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Insecticide Usage on Conventional and Organic Lettuce in the Desert, 2021-2022

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Introduction: The development of accurate data on insecticide usage is important to the assessment of IPM programs in Arizona. A reliable estimate of insecticide use patterns is one of our most objective tools for assessing changes in management practices. This information allows us to build relevant databases for measuring user behaviors and adoption of new IPM technologies. For PCAs, it can translate their efforts into economic terms for their clientele and confirms their value to the lettuce industry by showing the importance of their cost-effective management in desert lettuce production. This summary provides estimates of insecticide use during the 2020-21 growing season and trends on lettuce IPM over the past 17 years.

Methods: Growers and PCAs attended a Head Lettuce Insect Losses and Impact Assessment Workshops in Yuma on April 20, 2022 and completed surveys in a guided process. The workshops were conducted in an interactive manner where participants were given a presentation that established the incentives for participation, explained the crop insect loss system, and further walked the participants through the estimation process. This summary presents results from the insecticide use surveys for lettuce produced in Yuma County, AZ and Imperial County, CA. The data were generated by requesting that PCAs estimate the use frequency of various products and the percentage of treated acres for each product in both conventional and organic lettuce. Estimates of total treated acreage were generated using the acreage reported from each survey participant. This data has allowed us to track changes in insecticide use patterns over time in greater detail in both fall and spring lettuce. In general, the most used insecticides in fall and spring lettuce correspond directly to the key pests that typically occur during these growing periods.

A total of 24 surveys were completed in 2022 for conventional lettuce, representing an estimated total of 34,411 fall acres and 32,761 acres from Yuma and neighboring Imperial County (Holtville/Brawley/Bard/Winterhaven). A total of 2099 fall acres and 2267 spring acres were reported for organic lettuce.

Conventional Lettuce

When compared by class of chemistry using the IRAC mode of action classification system, the pyrethroids (applied as foliar sprays and sprinkler chemigations) were again the most commonly used insecticide class in fall and spring lettuce **(Tables 1 & 2)**.The reason for this is quite evident; pyrethroids are the safest and most inexpensive broad spectrum insecticide still available for use in tank-mixtures for effective contact control of flea beetles, crickets, plant bugs and some Lepidopterous larvae and adults (cabbage looper and corn earworm). Over the past 18 years, pyrethroid usage has remained consistently high **(Fig. 1 & 5)** in fall and spring lettuce, and accounts for the bulk of broad-spectrum chemistry used to control insects in lettuce **(Fig 6 & 8)**.

Overall, organophosphate/carbamate usage increased over the past seasons. On spring lettuce in 2022, methomyl (Lannate) usage was higher than the previous 5 years, and acephate usage increased slightly with the threat of INSV infection **(Fig 5)**. Both insecticides remain important rotational partners for western flower thrips management, particularly with only a few viable alternatives available. Their use for control of lepidopterous larvae and aphid control has been displaced primarily by several reduced-risk chemistries, and as noted above, pyrethroids provide a safer, more cost-effective broad-spectrum alternative.

The spinosyns remain the second most used class of insecticides, where 100% of the responding PCAs indicated that they used Radiant on fall lettuce in 2020-21 **(Table 1 and 2).** Radiant usage against both lepidopterous larvae **(Figure 1, Table 3)** and thrips **(Figure 5, Table 5)** has remained steady over the past 18years, averaging over 2 sprays per treated acre. This is presumably due to the early Lep pressure experienced in the fall, and the thrips pressure this spring.

The Diamides (Coragen, Besiege, Minecto Pro, Exirel and Verimark, and Harvanta) were a commonly used chemistry in fall and spring lettuce **(Table 1 and 2).** PCAs have steadily incorporated this new chemical class into their Lepidopterous larvae management programs since becoming available in 2008, and diamides were applied to over 80% of the fall lettuce acreage (**Fig 1)**. Among the diamides, Harvanta (cyclaniliprole), a new 3rd generation diamide and Beleaf, an in-can mixture of chlorantraniliprole and lambda cyhalothrin were the most used, whereas Coragen use declined compared to last season. The 2nd generation diamide cyantraniliprole pre-mixture, Minecto Pro, was used on about 11% of the seasonal acers, and slightly more than its diamide counterpart, Exirel. Diamide soil usage (Coragen) decreased in 2020, and Verimark use was increased slightly **(Fig 1, Table 3).**

Another important class of chemistry used in fall and spring lettuce are the neonicotinoids-4A (the 3rd most used chemistry in lettuce in 2020-21) driven primarily by soil-applied imidacloprid for whiteflies and aphids **(Figures 3, 4 & Fig 8)**. The usage of imidacloprid on both fall and spring lettuce has increased markedly since 2009 but decreased markedly in 2021-22. Last season it was applied to less than 70% of fall and spring acres **(Table 3-4).** Foliar neonicotinoid usage also decreased last season on lettuce as a result of effective numerous cost-effective alternates now available to PCAs. However, Movento was applied on over 93% of the spring acers in 2022 and was the most used insecticide for sucking insect control, and in particular, Lettuce aphid **(Fig 4 and 7)**. Similarly, Sequoia, Sivanto, PQZ and Versys accounted for significant usage this spring due to the widespread aphid outbreaks growers experience last season. Torac usage was up slightly last spring for thrips management but was only used on about 5% of the acreage **(Fig 5).**

From an IPM perspective, the local produce industry continues to make great strides in minimizing environmental impacts in lettuce production by continuing to incorporate the newer reduced-risk insecticides into their insect management programs. To date there have been no major incidents of field failures or measurable lack of insect susceptibility with these compounds in lettuce due largely to the judicious usage of the key products. This has occurred due to the availability of multiple modes of actions with cost-effective activity against most key pests, and the conscientious efforts of PCAs to alternate application of these chemistries during the crop season. Although the broad spectrum, consumer–friendly pyrethroids have been the predominant chemistry applied to lettuce, for the past eight seasons PCAs treated a greater percentage of their lettuce acreage with selective, reduced-risk products than with the broadly toxic, OP/ carbamate and chemistries **(Fig 8 & 9)**.

Organic Lettuce

For the 3rd consecutive year, Entrust was applied to 100% of fall lettuce when Lep larvae are most economically important. Similarly, Entrust was applied to 100% of the spring acreage in 2022 where western flower thrips management is critical **(Table 5 and 6, Fig 10 and 11).** Pyganic, was the second most used product in fall lettuce followed by Bt and Azadirachtin/neem oil products. In spring lettuce, Azadirachtin/neem oil products was applied to greater than 80% of the acres when aphid management is critical. M-Pede and Celite were used on less than 10% of fall and spring lettuce acres, and Venerate use was not reported last season on organic crops. Overall, Entrust was applied to 2X as many acres as any other organic product **(Fig 12).**

Conclusions

In conclusion, selective, reduced risk insecticides will continue to play an increasing role in management of insect pests in desert lettuce. As new active ingredients become available, the industries reliance on the broadly toxic organophosphate and carbamate compounds will likely decline. The availability of new modes of action with activity against western flower thrips would certainly reduce the industries reliance on OPs and carbamates. Fortunately, there are several experimental active ingredients being developed by industry that have shown good residual control of thrips. Because of the intensive pest spectrum that PCAs face in the desert, coupled with the demands for high quality, cosmetically acceptable lettuce, there will still be a need for broad spectrum products (i.e., pyrethroids). A note of caution though, given the importance of the pyrethroids and the trends in their heavy usage, PCAs should only use them when necessary to preserve their susceptibility. Furthermore, if the organic lettuce industry hopes to remain sustainable, effective biopesticide alternatives for aphids, whiteflies, beetles and thrips will be necessary in the future.

Acknowledgement: *Special thanks go out to all the PCAs and growers who took time away from their busy schedules to participate in these surveys over the 18 years. Without your efforts, this historical data would not exist.*

Table 1. Insecticide chemistries used on Fall Lettuce, 2021

	Fall Lettuce, 2021				
Insecticide Chemistry	**IRAC group**	**% PCA's Using Products**	**% treated acres**	**No. applications**	**Treated [1] acres**
Carbamates	1A	68.2	48.2	1.1	16,585
Organophosphates	1B	13.6	6	1.0	2,055
Pyrethroids - Foliar	3A	100	100	3.3	119,686
Pyrethroids - Chemigation	3A	95.5	74.4	1.0	25,605
Pyrethroids - Total					145,291
Neonicotinoids -Soil	4A	90.1	67.6	1.0	23,271
Neonicotinoids -Foliar	4A	17.1	7.6	1.0	2,537
Neonicotinoids -Total					25,808
Sulfoxamines	4C	31.8	7.3	1.3	3,602
Butenolides	4D	27.3	7.4	1.5	3,640
Spinosyns	5	100	99.6	2.3	76,431
Avermectins	6	31.8	10.8	1.0	3,730
JH mimic	7C	0	0	0	0
Selective feeding blockers	9B	9.1	0.8	1.0	290
Selective feeding blockers	9D	4.5	0.3	1.0	100
Chitin Synthesis inhibitor	16	0	0	0	0
Ecdysone agonists	18	22.7	11.6	1.0	3,980
METI inhibitors	21	4.5	0.1	1.0	10
Na channel blockers	22	9.1	3.1	1.0	1,050
Tetramic acids	23	18.2	4.0	1.1	1,610
Diamides -Soil	28	22.7	6.1	1.0	2,115
Diamides- Foliar	28	81.8	51.0	1.1	22,542
Diamides- Total					24,647
Chordotonal organ modulators	29	22.7	6.7	1.5	3,580

[1] *Total acres treated estimated by multiplying: % acres treated * number of times treated * acreage estimated by participating PCAs in the survey.*

Table 2. The top insecticide chemistries used on Spring Lettuce, 2022

Insecticide Chemistry	IRAC group	% PCA's Using Products	% treated acres	No. applications	Treated [1] acres
	Spring Lettuce, 2022				
Carbamates	1A	81.0	56.8	1.3	37,256
Organophosphates	1B	13.6	5.6	1.0	1,838
Pyrethroids - Foliar	3A	95.2	91.9	2.6	90,260
Pyrethroids - Chemigation	3A	52.4	33	1.0	10,805
Pyrethroids - Total					101,065
Neonicotinoids -Soil	4A	81.0	62.6	1.0	20,511
Neonicotinoids -Foliar	4A	14.3	17.2	1.3	11,138
Neonicotinoids -Total					31,649
Sulfoxamines	4C	90.4	46.4	1.1	18,002
Butenolides	4D	66.7	37.2	1.1	17,892
Spinosyns	5	95.2	93.3	1.8	56,707
Avermectins	6	28.6	13.1	1.0	4,285
JH mimic	7C	9.5	0.7	1.0	220
Selective feeding blockers	9B	47.6	22.1	1.2	8,502
Selective feeding blockers	9D	52.4	20.0	1.0	6,537
Chitin Synthesis inhibitor	16	0	0	0	0
Ecdysone agonists	18	9.5	1.8	1.5	575
METI inhibitors	21	9.5	5.2	1.0	1,700
Na channel blockers	22	4.8	0.2	1.0	60
Tetramic acids	23	95.2	93.3	1.8	56,707
Diamides -Soil	28	9.5	0.7	1.0	220
Diamides- Foliar	28	71.4	47.6	1.2	23,582
Diamides- Total					23,802
Chordotonal organ modulators	29	66.7	22.1	1.0	7,249

*[1] Total acres treated estimated by multiplying: % acres treated * number of times treated * acreage estimated by participating PCAs in the survey.*

Table 3. Insecticides applied to Fall Lettuce, 2021.

Insecticide Product	IRAC group	% PCA's Using Product *(n=22)*	% Treated acres	Avg. no. applications	Treated [1] acres
	Fall Lettuce, 2021				
Pyrethroids - Foliar	3A	100	98.7	3.3	112,047
Radiant	5	100	99.6	2.3	76,431
Pyrethroids – Chemigation	3A	95.5	74.4	1.0	25,605
Imidacloprid -Soil	4A	86.4	67.5	1.0	23,231
Proclaim	6	72.7	46.1	1.1	20,168
Lannate (methomyl)	1A	68.2	48.2	1.1	16,585
Harvanta	28	31.8	17.8	1.2	10,382
Besiege	28+3A	45.5	17.1	1.0	5,877
Coragen (Foliar)	28	36.4	14.1	1.1	5,741
Intrepid	18	22.7	11.6	1.0	3,980
Minecto Pro	28+6	31.8	10.8	1.0	3,730
Sivanto	4D	27.3	7.4	1.5	3,640
Sequoia	4C	31.8	7.3	1.3	3,602
Beleaf	29	22.7	6.7	1.5	3,580
Orthene (acephate)	1B	13.6	6	1.0	2,055
Endigo	4A+3A	13.6	5.1	1.0	1,762
Movento	28	18.2	4.0	1.1	1,610
Coragen (Soil)	28	9.1	4.6	1.0	1,580
Avaunt	22	9.1	3.1	1.0	1,050
Actara	4A	4.5	2	1.0	700
Exirel (foliar)	28	31.8	1.7	1.0	572
Verimark (soil)	28	13.6	1.6	1.0	535
PQZ	9B	9.1	0.8	1.0	290
Versys	9D	4.5	0.3	1.0	100
Assail	4A	4.5	0.5	1.0	75
Venom / Scorpion (soil)	4A	4.5	0.1	1.0	40
Torac	21	4.5	0.1	1.0	10
Venom / Scorpion (foliar)	4A	0	0	0	0
Dimethoate	1A	0	0	0	0
Senstar	23+7C	0	0	0	0
Imidacloprid (foliar)	4A	0	0	0	0
Malathion	1B	0	0	0	0
Oberon	23	0	0	0	0
Knack	7C	0	0	0	0
Courier	16	0	0	0	0
Fulfill	9B	0	0	0	0
Agri-Mek (abamectin)	6	0	0	0	0

*[1] Total acres treated estimated by multiplying: % acres treated * number of times treated * acreage estimated by participating PCAs in the survey.*

Table 4. Insecticides applied to Spring Lettuce, 2022.

Insecticide Product	Spring Lettuce, 2022				
	IRAC group	% PCA's Using Product *(n=21)*	% Treated acres	No. applications	Treated [1] acres
Pyrethroids - Foliar	3A	95.5	91.9	2.6	86,874
Radiant	5	100	98.3	2.1	64,794
Movento	28+16	95.5	93.3	1.8	56,707
Lannate (methomyl)	1A	81.0	56.8	1.3	37,256
Imidacloprid -Soil	3A	81.0	62.6	1	20,511
Sequoia	4C	90.5	46.4	1.1	18,002
Sivanto	4D	66.7	37.2	1.1	17,892
Harvanta	28	28.6	24.2	1.3	14,162
Assail	4A	9.5	17	1.5	11,075
Pyrethroids - Chemigation	3	52.3	33	1	10,805
PQZ	9B	47.6	22.1	1.2	8,502
Beleaf	29	66.7	22.1	1	7,249
Versys	9D	52.4	20	1	6,537
Minecto Pro	28+6	28.6	13.1	1	4,285
Besiege	28+3A	28.6	10.1	1	3,323
Orthene (acephate)	1B	14.2	5.4	1	1,775
Proclaim	6	23.8	5.2	1	1,715
Torac	21	9.5	5.2	1	1,700
Coragen -Foliar	28	23.8	3.9	1	1274
Intrepid	18	9.5	1.8	1.5	575
Exirel -Foliar	28	19.0	0.8	1	275
Senstar	23+7C	9.5	0.7	1	220
Verimark (soil)	28	9.5	0.7	1	220
Dimethoate	1A	4.8	0.2	1	75
Endigo	4A+3	4.8	0.2	1	63
Avaunt	22	4.8	0.2	1	60
Agri-Mek (abamectin)	6	0	0	0	0
Imidacloprid - Foliar	4A	0	0	0	0
Venom/Scorpion -Foliar/Soil	4A	0	0	0	0
Coragen -Soil	28	0	0	0	0
Fulfill	9B	0	0	0	0
Actara	4A	0	0	0	0
Malathion	1B	0	0	0	0
Oberon	23	0	0	0	0
Knack	7C	0	0	0	0
Courier	16	0	0	0	0

*[1] Total acres treated estimated by multiplying: % acres treated * number of times treated * acreage estimated by participating PCAs in the survey.*

Table 5. Insecticides applied to Organic fall Lettuce, 2021.

Insecticide	IRAC group	Fall Lettuce - 2021 *(September -November)* Acres (%) treated with this product	Avg no. of applications	Treated acers	% PCA using Product (n=12)
Entrust	**5**	100.0	2.2	3,822	100.0
Pyganic	**3**	47.5	1.4	1,352	91.6
Azadirachtin/Neem products	**UN**	35.5	1.4	918	63.6
Bt (*Bacillus thuringiensis)*	**11**	34.8	1.3	1,106	81.8
M-Pede	**UN**	8.9	1.5	337	18.2
Celite	**UN**	1.9	1.0	40	8.3
Venerate	**UN**	0.0	0.0	0	0.0

*[1] Total acres treated estimated by multiplying: % acres treated * number of times treated * acreage estimated by participating PCAs in the survey.*

Table 6. Insecticides applied to Organic spring Lettuce, 2022.

Insecticide		Spring Lettuce - 2022 *(December-March)* Acres (%) treated with this product	Avg no. of applications	Treated acers	% PCA using Product (n=10)
Entrust	**5**	100.0	2.1	3,760	100.0
Pyganic	**3**	45.2	1.5	1,362	90.0
Azadirachtin/Neem products	**UN**	83.8	1.8	2,957	90.0
Bt (*Bacillus thuringiensis)*	**11**	38.4	1.4	1,189	100.0
M-Pede	**UN**	11.0	1.1	250	40.0
Celite	**UN**	7.1	1.0	160	10.0
Venerate	**UN**	0.0	0.0	0	0.0

*[1] Total acres treated estimated by multiplying: % acres treated * number of times treated * acreage estimated by participating PCAs in the survey.*

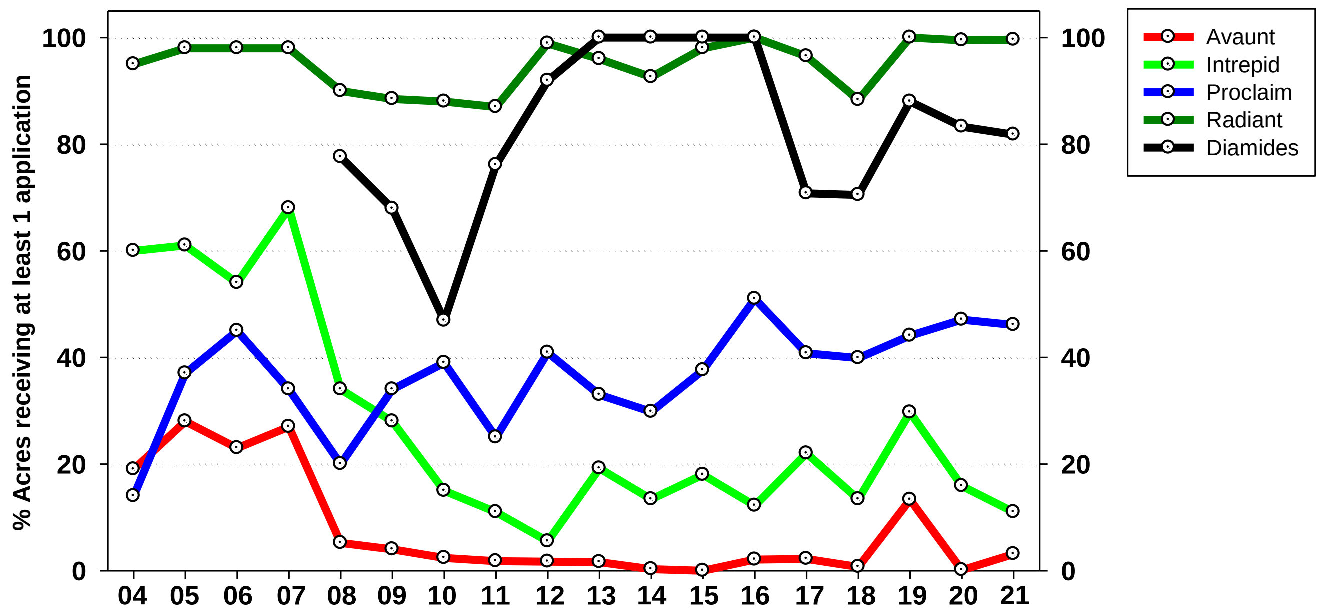

Figure 1. Trends in insecticide use for control of **Lepidopterous larvae** in Fall lettuce, 2004-2021.

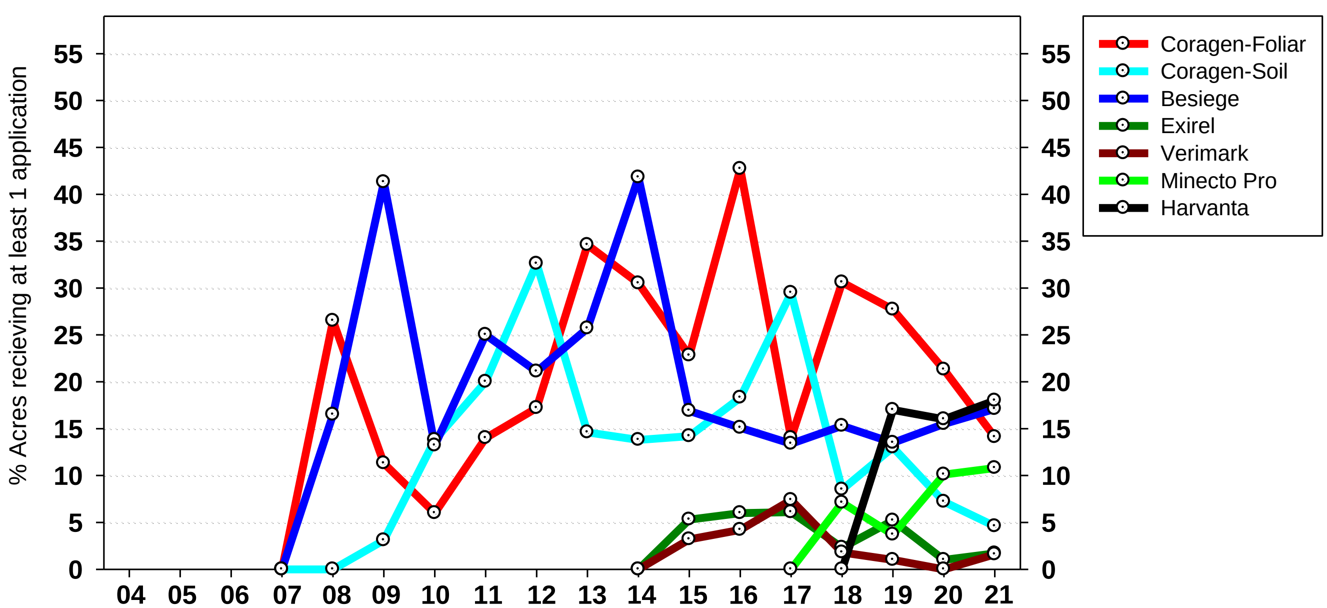

Figure 2. Trends in **Diamide** insecticide use for control of **Lepidopterous larvae** in Fall lettuce, 2004-2021.

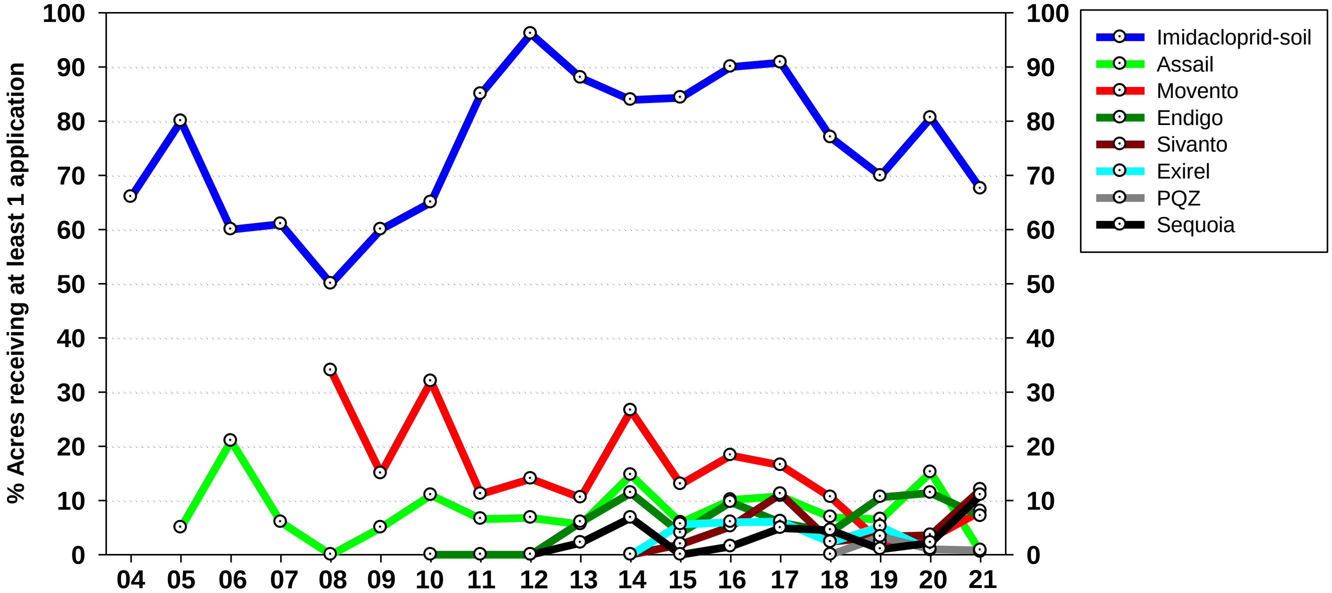

Figure 3. Trends in insecticide use for control of ***Bemisia* Whiteflies and other sucking pests i**n Fall lettuce, 2004-2021.

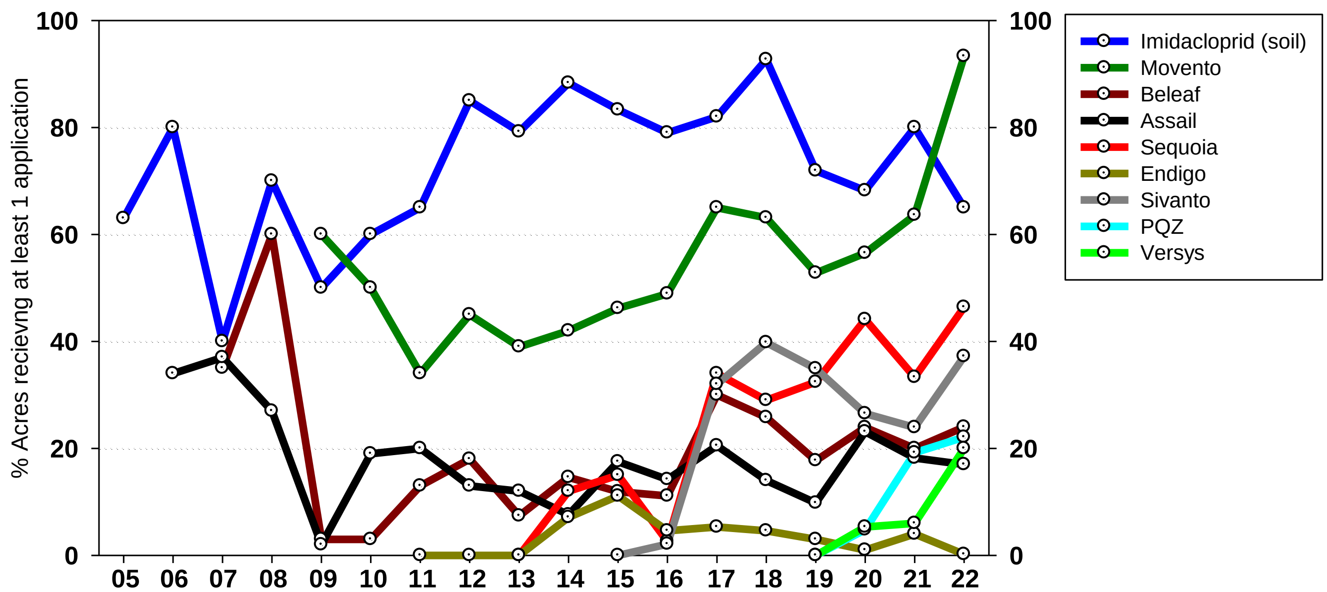

Figure 4. Trends in insecticide use for control of **Aphids** in Spring lettuce, 2005-2022.

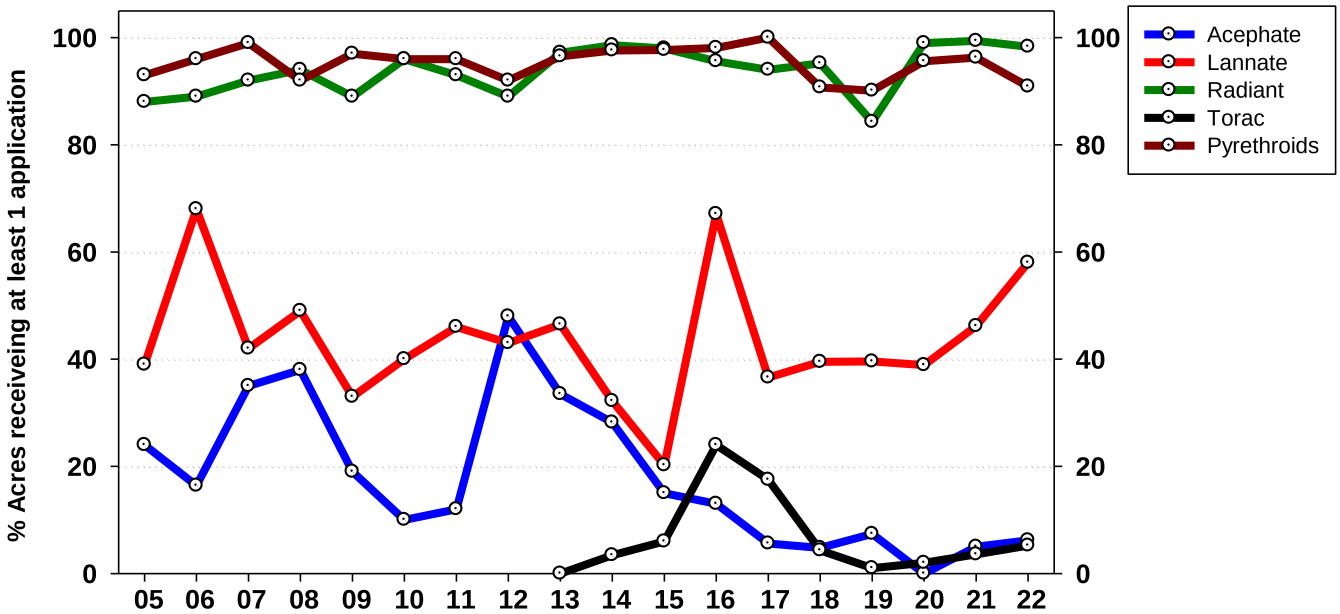

Figure 5. Trends in insecticide use for control of **Western Flower Thrips** in Spring lettuce, 2005-2022.

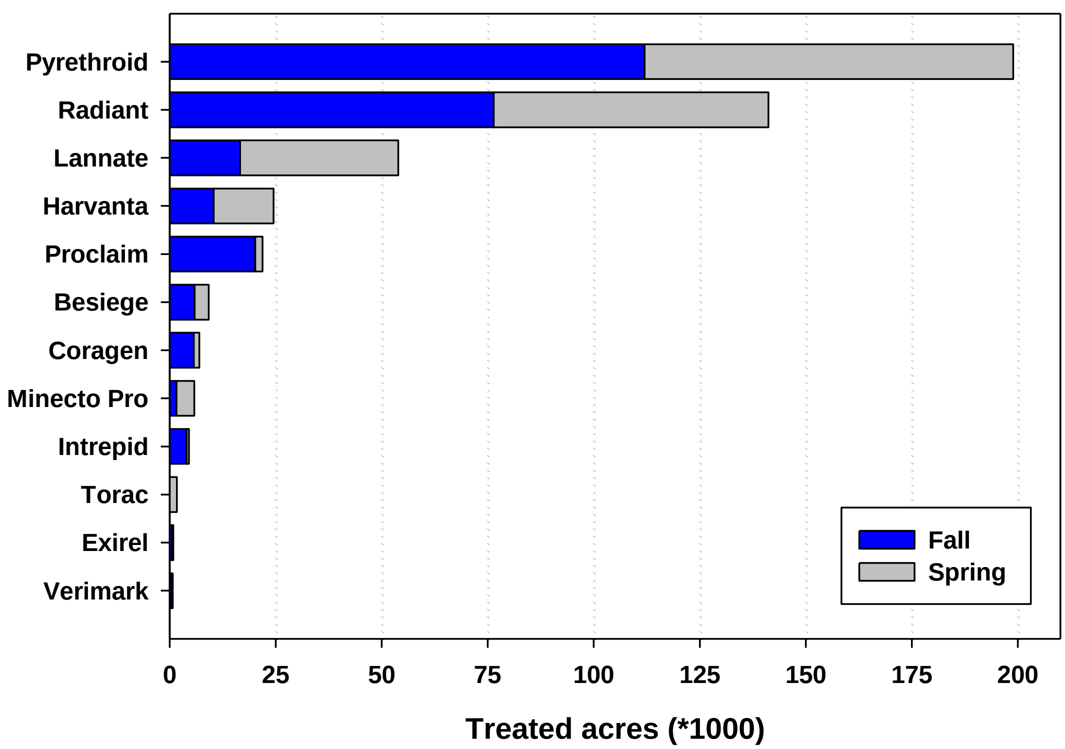

Figure 6. Estimates of insecticide use for Chewing and Contact insect control on Lettuce, 2021-2022.

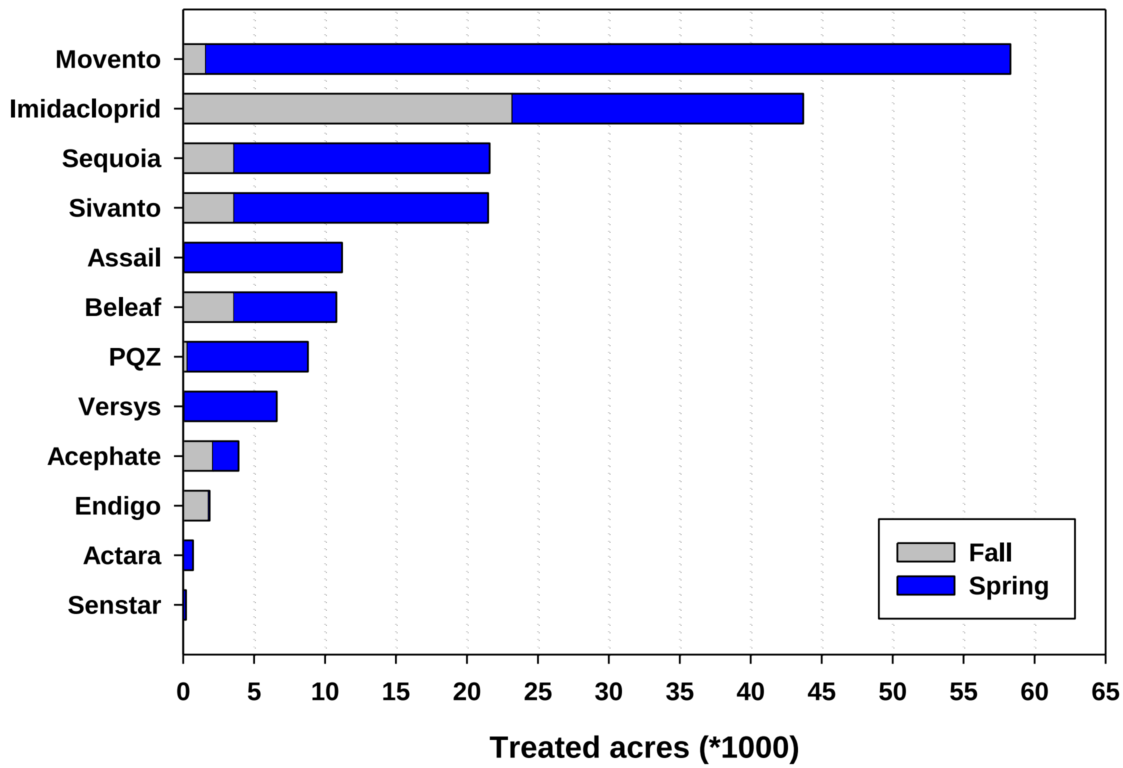

Figure 7. Estimates of insecticide use for sucking insect control on Lettuce, 2021-2022

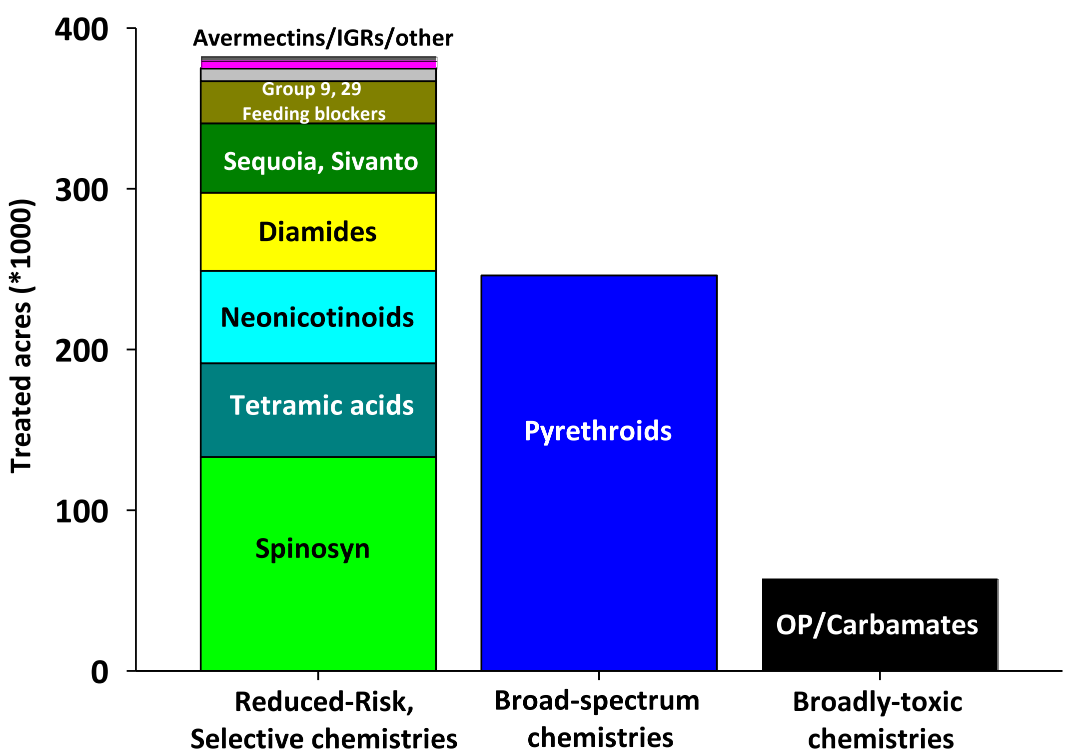

Figure 8. Estimates of total insecticide use for seasonal insect control on Lettuce, 2021-2022.

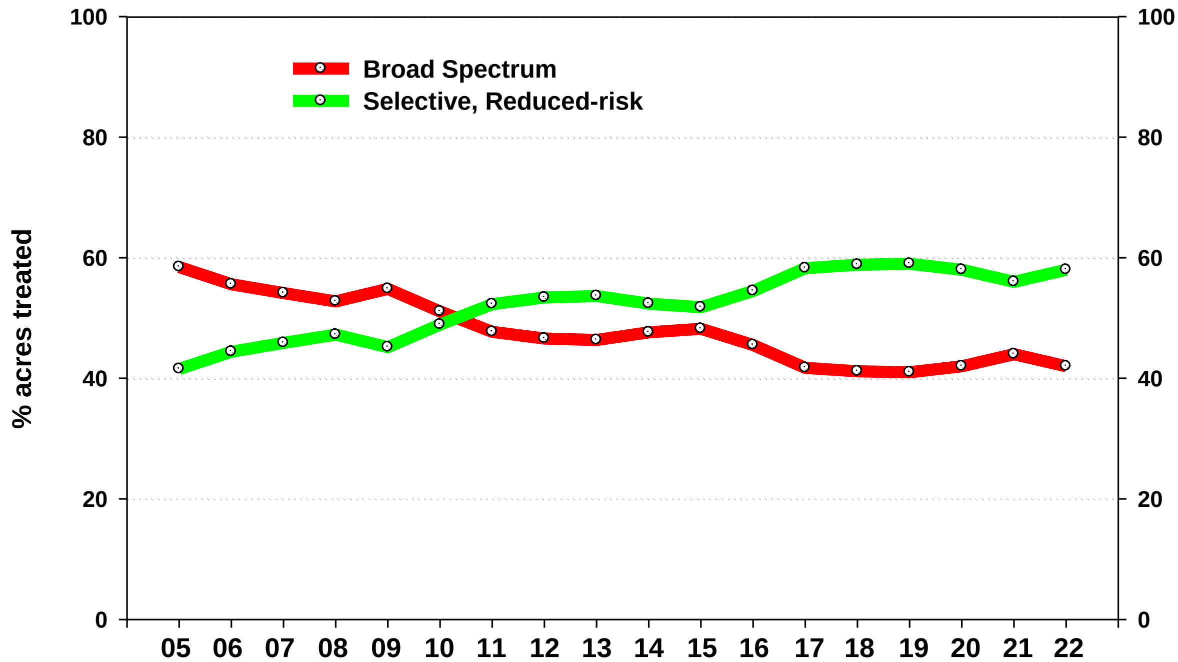

Figure 9. Percentage acreage treated with broad spectrum, and selective, reduced -risk insecticides on desert lettuce, 2005-2022.

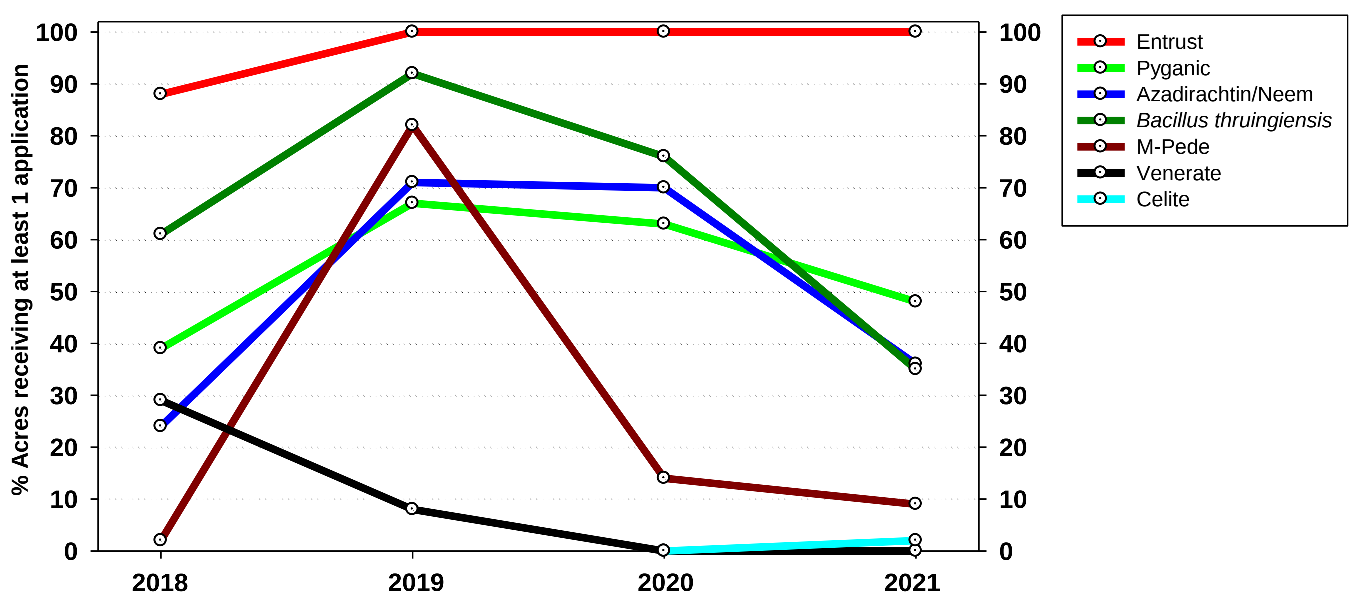

Figure 10. Percentage organic acreage treated with biopesticides in fall lettuce, 2018-2021.

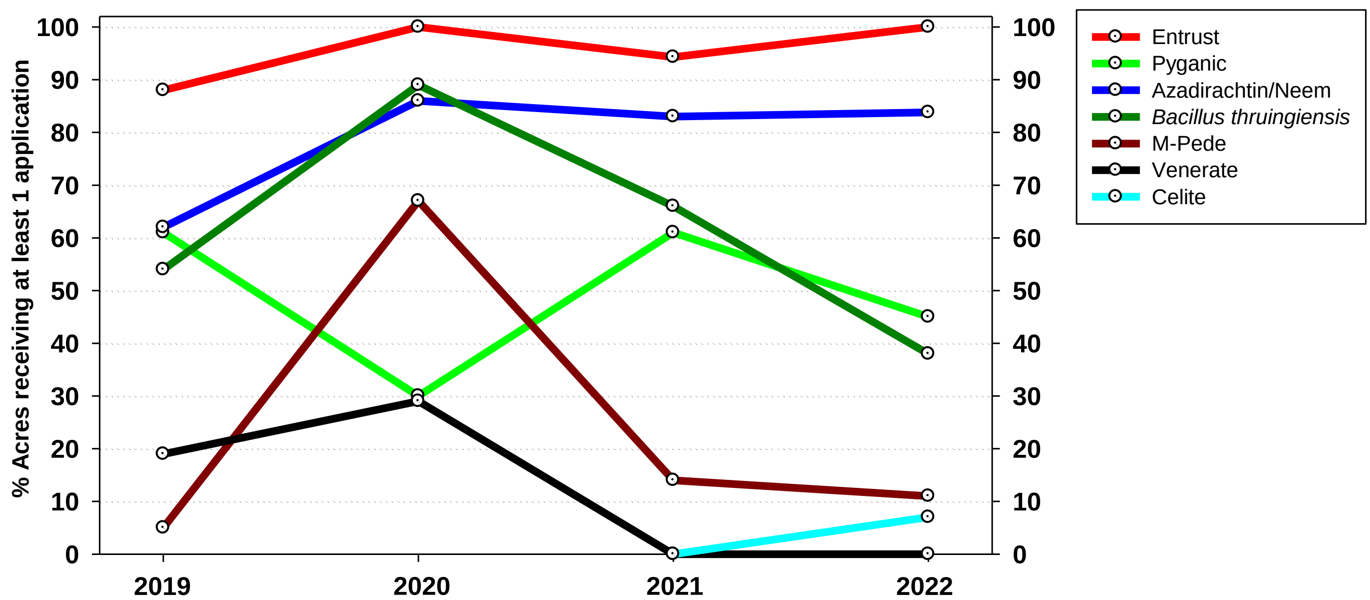

Figure 11. Percentage organic acreage treated with biopesticides in spring lettuce, 2019-2022.

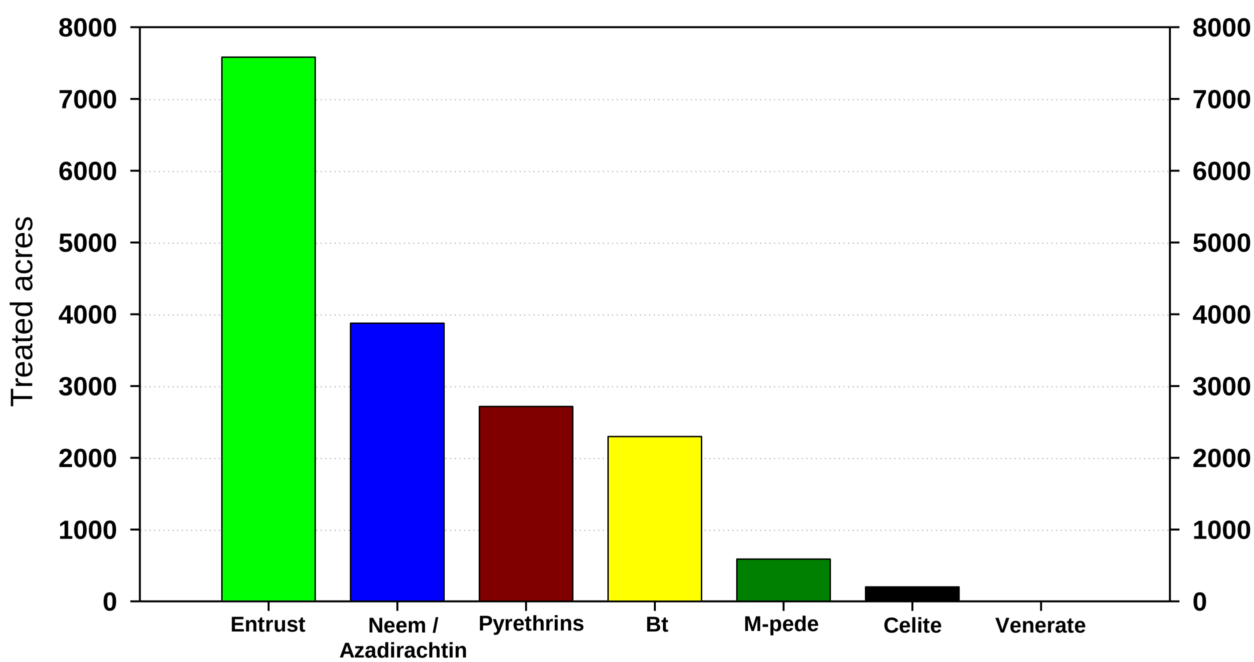

Figure 12. Estimates of total insecticide use for seasonal insect control on organic Lettuce, 2021-22.