Insecticide Usage on Conventional and Organic Lettuce in the Desert, 2022-2023

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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 2022-23 growing season and trends on lettuce IPM over the past 19 years.

Methods: Growers and PCAs attended a Lettuce Insect Losses and Impact Assessment Workshop in Yuma on May 9, 2023, 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. Maricopa 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 commonly used insecticides in fall and spring lettuce correspond directly to the key pests that typically occur during these growing periods.

A total of 21 surveys were completed in 2023 for conventional lettuce, representing an estimated total of 27,323 fall acres and 26,472 acres from Yuma, Scottsdale and neighboring Imperial County (Holtville/Brawley/Bard/Winterhaven). For organic lettuce, a total of 2764 fall acres and 3443 spring acres were reported.

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)**.The reason for this is quite evident; pyrethroids are the safest and most inexpensive broad spectrum insecticide still available for effective contact control of flea beetles, crickets, plant bugs and some Lepidopterous larvae and adults (cabbage looper and corn earworm). Over the past 19 years, pyrethroid usage has remained consistently high **(Fig. 5)** in fall and spring lettuce, and accounts for the bulk of broad-spectrum chemistry used to control insects in lettuce **(Fig 6 & 8)**.

Although, organophosphate/carbamate usage increased over the previous 2 seasons, methomyl (Lannate) usage declined by more than 20% compared to 2022 and was lower this year than the previous 5 years **(Fig 5)**. Similarly, acephate decreased significantly. 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 and spring lettuce in 2022-23 **(Table 1, 2 and 3).** Radiant usage against both lepidopterous larvae **(Figure 1)** and thrips **(Figure 5)** has remained steady over the past 18years, averaging over 2 sprays per treated acre. This is presumably due to the annual beet armyworm and cabbage looper pressure experienced each fall, and the thrips pressure during the 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 over the past 4 seasons (**Fig 1**). Among the diamides, Harvanta (cyclaniliprole), a new 3rd generation diamide, Minecto Pro (an in-can mixture of cyantraniliprole and abamectin) and Besiege (an in-can mixture of chlorantraniliprole and lambda cyhalothrin) were the most used. Although Coragen foliar use has steadily been declining over the past 5 years, soil applied Coragen more than doubled compared to the previous season **(Fig 1, Table 2 and 3).**

Another important class of chemistry used in fall and spring lettuce are the neonicotinoids-4A (the 3rd most used chemistry in lettuce in 2022-23) driven primarily by soil-applied imidacloprid for whiteflies and aphids **(Fig 3, 4 & Fig 7)**. The usage of imidacloprid on both fall and spring lettuce increased markedly in 2022-23, treated on well above 80% of the acreage **(Tables 2-3).** Foliar neonicotinoid usage decreased last season on lettuce likely due to the availability of many cost-effective alternates now available to PCAs. However, for the 2nd consecutive season, Movento was applied on ~90% of the spring acres in 2023 and was the most used insecticide for sucking insect control, and in particular, Lettuce aphid **(Fig 4 and 7)**. Similarly, Sequoia, Sivanto, Versys and Beleaf accounted for significant usage this spring due to the widespread aphid outbreaks growers experienced. Torac usage was up slightly last spring for thrips management 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 several years PCAs treated a greater percentage of their lettuce with selective, reduced-risk products than with the pyrethroid, OP and carbamate chemistries **(Fig 8 & 9)**.

Organic Lettuce/Biopesticides

For the 4th 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 and 2023 where western flower thrips management is critical **(Table 5 and 6, Fig 10 and 11).** Bt and Pyganic were the next most commonly used product in fall lettuce. In spring lettuce, Azadirachtin/neem oil products and Bt were most commonly used products next to Entrust. M-Pede , Celite and Venerate were used on significantly fewer acres. Overall, Entrust was applied to more than 2X as many acres as any other organic biopesticide 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 and are slated for registration with in the next few years. 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 complete these surveys over past the 19 years. Without your efforts, this historical data would not exist.*

Table 1. Insecticide chemistries used on fall and spring lettuce, 2022-23

Insecticide Chemistry	IRAC group	Fall Lettuce, 2022		Spring Lettuce, 2023	
		% PCA's Using Products	Treated [1] acres	% PCA's Using Products	Treated [1] acres
Carbamates	1A	47.6	11,193	52.4	14,299
Organophosphates	1B	4.8	500	4.8	200
Pyrethroids - Foliar	3A	95.2	81,263	95.2	55,294
Pyrethroids - Chemigation	3A	95.2	19,614	52.4	8,330
Pyrethroids - Total			100,877		63,624
Neonicotinoids -Soil	4A	100	23,050	95.2	22,232
Neonicotinoids -Foliar	4A		1,470	14.3	4,700
Neonicotinoids -Total			24,520		26,932
Sulfoxamines	4C	38.1	2,005	100	17,509
Butenolides	4D	28.6	1,405	85.7	9,356
Spinosyns	5	100	57,720	100	50,874
Avermectins	6	76.2	18,511	47.6	7,417
Juenile hormone mimics	7C	0	0	0	0
TRPV channel modulators	9B	0	0	52.4	4,055
TRPV channel modulators	9D	0	0	47.6	8,213
Chitin biosynthesis inhibitors-1	16	0	0	0	0
Ecdysone receptor agonists	18	19	3,380	19.0	1,787
METI inhibitors	21	0	0	14.3	1,782
Na channel blockers	22	4.8	125	4.8	125
Tetramic acid derivatives	23	23.8	1,233	90.5	36,758
Diamides -Soil	28	23.8	4,025	14.3	1,175
Diamides- Foliar	28	42.9	19,325	38.1	13,174
Diamides- Total			23,350		14,349
Nicotinamidase inhibitors	29	14.3	475	61.9	6,503

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

Table 2. Insecticides applied to Fall Lettuce, 2022.

Insecticide Product	Fall Lettuce, 2022				
	IRAC group	% PCA's Using Product *(n=21)*	% Treated acres	Avg. no. applications	Treated [1] acres
Pyrethroids - Foliar	3A	95.2	97.9	3.17	79,913
Radiant	5	100	92.0	2.3	57,720
Imidacloprid -Soil	4A	100	84.4	1	23,050
Pyrethroids – Chemigation	3A	95.2	66.2	1.15	19,614
Proclaim	6	76.2	46.7	1.04	13,269
Lannate (methomyl)	1A	47.6	29.8	1.3	11,193
Minecto Pro	28+6	28.6	17.1	1.1	5,242
Besiege	28+3A	42.9	17.2	1.1	5,030
Harvanta	28	28.6	16.1	1	4,390
Coragen (Foliar)	28	33.3	10.2	1.2	3,524
Intrepid	18	19.0	12.4	1	3,380
Coragen (Soil)	28	23.8	12.0	1	3,275
Sequoia	4C	38.1	7.3	1	2,005
Sivanto	4D	28.6	5.1	1	1,405
Endigo	4A+3A	4.8	4.9	1	1,350
Movento	23	23.8	4.5	1	1,233
Exirel (foliar)	28	23.8	4.2	1	1,139
Verimark (soil)	28	9.5	2.7	1	750
Orthene (acephate)	1B	4.8	1.8	1	500
Beleaf	29	14.3	1.7	1	475
Avaunt	22	4.8	0.5	1	125
Assail	4A	4.8	0.5	1	120
Actara	4A	0	0	0	0
PQZ	9B	0	0	0	0
Versys	9D	0	0	0	0
Venom / Scorpion (soil)	4A	0	0	0	0
Torac	21	0	0	0	0
Venom / Scorpion (foliar)	4A	0	0	0	0
Dimethoate	1B	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 3. Insecticides applied to Spring Lettuce, 2023.

Insecticide Product	IRAC group	% PCA's Using Product *(n=21)*	% Treated acres	No. applications	Treated [1] acres
	Spring Lettuce, 2023				
Pyrethroids - Foliar	3A	95.2	88.2	2.6	55,294
Radiant	5	100	97.0	2.1	50,874
Movento	23	90.5	87.1	1.6	36,758
Imidacloprid -Soil	4A	95.2	84.0	1	22,232
Sequoia	4C	100	50.5	1.3	17,509
Lannate (methomyl)	1A	52.4	36.9	1.3	14,299
Sivanto	4D	85.7	33.6	1.1	9,356
Pyrethroids – Chemigation	3A	52.4	19.0	1.6	8,330
Versys	9D	47.6	26.5	1.2	8,213
Beleaf	29	61.9	21.8	1.13	6,503
Assail	4A	9.5	8.9	1.9	4,600
Minecto Pro	28+6	19.0	12.0	1.2	3,875
PQZ	9B	47.6	13.4	1	3,555
Proclaim	6	47.6	13.4	1	3,542
Besiege	28+3A	38.1	11.6	1.1	3,473
Harvanta	28	19.0	11.1	1	2,950
Coragen (Foliar)	28	28.6	7.1	1.1	2,076
Intrepid	18	19.0	6.8	1	1,787
Torac	21	14.3	6.7	1	1,782
Coragen (Soil)	28	14.3	3.5	1	925
Exirel (foliar)	28	9.5	3.0	1	800
Fulfill	9B	4.8	1.9	1	500
Verimark (soil)	28	9.5	0.95	1	250
Orthene (acephate)	1B	4.8	0.76	1	200
Avaunt	22	4.8	0.5	1	125
Endigo	4A+3A	4.8	0.4	1	100
Actara	4A	0	0	0	0
Venom / Scorpion (soil)	4A	0	0	0	0
Venom / Scorpion (foliar)	4A	0	0	0	0
Dimethoate	1B	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

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

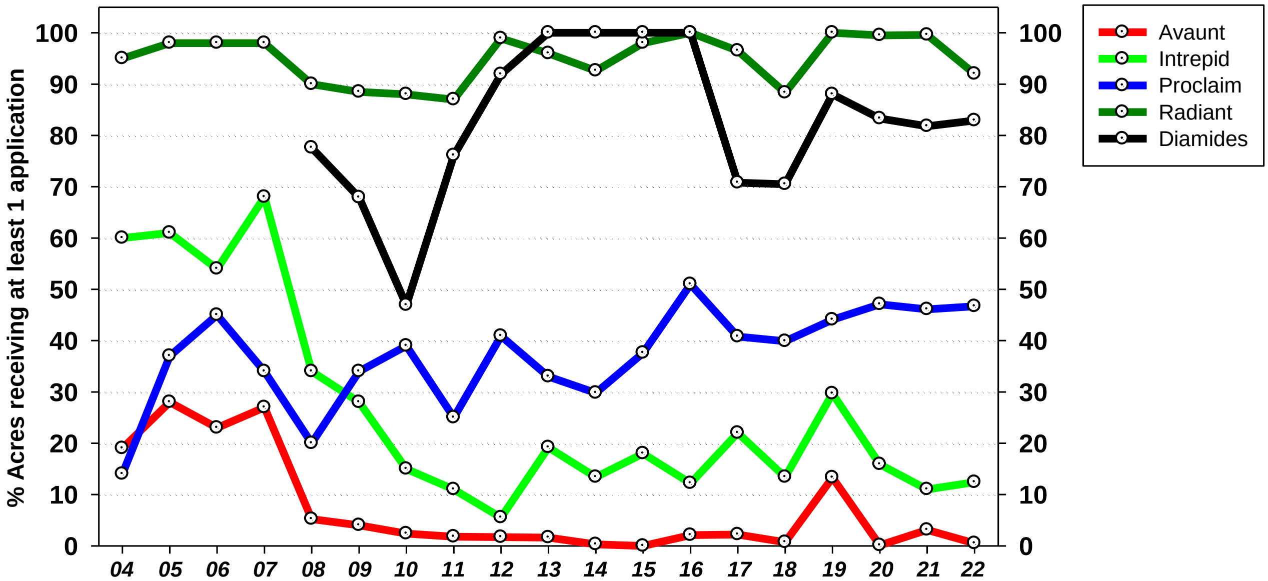

Figure 1. Trends in insecticide use for control of **Lepidopterous larvae** in Fall lettuce, 2004-2022.

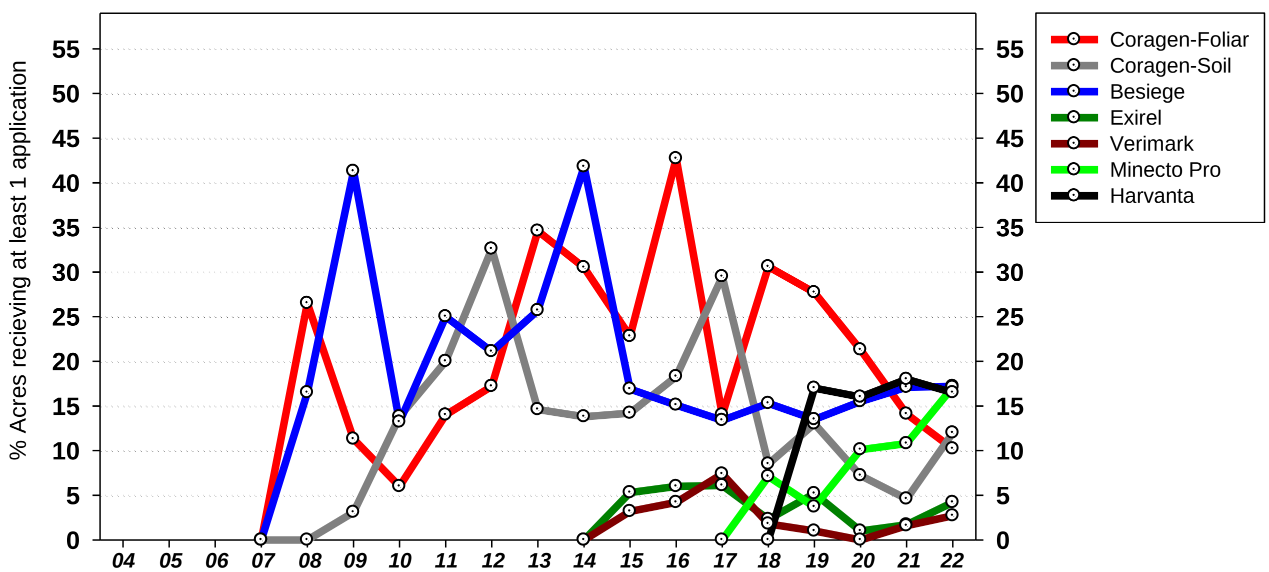

Figure 2. Trends in **Diamide** insecticide use for control of **Lepidopterous larvae** in Fall lettuce, 2004-2022.

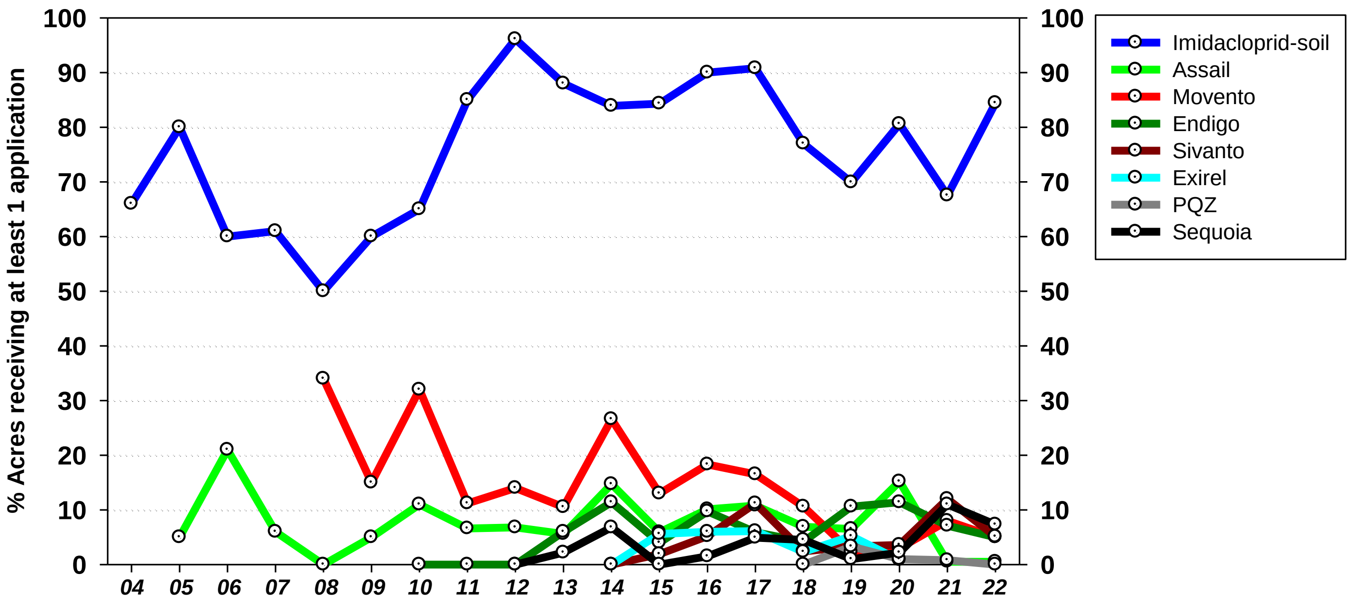

Figure 3. Trends in insecticide use for control of ***Bemisia*** **Whiteflies and other sucking pests** in Fall lettuce, 2004-2022.

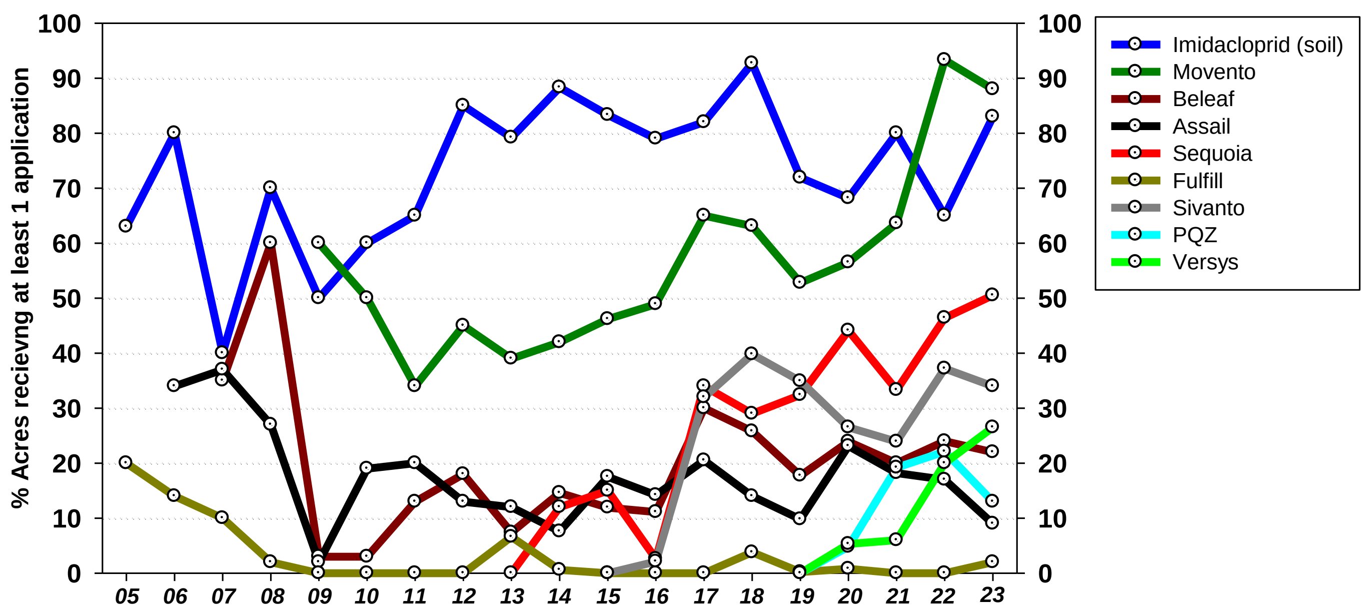

Figure 4. Trends in insecticide use for control of **Aphids** in Spring lettuce, 2005-2023.

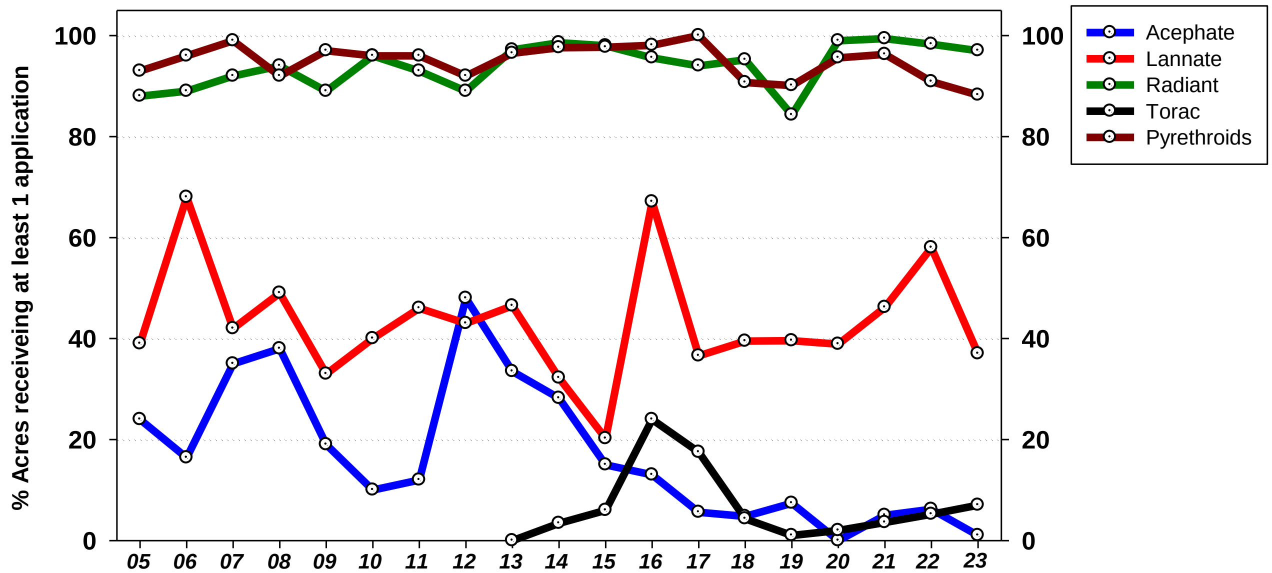

Figure 5. Trends in insecticide use for control of **Western Flower Thrips** in Spring lettuce, 2005-2023.

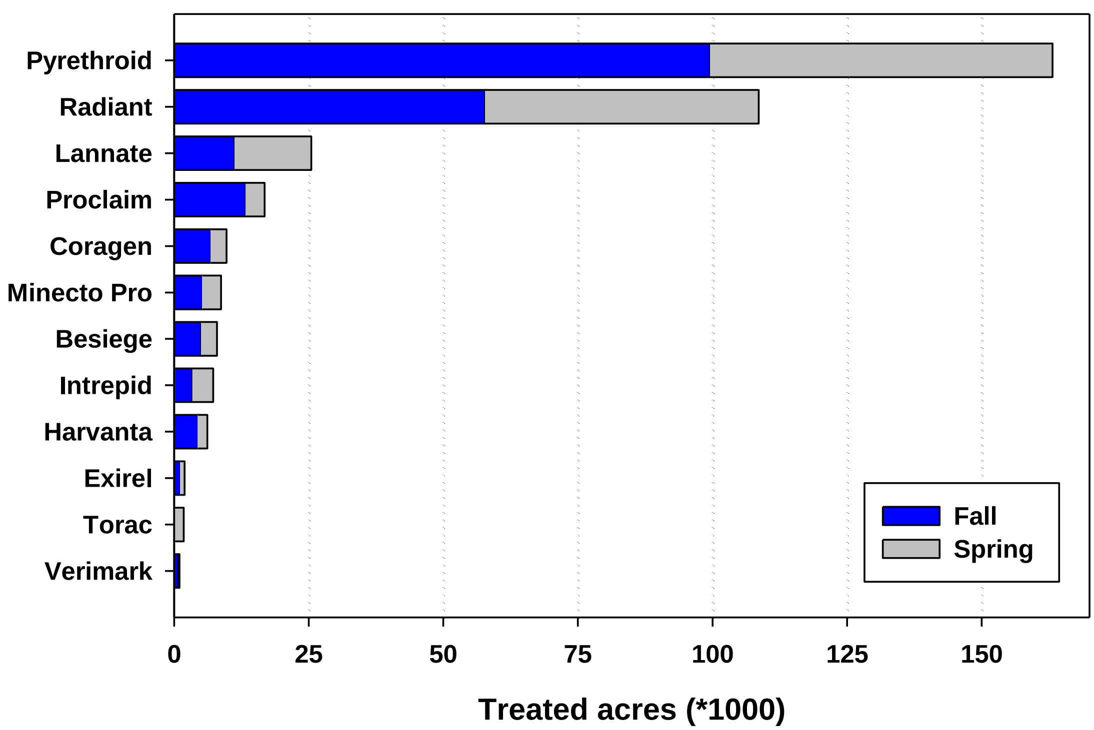

Figure 6. Estimates of insecticide use for Chewing and Contact insect control on Lettuce, 2022-2023.

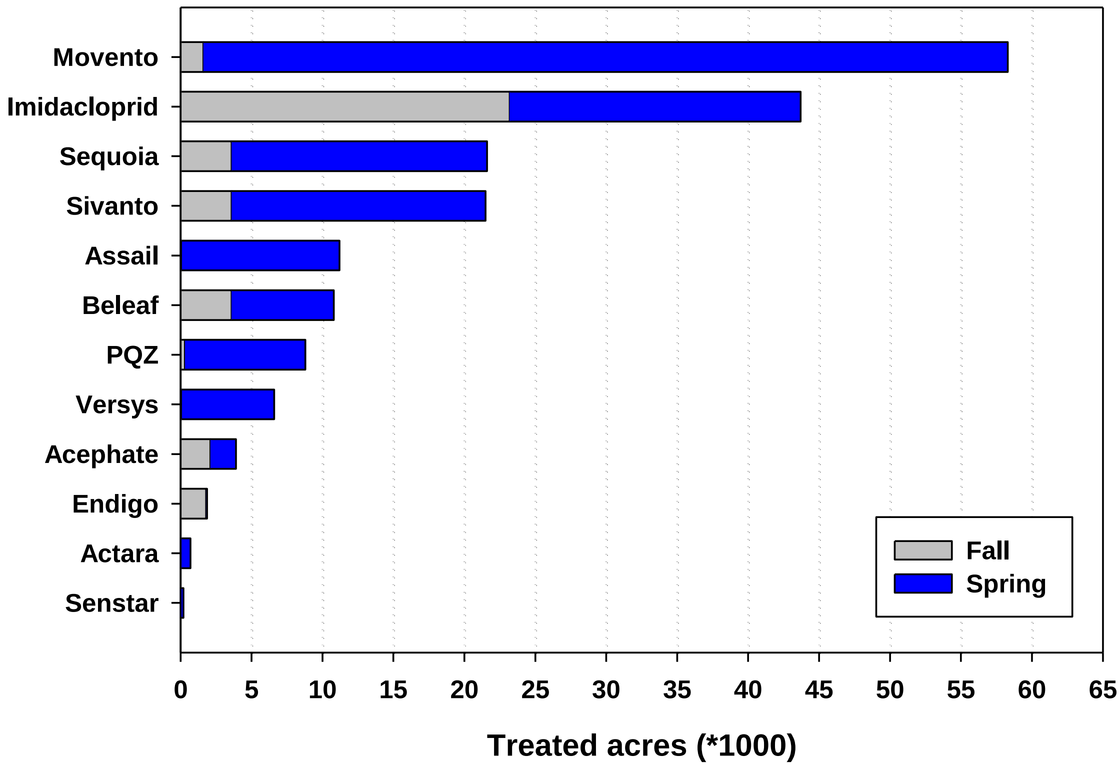

Figure 7. Estimates of insecticide use for sucking insect control on Lettuce, 2022-2023.

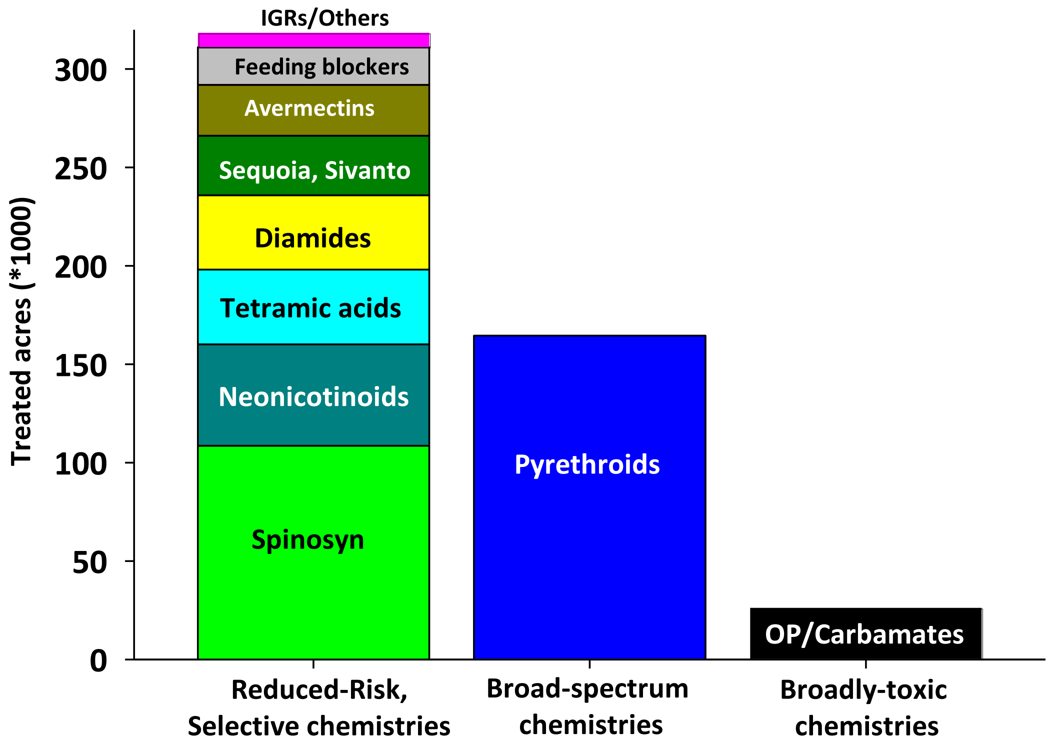

Figure 8. Estimates of total insecticide use for seasonal insect control on Lettuce, 2022-2023.

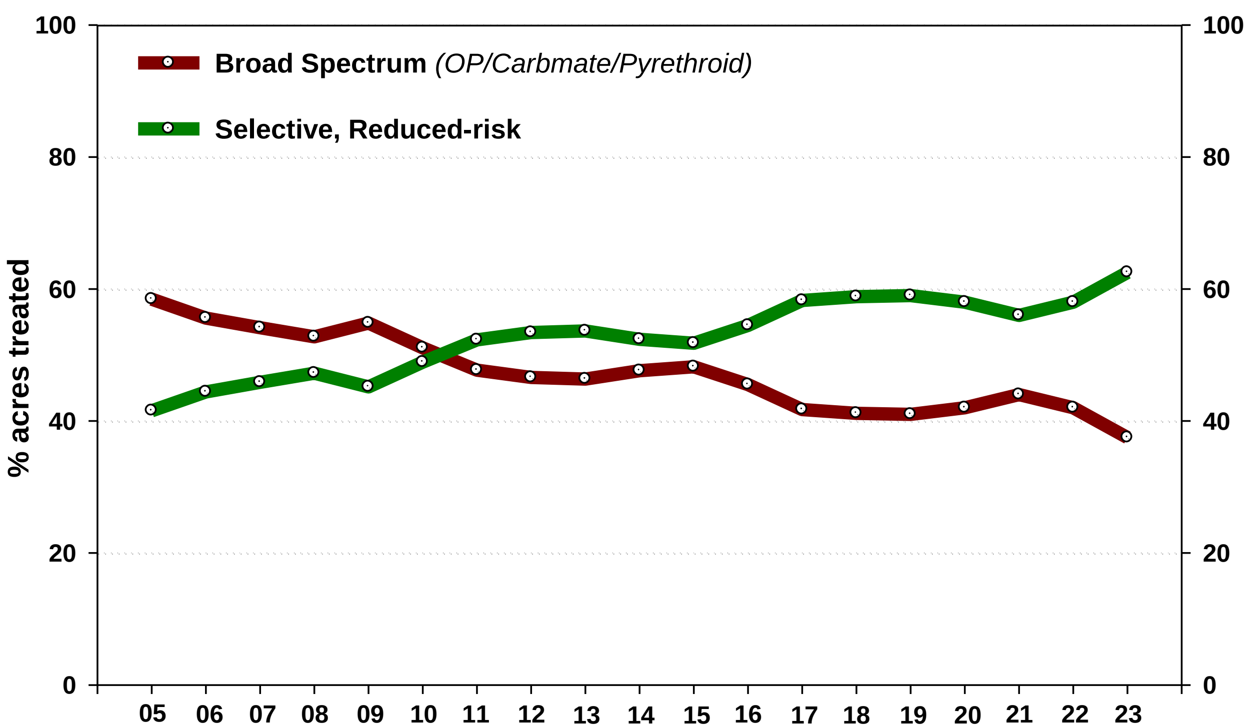

Figure 9. Percentage acreage treated with broad spectrum, and selective, reduced -risk insecticides on desert lettuce, 2005-2023.

Table 5. Insecticides applied to **Organic Fall Lettuce**, 2022.

Insecticide	IRAC group	Fall Lettuce - 2022			
		% PCA using Product (n=12)	Acres (%) treated with this product	Avg no. of applications	Treated acers
Entrust	**5**	100	100	2.2	6,746
Bt (*Bacillus thuringiensis)*	**11**	92.3	56	1.4	2,079
Pyganic	**3**	84.6	27.0	1.5	929
Azadirachtin/Neem products	**UN**	38.5	13.1	1.5	568
Celite	**UN**	7.7	8.2	1	228
M-Pede	**UN**	30.8	3.5	1	98
Venerate	**UN**	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**, 2023.

Insecticide		Spring Lettuce - 2023			
		% PCA using Product (n=12)	Acres (%) treated with this product	Avg no. of applications	Treated acers
Entrust	**5**	100	100	2.3	7,951
Azadirachtin/Neem products	**UN**	84.6	36.7	2.5	3720
Bt (*Bacillus thuringiensis)*	**11**	92.3	61.5	1.3	2,601
Pyganic	**3**	84.6	25.4	1.5	876
M-Pede	**UN**	38.5	19.4	1	668
Celite	**UN**	7.7	6.1	1	210
Venerate	**UN**	7.7	4.5	1	150

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

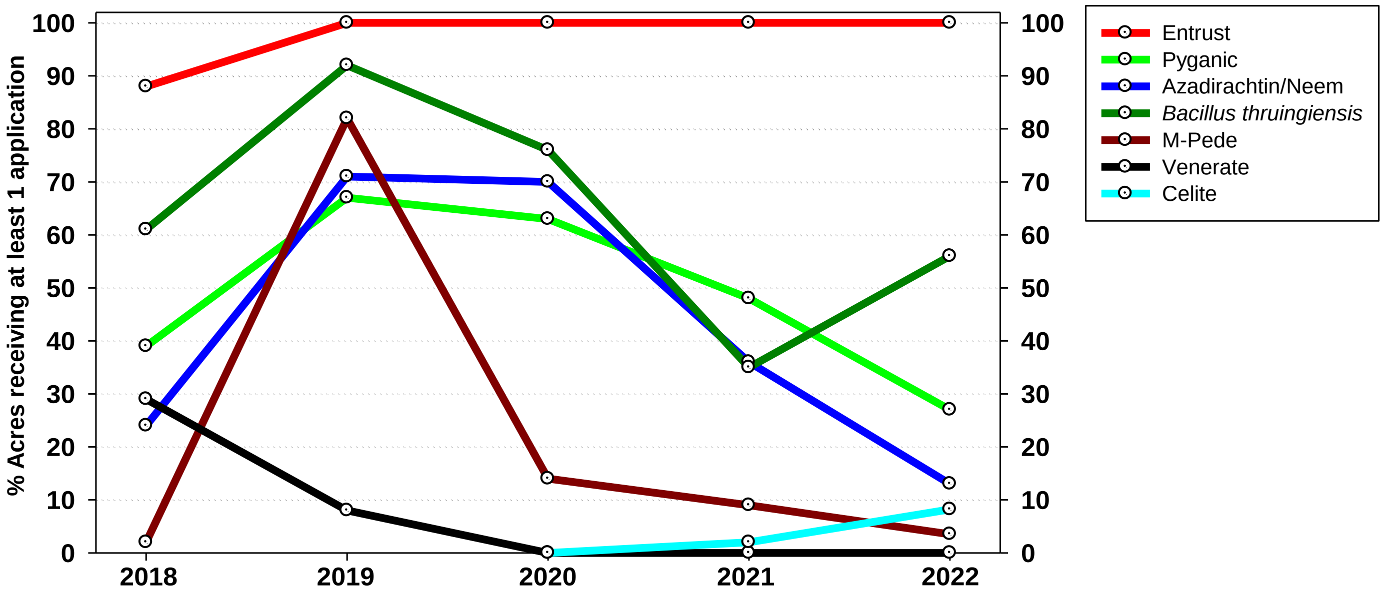

Figure 10. Percentage organic acreage treated with biopesticides in fall lettuce, 2018-2022.

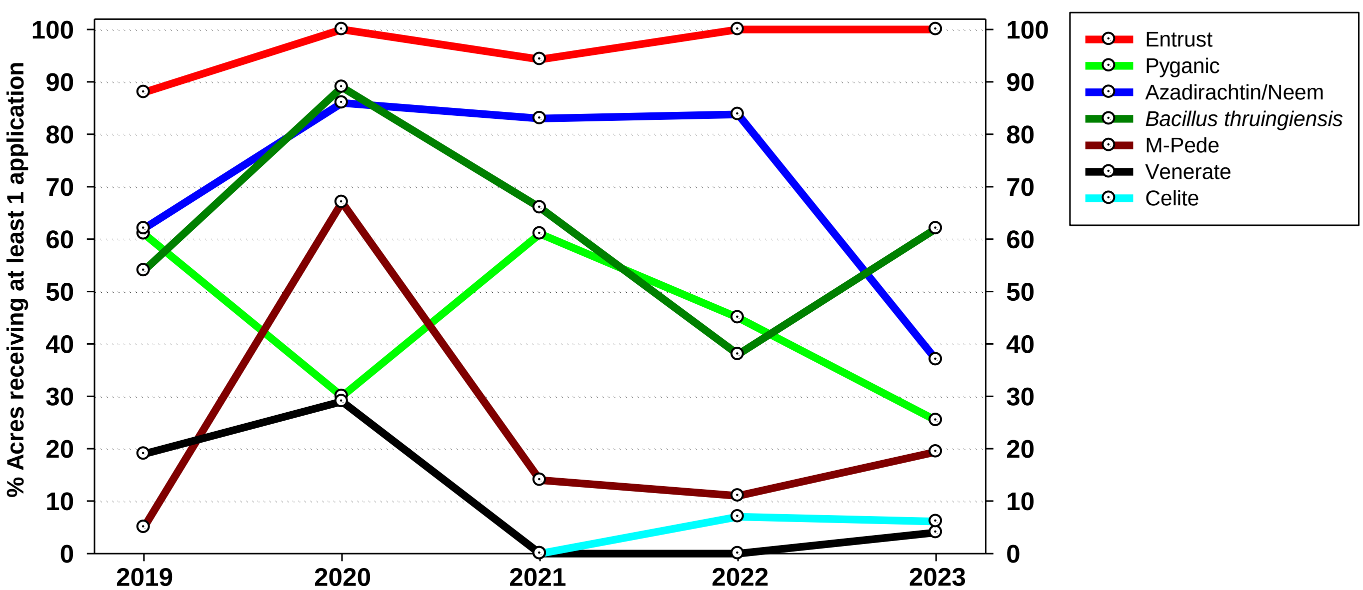

Figure 11. Percentage organic acreage treated with biopesticides in spring lettuce, 2019-2023.

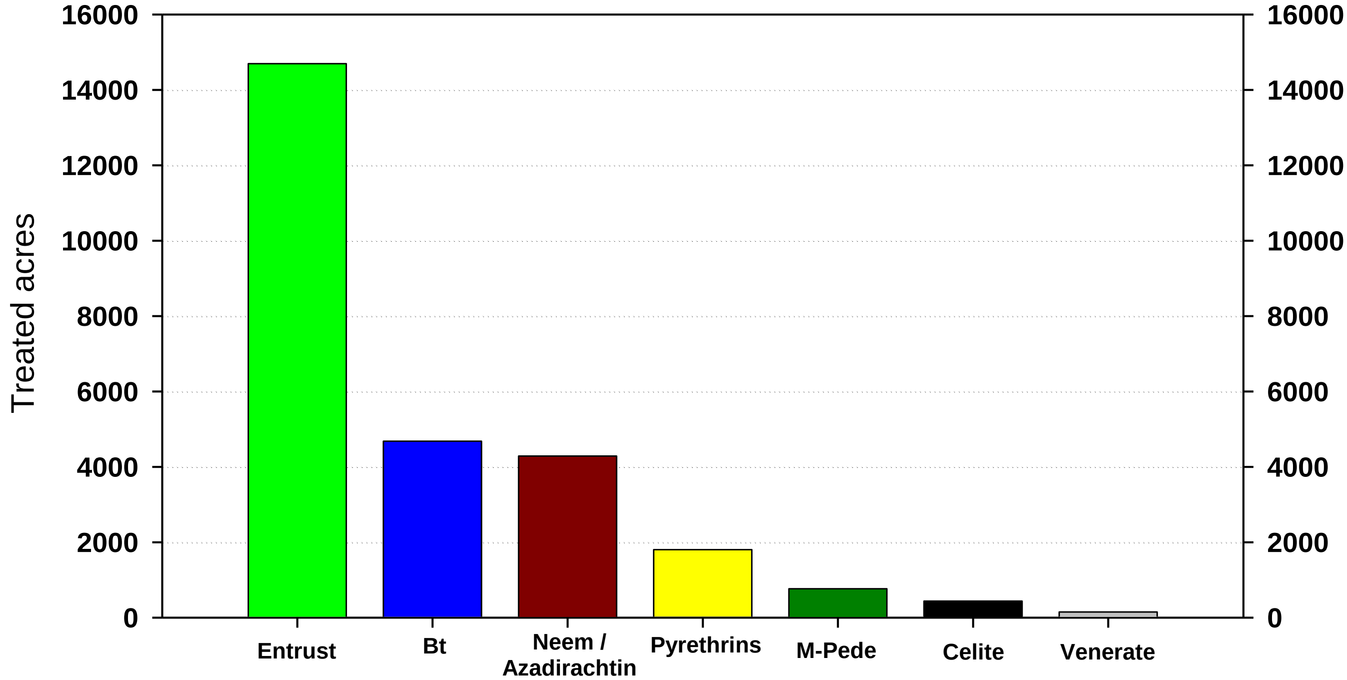

Figure 12. Estimates of total insecticide use for seasonal insect control on **Organic Lettuce**, 2022-23.