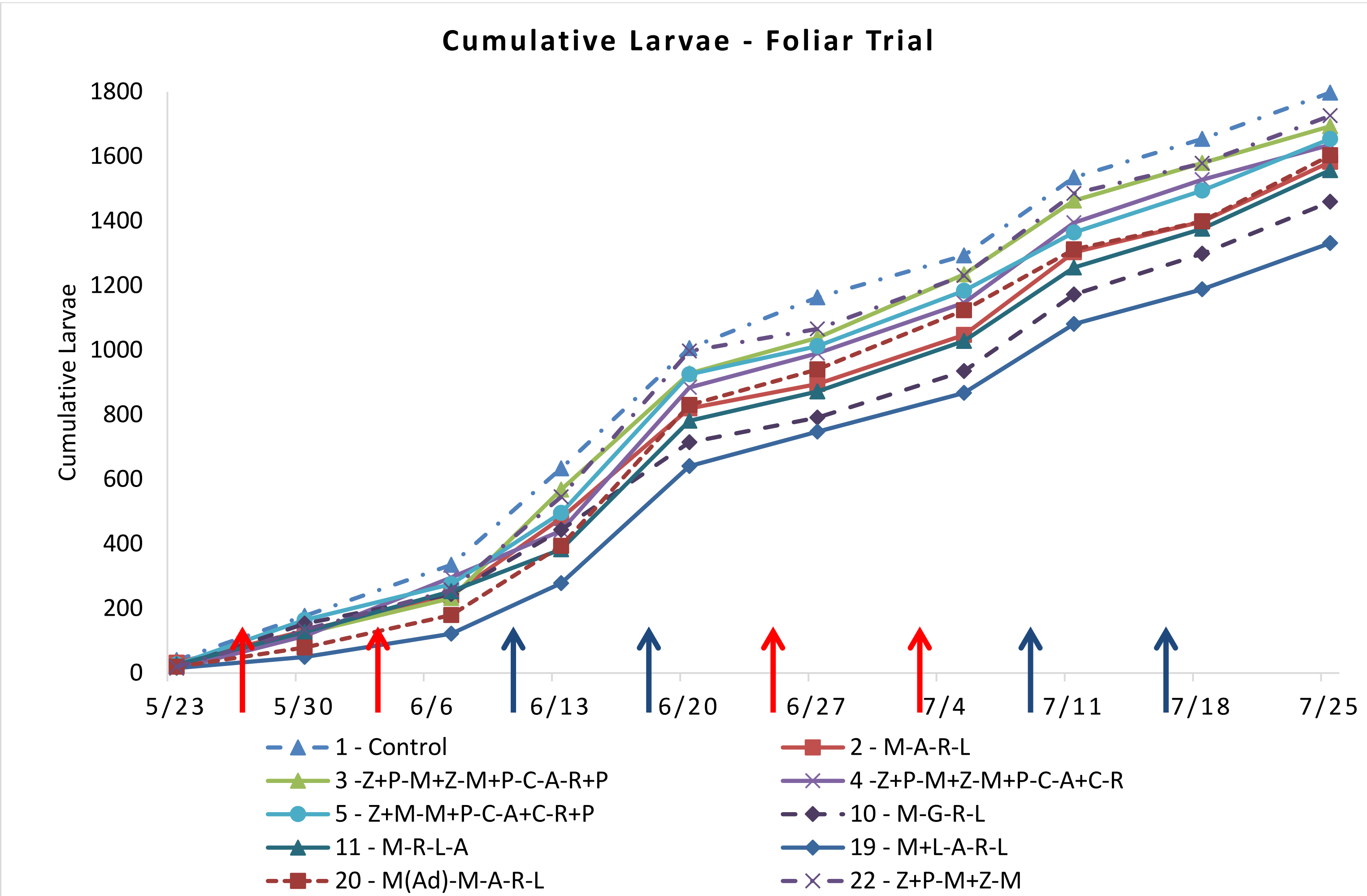

Figure 3. Cumulative thrips larval counts for the standard foliar insecticide trial. Insecticide abbreviations: A=Agri-Mek, Ad=Admire, C=Captiva, G=Gladiator, L=Lannate, M=Movento, P=M-Pede, R=Radiant, Z=Aza-Direct. See Tables 2 and 3 for additional information on applications. Malheur Experiment Station, Oregon State University, Ontario, OR, 2016.

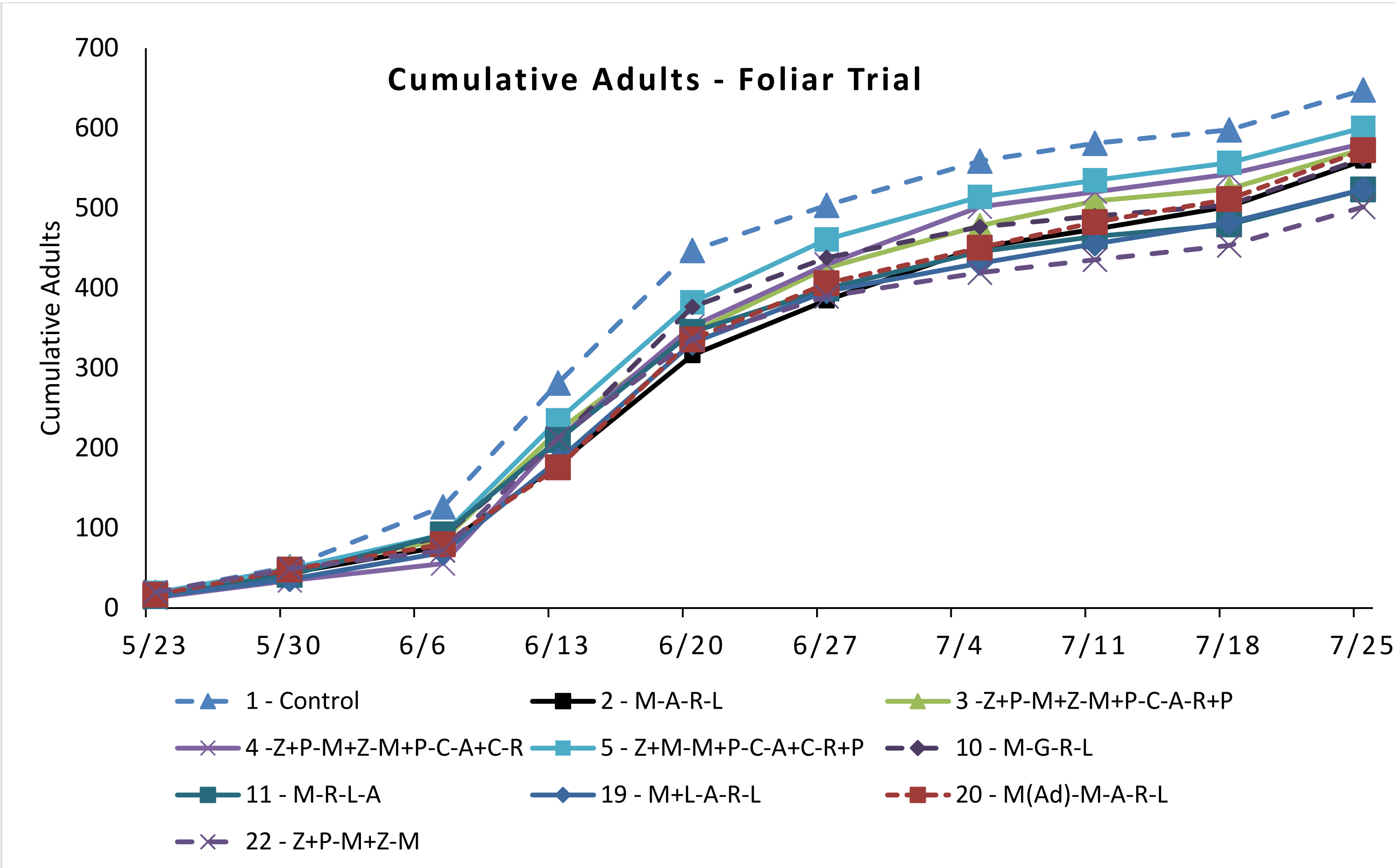

Figure 4. Cumulative thrips adult counts for the standard foliar insecticide trial. Insecticide abbreviations: A=Agri-Mek, Ad=Admire, C=Captiva, G=Gladiator, L=Lannate, M=Movento, P=M-Pede, R=Radiant, Z=Aza-Direct. See Tables 2 and 3 for additional information on applications. Malheur Experiment Station, Oregon State University, Ontario, OR, 2016.

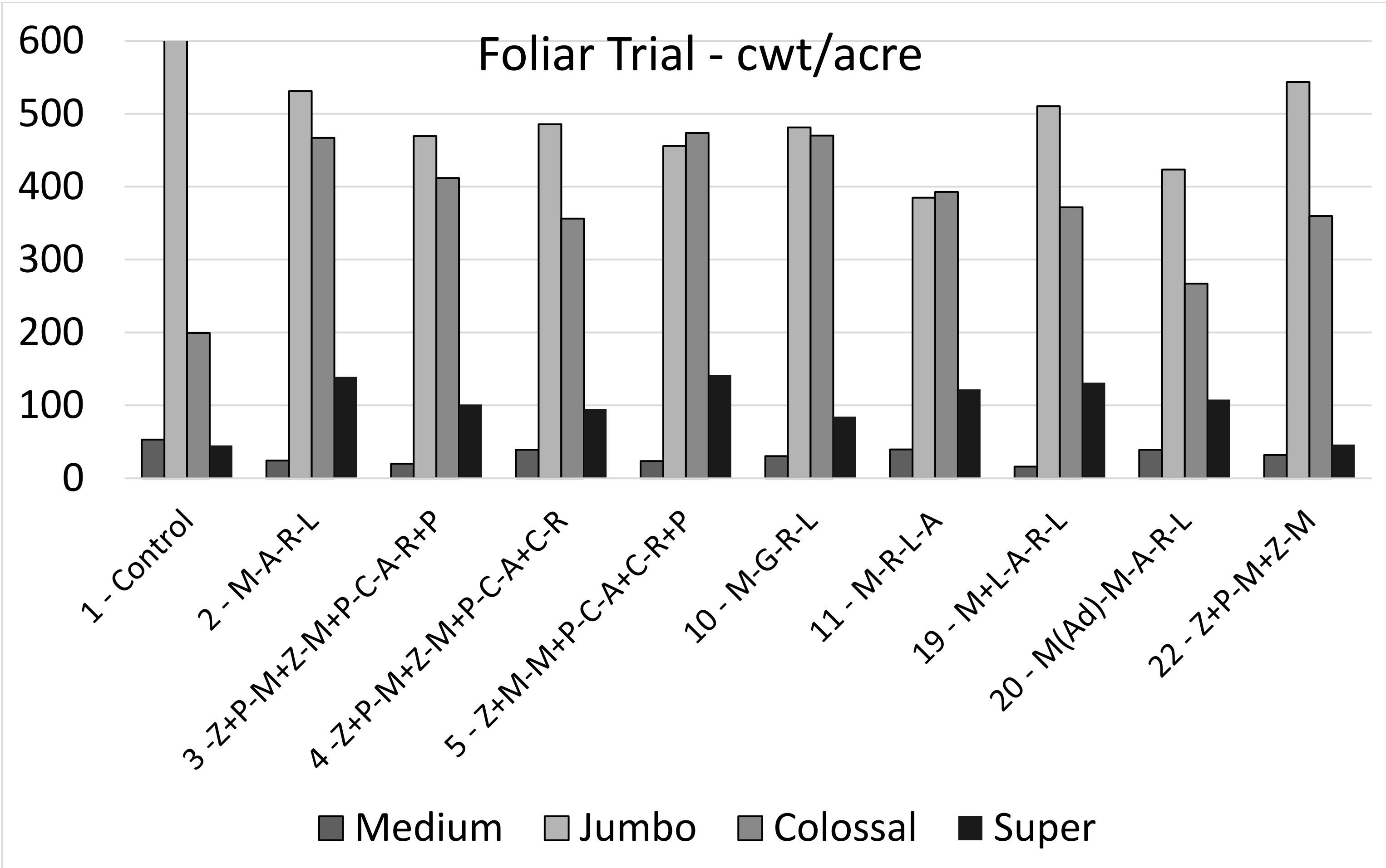

Figure 5. Marketable onion yield results by size category for the drip application trial. Insecticide abbreviations: A=Agri-Mek, Ad=Admire, C=Captiva, G=Gladiator, L=Lannate, M=Movento, P=M-Pede, R=Radiant, Z=Aza-Direct. See Tables 2 and 3 for additional information on applications. Malheur Experiment Station, Oregon State University, Ontario, OR, 2016.

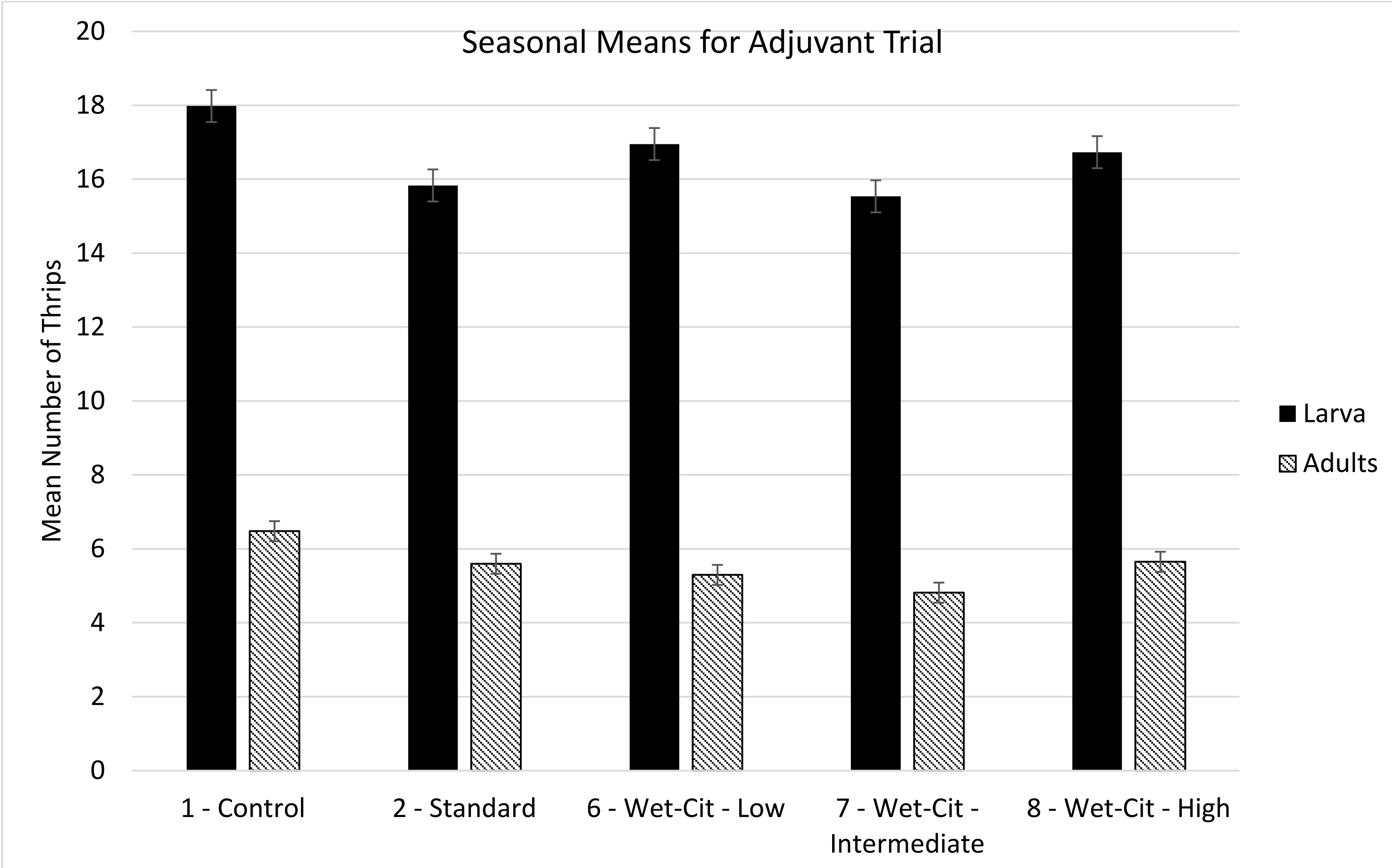

Figure 6. Seasonal mean number of immature (larval) and adult thrips in the adjuvant trial. The intermediate rate of WETCIT provided comparable control to the standard adjuvants. The intermediate rate of WETCIT provided some slight improvement in the performance of Lannate. Malheur Experiment Station, Oregon State University, Ontario, OR, 2016.

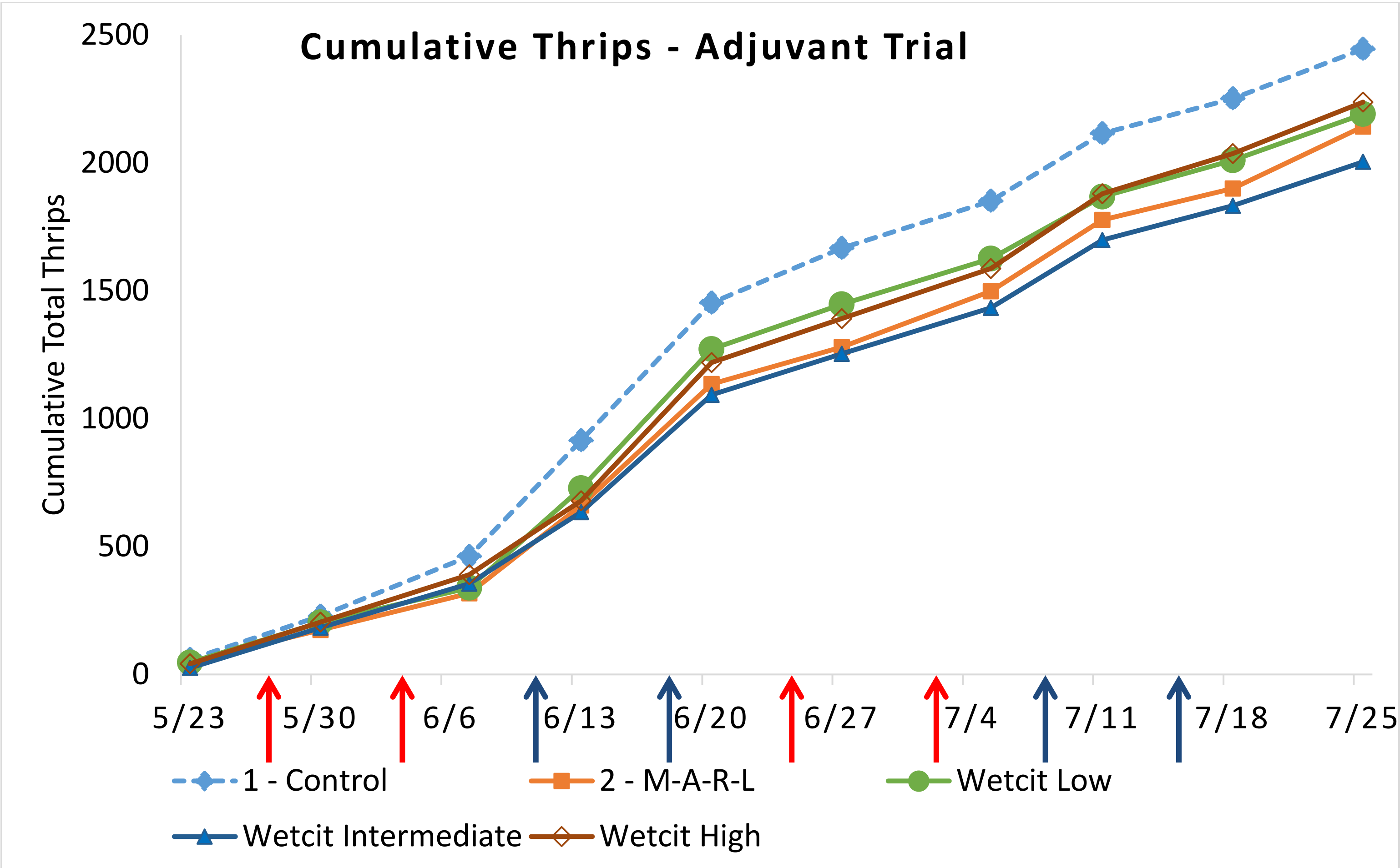

Figure 7. Effect of adjuvants on total cumulative numbers of thrips when using the standard insecticide spray program of Movento, Agri-Mek, Radiant, and Lannate. Application dates are marked by the arrows on the x-axis. See Tables 2 and 4 for additional details on applications. The intermediate rate of WETCIT (0.40% v:v) was as effective as using MSO with Movento and Agri-Mek, Dyne-Amic with Radiant, and NIS with Lannate. Based on this trial, WETCIT may improve the activity of Lannate and has comparable effects on the other insecticides as standard adjuvants. Malheur Experiment Station, Oregon State University, Ontario, OR, 2016.

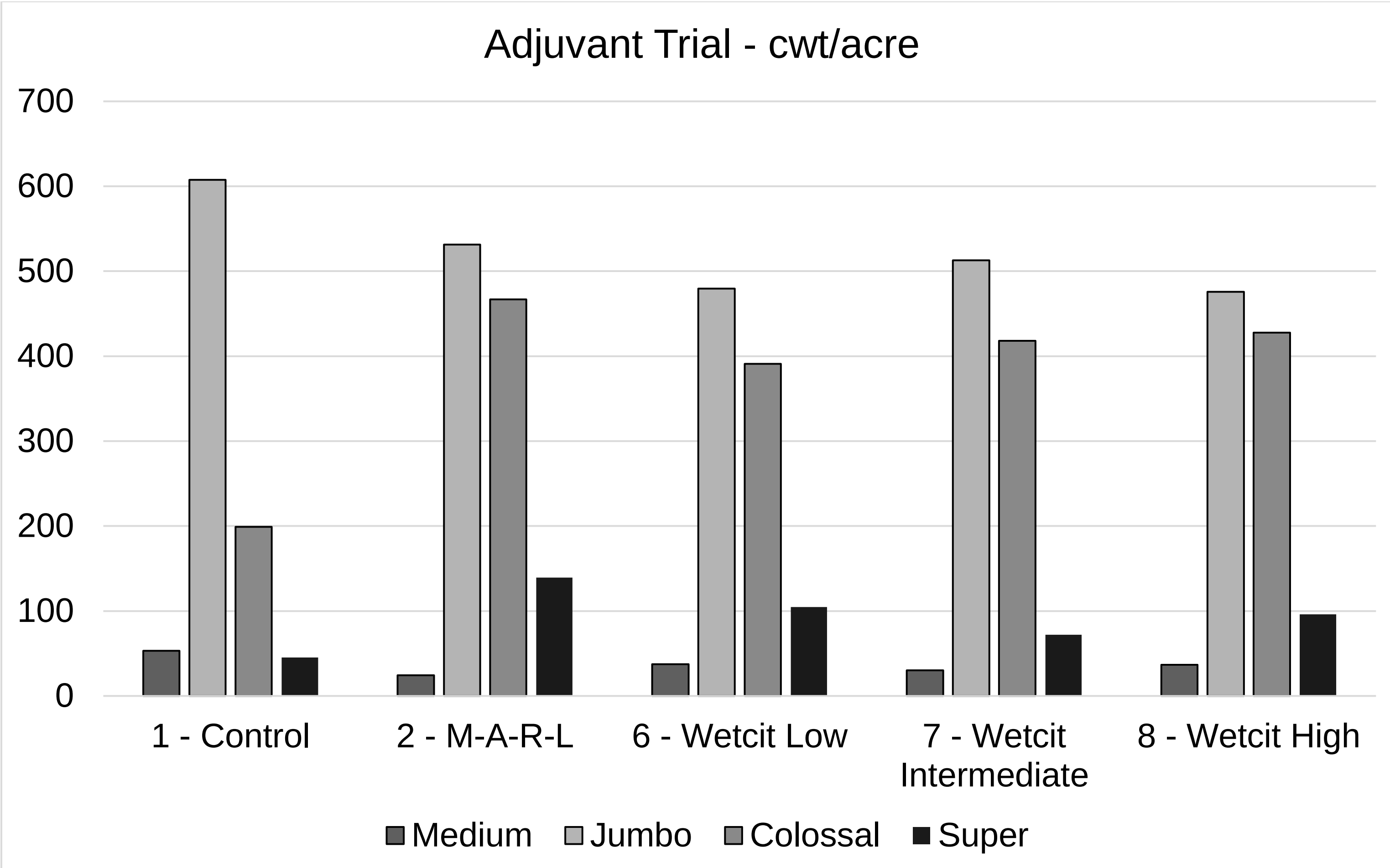

Figure 8. Marketable onion yield results by size category for the adjuvant application trial. All treatments received the same insecticide applications. Insecticide abbreviations: A=Agri-Mek, L=Lannate, M=Movento, R=Radiant. Treatment 2 is the reference standard, which utilized MSO with Agri-Mek and Movento, Dyne-Amic with Radiant, and NIS with Lannate. The other treatments (6,7,8) utilized different rates of WETCIT. See Table 4 for additional information on adjuvant applications. Malheur Experiment Station, Oregon State University, Ontario, OR, 2016.

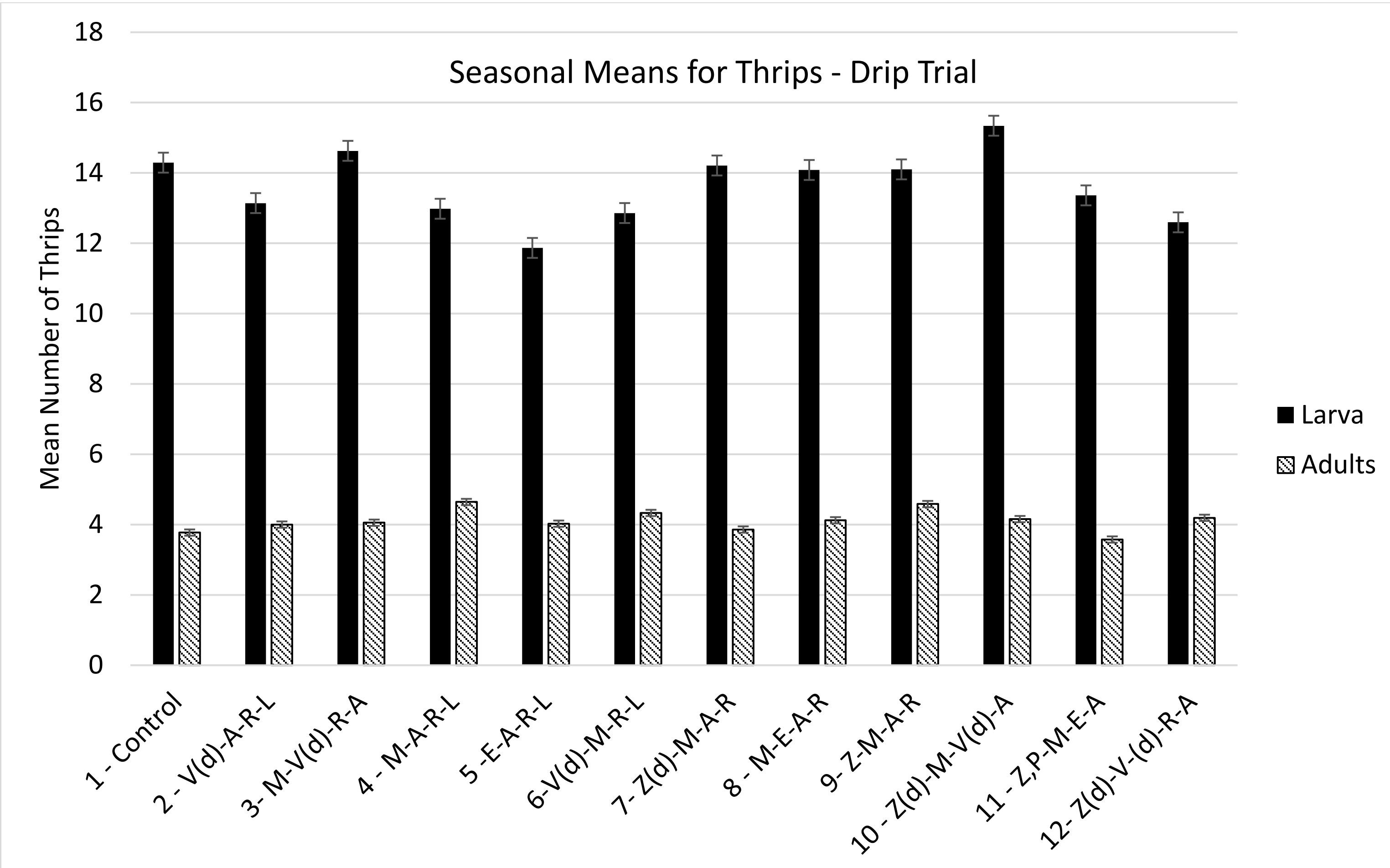

Figure 9. Seasonal averages for larval and adult thrips in the drip application trial. Insecticide abbreviations: A=Agri-Mek, E=Exirel, L=Lannate, M=Movento, R=Radiant, V(d)=Verimark by drip, Z=Aza-Direct, Z(d)=Aza-Direct by drip. See Tables 2 and 5 for explanation of treatments. Malheur Experiment Station, Oregon State University, Ontario, OR, 2016.

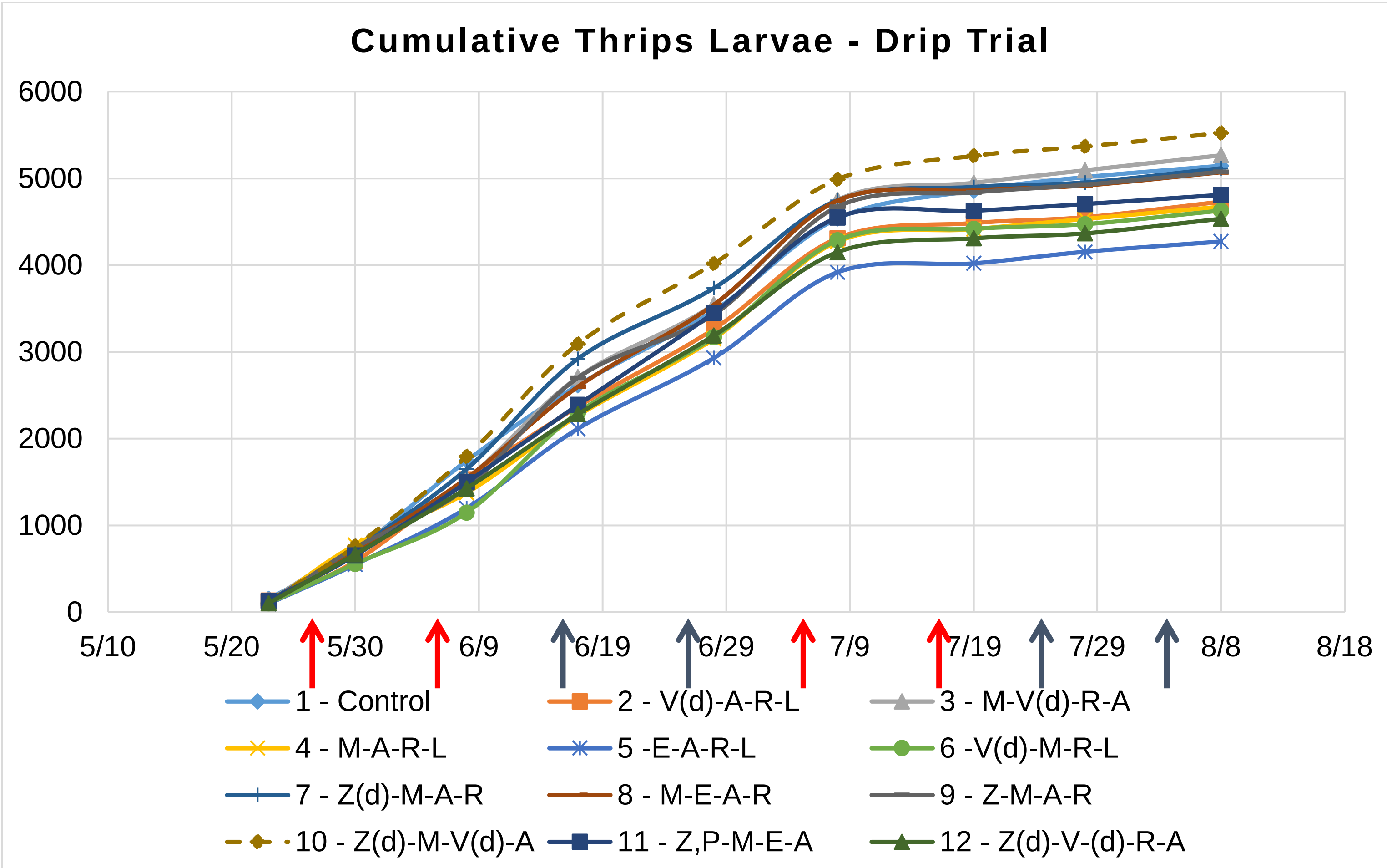

Figure 10. Cumulative seasonal counts for larval thrips in the drip application trial. Insecticide abbreviations: A=Agri-Mek, E=Exirel, L=Lannate, M=Movento, R=Radiant, V(d)=Verimark by drip, Z=Aza-Direct, Z(d)=Aza-Direct by drip. See Tables 2 and 5 for explanation of treatments. Malheur Experiment Station, Oregon State University, Ontario, OR, 2016.

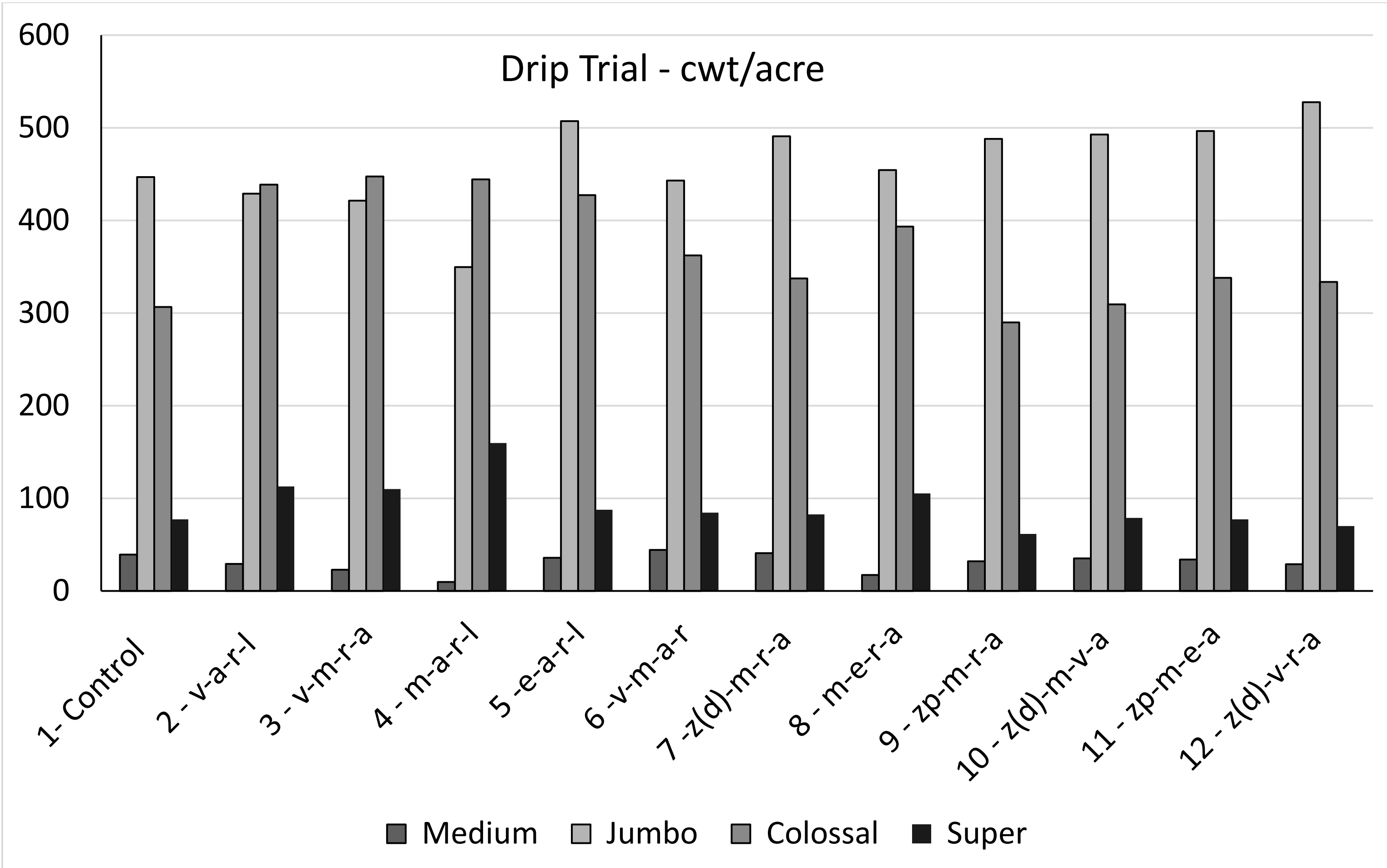

Figure 11. Marketable onion yield results by size category for the drip application trial. Abbreviations for insecticides: A=Agri-Mek, E=Exirel, L=Lannate, M=Movento, P=M-Pede, R=Radiant, V=Verimark, Z=Aza-Direct [Z(d) are drip applications]. See Tables 2 and 5 for additional information on applications. Malheur Experiment Station, Oregon State University, Ontario, OR, 2016.