EVALUATION OF INSECTICIDES AND INSECTICIDE USE PATTERNS FOR MANAGEMENT OF THRIPS AND IRIS YELLOW SPOT VIRUS

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Overview

Onion thrips and the iris yellow spot virus (IYSV) that these thrips vector are major limiting factors for onion production in the Treasure Valley. There are about 20,000 acres of onions produced within a 50-mile radius of Ontario, Oregon. This high concentration of onions causes unique production challenges, especially for onion thrips and IYSV management. Thrips are able to rapidly develop resistance to insecticides, and new insecticides may quickly lose their effectiveness. Therefore, it is important to assess the effectiveness of currently registered insecticides and to develop alternative management methods as part of an overall integrated pest management (IPM) program. A field experiment was conducted to evaluate 20 insecticide management programs, which included the use of 13 different insecticides applied in various sequences over the course of the growing season, for the management of thrips and IYSV and their effect on onion yields.

Materials and Methods

Cultural Practices

Onions were grown on an Owyhee silt loam with a pH of 7.3 and 1.6% organic matter, which had been previously planted to wheat. In the fall of 2012, the wheat stubble was shredded and the field was irrigated. Based on a soil analysis done in the fall of 2012, 49 lb of phosphorus/acre, 200 lbs of sulfur/acre, and 1 lb of boron/acre were broadcast before plowing. The field was then disked, moldboard plowed, and groundhogged. On September 24, the field was fumigated with Vapam® at 15 gal/acre and bedded at 22 inches.

Onion seed (‘Vaquero’; Nunhems, Parma, ID) was planted on March 15 in double rows, spaced 3 inches apart at 9 seeds/ft of each single row, equivalent to 150,000 seeds/acre. Each double row was planted on beds spaced 22 inches apart. Planting was done with customized John Deere Flexi Planter units equipped with disc openers. Immediately after planting, Lorsban® 15G insecticide was banded at 3.7 oz/1,000 ft of row (0.82 lbs ai/acre), and the soil surface was rolled. Onion emergence began on 8 April.

Onions were grown under drip irrigation. The field had drip tape laid at 4-inch depth between 2 onion beds during planting. Drip tape (Toro Aqua-Traxx, Toro Co., El Cajon, CA) with emitters spaced 12 inches apart and an emitter flow rate of 0.22 gal/min/100 ft was laid at 4 inch depth between 2 onion beds at the time of planting. The distance between the tape and the center of each bed was 11 inches. The water application rate was 0.06 inch/hour.

The field was irrigated as necessary to maintain soil water tension at 20 cb at 8-inch depth. Soil water tension was monitored by six granular matrix sensors (GMS, Watermark Soil Moisture Sensors Model 200SS, Irrometer Co. Inc., Riverside, CA) centered at 8-inch depth below the onion row. The sensors were automatically read three times a day with an AM-400 meter (Mike Hansen Co., East Wenatchee, WA).

Insecticide Applications

Insecticides were applied weekly beginning May 23, according to the schedule and rates listed in Tables 1 and 2. Five experimental treatments were compared to an untreated check treatment and a standard insecticide treatment. Insecticides were applied with a CO_2 backpack sprayer using a 4 nozzle boom with 11004 nozzles at 30 psi and 35 gal/acre.

Data Collection

Weekly thrips counts were made, starting on May 20. Thrips counts were made by counting the number of thrips on 15 consecutive plants in 1 of the middle 2 rows of each plot. Each treatment plot was 4 double rows wide by 23 ft long.

Onions in each plot were evaluated subjectively for severity of symptoms of IYSV and thrips feeding damage on July 30. Fifteen consecutive plants in one of the middle 2 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.

The rating scale was as follows:

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

The onions were lifted on September 13 to field cure. Onions from the middle two double rows in each plot were topped by hand and bagged on September 24. The onions from each plot were graded on October 1. 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 Discussion

Temperatures were warmer throughout the growing season in 2013 than the 30-year historic averages (Fig. 1). The warm early spring temperatures likely contributed to an early buildup of thrips populations.

Only certain insecticides were effective in reducing thrips populations relative to the untreated control during the early season (Table 3). Radiant® and Lannate® performed well in early season applications (e.g., Treatments 11, 19, 20). Torac™, which is not currently registered for use on onions, significantly reduced thrips numbers early in the season (Treatments 16, 18). Later season applications of Torac were not effective, probably because it is a contact insecticide and could not readily reach thrips in the necks of more mature plants.

Movento® was not effective in the 2013 trials when used alone at the start of spray programs (e.g., Treatments 2, 3, 10, 12, and 17). In programs where Movento was used in the third and fourth spray application, it proved more effective, but only after a second application of Movento was made (Treatments 11, 13, 14, 20).

Agri-Mek® performed well in treatments where it followed two applications of Movento (Treatments 2, 3, 4).

Radiant and Lannate generally worked well throughout the season. However, Lannate performed poorly as a stand-alone program (Treatment 19) or if used more than in two consecutive applications. Radiant was generally the most successful insecticide for quickly lowering large thrips populations.

Requiem® was not effective when applied by itself (Treatment 3). However combinations of Requiem and Agri-Mek or Radiant or Lannate were effective. The season-long program where combinations of Requiem and other standard insecticides (Movento, Agri-Mek, Radiant, and Lannate) were used (Treatment 5) had among the lowest season long thrips totals.

Onion bulb yield was significantly affected by thrips pressure. Increasing thrips abundance decreased total marketable yield (Fig. 2). Thrips feeding damage and IYSV lead to significant decreases in onion bulb size. Increasing thrips abundance shifts yields away from larger onion size classes to smaller size classes (Fig. 3).

Season-long management of thrips is important, but management programs that provided the best management mid-season (late June to early July) tended to produce the best yields (e.g., Treatment 11, 13, 20).

Acknowledgments

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Table 1. Insecticide sequences treatments tested for efficacy against onion thrips and iris yellow spot virus. Malheur Experiment Station, Oregon State University, Ontario, OR, 2013. Continued on next page.

Application date	**5/23**	**5/30**	**6/6**	**6/12**	**6/20**	**6/27**	**7/3**	**7/10**
				Application number				
Treatment	**1st**	**2nd**	**3rd**	**4th**	**5th**	**6th**	**7th**	**8th**
1	Control	-	-	-	-	-	-	-
2	Movento	Movento	Agri-mek	Agri-mek	Radiant	Radiant	Lannate	Lannate
3	Movento	Movento	Agri-mek	Agri-mek	Radiant	Radiant	Requiem	Requiem
4	Movento + Requiem	Movento + Requiem	Agri-mek	Agri-mek	Radiant + Requeim	Radiant + Requiem	Lannate	Lannate
5	Movento + Requiem	Movento + Requiem	Agri-mek + Requiem	Agri-mek + Requiem	Radiant + Requeim	Radiant + Requiem	Lannate + Requiem	Lannate + Requiem
6	Exirel 10 SE	Exirel 10 SE	Agri-mek	Agri-mek	Radiant	Radiant	Lannate	Lannate
7	Exirel 10 SE	Exirel 10 SE	Exirel 10 SE	Exirel 10 SE	Radiant	Radiant	Lannate	Lannate
8	Benevia OD	Benevia OD	Benevia OD	Benevia OD	Radiant	Radiant	Lannate	Lannate
9	Gladiator	Gladiator	Gladiator	Gladiator	Gladiator	Gladiator	Gladiator	Gladiator
10	Movento	Movento	Gladiator	Gladiator	Radiant	Radiant	Lannate	Lannate
11	Radiant	Radiant	Movento	Movento	Lannate	Lannate	Agri-mek	Agri-mek
12	Movento	Movento	Radiant	Radiant	Lannate	Lannate	Lannate	Agri-mek

Application date	5/23	5/30	6/6	6/12	6/20	6/27	7/3	7/10
				Application number				
Treatment	**1st**	**2nd**	**3rd**	**4th**	**5th**	**6th**	**7th**	**8th**
13	M-Pede + Aza-Direct	M-Pede + Aza-Direct	Movento	Movento	Lannate	Lannate	Radiant	Radiant
14	M-Pede + Aza-Direct	M-Pede + Aza-Direct	Movento	Movento	Scorpion	Radiant	Scorpion	Radiant
15	M-Pede + Aza-Direct	M-Pede + Radiant	M-Pede + Movento	Scorpion	Movento + Aza-Direct	Lannate	Lannate	Lannate
16	Torac	Torac	Agri-mek	Agri-mek	Radiant	Radiant	Lannate	Lannate
17	Movento	Movento	Torac	Torac	Radiant	Radiant	Lannate	Lannate
18	Torac	Torac	Torac	Torac	Torac	Torac	Torac	Torac
19	Lannate	Lannate	Lannate	Lannate	Lannate	Lannate	Lannate	Lannate
20	Lannate	Lannate	Movento	Movento	Agri-mek	Agri-mek	Radiant	Radiant

(Table 1 Continued)

Table 2. Characteristics of insecticides tested in 20 treatments for efficacy against onion thrips. Malheur Experiment Station, Oregon State University, Ontario, OR, 2013. Not all insecticides used in these trials are currently registered for use on onions. **Please consult the label to determine appropriate uses.**

Product	Company	Rate (product per acre)	Adjuvant	Active ingredient	Mode of action group
Agrimek SC	Syngenta	3.5 fl oz	MSO 0.5% v/v	Abamectin	6
Aza-Direct	Gowan	12 fl oz	-	Azadirachtin	unknown
Gladiator	FMC	19 fl oz	MSO 0.5% v:v	Zeta-Cypermethrin Abamectin	3A and 6
Benevia 10% OD	DuPont	13.5 fl oz	MSO 0.5% v:v	Cyantraniliprole	28
Exirel 10% SE	DuPont	13.5 fl oz	MSO 0.5% v:v	Cyantraniliprole	28
Lannate LV	DuPont	3 pt	Preference 0.25% v/v	Methomyl	1A
M-Pede	Gowan	5.6 pt	-	Potassium salts of fatty acids	unknown
Movento	Bayer	5 fl oz	MSO 0.5% v/v	Spirotetramat	23
Radiant	Dow	8 fl oz	Dyne-Amic 3.75% v/v	Spinetoram	5
Requiem EC	Bayer	3 qt (Treatment 3) 1 qt (Treatment 4,5)		Synthetic terpenes derived from *Chenopodium ambrosioides*	unknown
Scorpion 35 SL	Gowan	7 fl oz		Dinotefuran	4A
Torac	Nichino	21 fl oz	MSO 0.25% v:v	Tolfenpyrad	21A

Table 3. Mean numbers of thrips per onion plant listed by sampling date in response to 20 insecticide programs. Insecticide applications were made weekly, beginning on May 23, 2013 and concluding on July 11, 2013. Malheur Experiment Station, Oregon State University, Ontario, OR, 2013. Continued on next page.

Treatment	**5/20**	**6/3**	**6/10**	**6/17**	**6/26**	**7/1**	**7/8**	**7/15**	**7/21**
	Pre-application	After 2nd	After 3rd	After 4th	After 5th	After 6th	After 7th	After 8th	2 wk post-application
1	6.5	33.1	45.2	51.3	47.2	55.0	32.4	53.2	29.5
2	6.5	28.4	12.6	26.6	8.4	10.2	11.1	44.4	25.8
3	8.2	31.5	14.0	38.8	23.0	10.0	26.4	61.5	20.8
4	7.3	24.4	10.9	23.6	13.5	12.0	17.4	25.3	25.1
5	7.5	20.6	6.6	16.2	5.8	6.3	17.5	34.0	21.0
6	7.0	23.1	72.8	37.8	31.1	28.2	17.1	27.7	23.4
7	7.4	26.8	71.2	72.8	37.9	27.6	20.1	31.4	26.2
8	3.9	22.8	78.4	84.1	40.0	31.1	22.2	21.9	21.9
9	6.2	6.0	12.9	13.9	17.0	16.0	20.8	27.7	21.1
10	7.0	30.6	5.0	6.1	2.9	2.6	11.6	29.1	17.7

Treatment	5/20	6/3	6/10	6/17	6/26	7/1	7/8	7/15	7/21
	Pre-application	After 2nd	After 3rd	After 4th	After 5th	After 6th	After 7th	After 8th	2 wk post-application
11	5.0	20.6	61.8	31.9	10.6	8.3	14.3	32.9	16.9
12	5.5	29.7	6.7	15.2	7.7	13.6	24.8	36.2	22.5
13	5.5	26.1	36.0	20.0	7.0	8.5	11.6	23.6	20.0
14	5.3	33.5	46.7	22.7	21.9	12.2	12.3	23.5	19.7
15	5.8	20.8	36.2	27.2	21.3	10.5	14.2	20.9	23.7
16	6.8	13.0	80.4	49.1	27.5	35.1	41.5	24.3	19.5
17	6.7	27.5	11.5	27.9	15.9	8.2	14.5	32.4	22.9
18	7.5	13.4	65.9	55.3	47.2	62.2	34.3	71.5	37.4
19	7.6	8.6	51.5	45.3	24.1	40.1	25.5	23.2	30.7
20	5.2	7.7	56.5	25.8	13.1	9.0	7.5	16.0	17.1
LSD	--	9.8	13.4	10.6	8.5	13.4	17.0	19.2	--
F test Probability	NS	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.01	<0.0001	NS

(Table 3 continued)

Table 4. Visual damage ratings for thrips feeding damage and iris yellow spot virus (IYSV) severity in response to 20 insecticide treatment programs. Data are the mean damage ratings (0-4 scale) of 15 plants per plot. Separate ratings were made on the outer, middle, and inner leaves of the same plants per plot. Ratings were done on 6 August. Malheur Experiment Station, Oregon State University, Ontario, OR, 2013. Continued on next page.

	Outer leaves		Middle leaves		Inner leaves	
Treatment	**thrips damage**	**IYSV**	**thrips damage**	**IYSV**	**thrips damage**	**IYSV**
1	3.15	0.78	3.37	0.92	3.40	0.30
2	2.32	0.40	2.85	0.43	2.87	0.35
3	2.73	0.63	3.10	0.93	3.50	0.27
4	2.37	0.38	2.48	0.35	2.52	0.37
5	2.73	0.45	3.17	0.35	3.35	0.15
6	2.75	0.33	3.03	0.43	3.15	0.27
7	2.52	0.40	2.80	0.43	2.85	0.18
8	3.00	0.75	3.22	0.58	3.28	0.22
9	2.18	0.60	2.60	0.47	3.00	0.30
10	2.13	0.53	2.32	0.53	1.97	0.27

Treatment	Outer leaves		Middle leaves		Inner leaves	
	thrips damage	IYSV	thrips damage	IYSV	thrips damage	IYSV
11	1.75	0.43	2.32	0.62	2.43	0.25
12	2.25	0.47	2.85	0.83	2.77	0.13
13	2.20	0.55	2.60	0.53	2.13	0.10
14	2.55	0.52	2.93	0.68	2.72	0.20
15	2.70	0.67	2.92	0.62	2.85	0.35
16	2.78	0.43	2.78	0.62	2.75	0.25
17	2.32	0.60	2.60	0.63	2.20	0.33
18	3.07	0.47	3.57	0.48	3.70	0.05
19	2.65	0.63	2.87	0.47	2.87	0.27
20	2.33	0.42	2.38	0.57	2.72	0.17

(Table 4 Continued)

Table 5. Onion yield in response to 20 insecticide treatment programs. Data are the mean number of hundredweight per acre (cwt/acre) for the different yield categories and the mean number of supercolossal bulbs per 50-lb sack. Malheur Experiment Station, Oregon State University, Ontario, OR, 2013. Continued on next page.

Treatment	**Total yield**	**Marketable yield**	**Total >4 inch**	**Super – colossal**	**Colossal**	**Jumbo**	**Medium**	**Small**	**Supers per 50 lbs**
1	1125	1118	331	26	305	769	19	7	36.3
2	1265	1258	584	83	501	653	22	6	33.2
3	1191	1186	453	42	411	713	20	5	34.1
4	1226	1221	604	88	516	601	16	5	38.6
5	1181	1177	583	79	504	575	19	3	32.8
6	1264	1259	496	42	455	750	12	4	33.0
7	1196	1192	493	49	444	680	19	4	36.1
8	1187	1183	383	39	344	784	16	4	33.6
9	1280	1275	760	184	576	502	14	5	31.7
10	1268	1264	593	85	508	652	18	4	34.1

Treatment	Total yield	Marketable yield	Total >4 inch	Super – colossal	Colossal	Jumbo	Medium	Small	Supers per 50 lbs
11	1327	1324	741	122	619	570	13	3	33.2
12	1286	1282	608	65	543	658	15	4	34.2
13	1302	1297	673	93	580	607	17	5	33.4
14	1276	1273	636	76	560	622	16	3	31.0
15	1175	1170	534	85	448	619	17	5	35.2
16	1216	1212	450	40	410	718	43	3	33.6
17	1181	1177	538	66	472	617	22	4	31.6
18	1105	1099	287	18	269	791	21	6	36.0
19	1211	1202	482	43	439	699	22	8	36.7
20	1391	1387	761	126	634	609	18	3	31.5
LSD	124	125	125	42	102	112	--	--	--
F test Probability	0.004	0.004	0.0001	0.0001	0.0001	0.0001	NS	NS	NS

(Table 5 Continued)

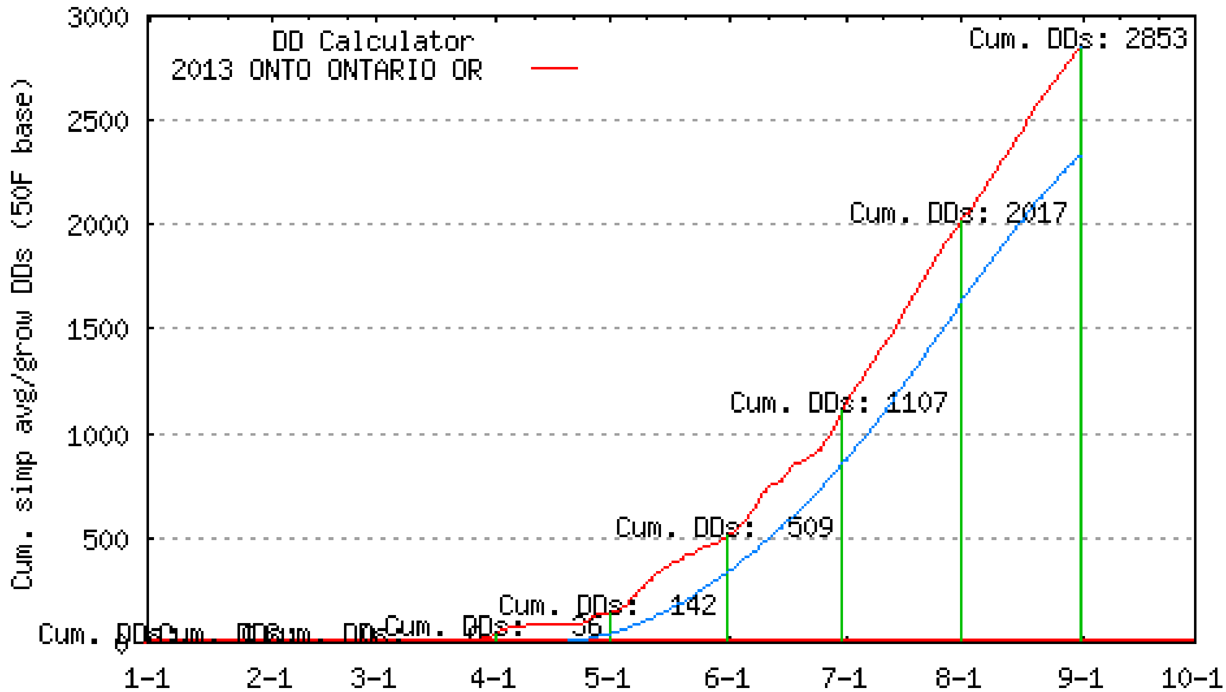

Figure 1. *Comparison of the accumulated degree-days for 2013 versus the 30-year average, as recorded at Ontario, OR. The upper line represents the 2013 degree-days (base 50°F), and the lower line represents the 30-year averages. Malheur Experiment Station,Oregon State University, Ontario, OR.*

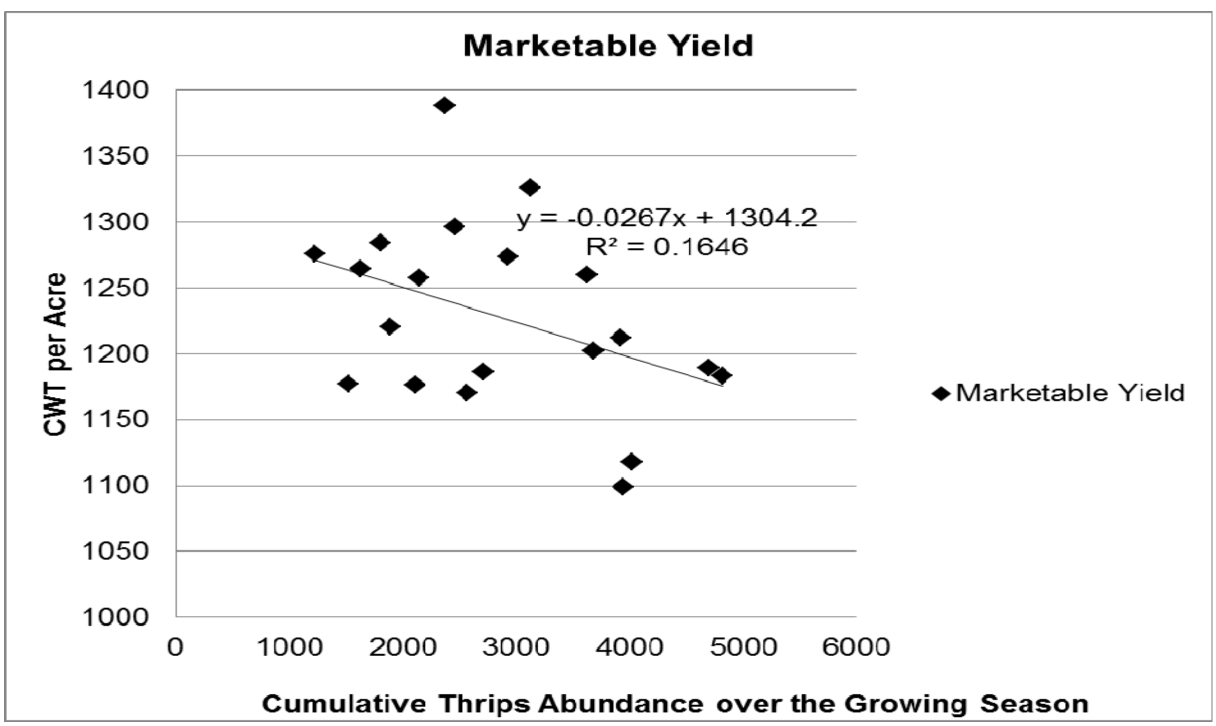

Figure 2. The effect of cumulative thrips abundance on total marketable yield of onions. Marketable yield declines with increasing thrips pressure. Malheur Experiment Station, Oregon State University, Ontario, OR, 2013.

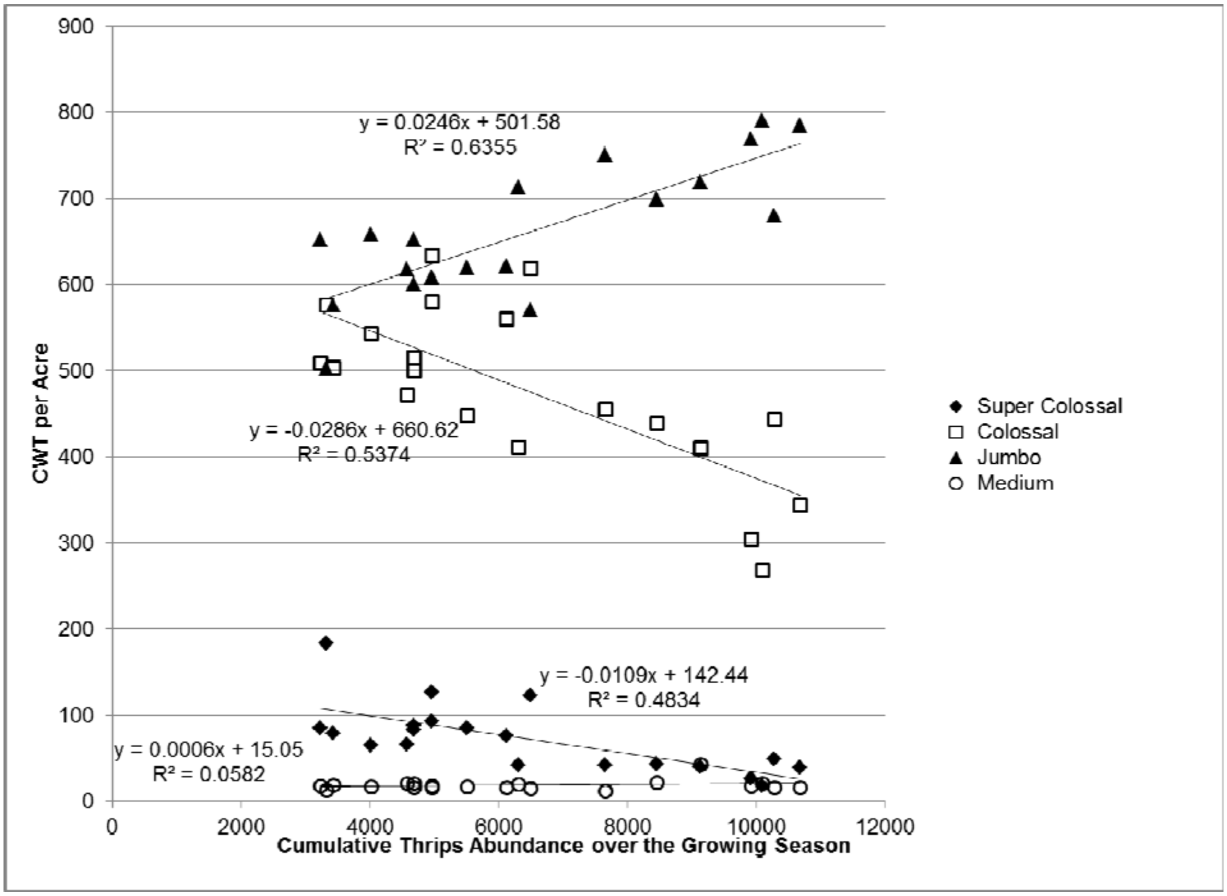

Figure 3. The effect of cumulative thrips abundance on yield of different size classes of onions. The greatest effect of increasing thrips pressure is the decline in yield of colossal and supercolossal bulbs and the increase in yield of the smaller jumbo-sized bulbs. Malheur Experiment Station, Oregon State University, Ontario, OR, 2013.