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Arizona
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Insecticide Usage on Conventional and Organic Lettuce in the Desert, 2005-2024

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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 2023-24 growing season and trends on lettuce IPM over the past 20 years.

Methods: Growers and PCAs attended a Lettuce Insect Losses and Impact Assessment Workshop in Yuma on May 22, 2024, 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 32 surveys were completed for conventional lettuce, representing an estimated 41,492 fall acres and 39,159 spring acers from Yuma and Imperial counties. For organic lettuce, a total of 5220 fall acres and 5083 spring acres were reported from Yuma, Imperil and Maricopa counties.

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 **(Table 1, Fig. 6)**.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 20 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)**.

Organophosphate/carbamate usage decreased considerably in 2023- 2024 compared to 2022 and methomyl (Lannate) usage declined by more than 20% compared to 2022 and remained lowere during the last 6 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. However, with the registration of Plinazolin anticipated in late 2024, OP/carbamate usage will likely continue to significantly decrease.

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 20 years, averaging well over 2 sprays per treated acre. This is due to beet armyworm and cabbage looper pressure experienced each fall, and 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 5 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 commonly used. Although Coragen foliar use has steadily been declining over the past 5 years, soil applied Coragen has been used on >10% of the average the past two growing seasons. **(Fig 2, Table 2 and 3).**

Another important class of chemistry used in fall and spring lettuce are the neonicotinoids-4A, 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 decreased in 2023-24, treated on ~ 70% 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 2023-24 and was the most used insecticide for sucking insect control, particularly for Lettuce aphid which has been very heavy **(Fig 4 and 7)**. Similarly, Sequoia, Sivanto, Versys, PQZ, and Beleaf accounted for significant usage this spring due to the widespread aphid outbreaks growers experienced. Torac usage was down last spring for thrips management on <2% of the acreage **(Fig 5).**

From an IPM perspective, the local produce industry has made 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 6th consecutive year, Entrust was applied to greater than 95% of fall lettuce when Lep larvae are most economically important. Similarly, Entrust was applied similarly to spring acreage in 2024 where Leps larvae and western flower thrips management is critical **(Table 4 & 5, Fig 10 and 11).** Bt, Pyganic and Azadirachtin/neem oil products were the next most commonly used product in fall and spring lettuce. M-Pede , Celite, and Venerate were used on significantly fewer acres. In this years survey, additional biopesticide compounds were reported to be used on organic lettuce including Cinnaction, Keyplex AWP Plus, Captiva Prime and Ecotect Plus. Overall, Entrust was applied to almost 2X acres as any other organic biopesticide product **(Fig 12).**

Conclusions: 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 industry's reliance on the broadly toxic organophosphate and carbamate compounds will continue to decline. The availability of new modes of action with activity against western flower thrips would certainly reduce the industry's reliance on OPs and carbamates. Fortunately, Plinazolin (Syngenta) has shown good residual control of thrips and is slated for registration within the year. 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 20 years. Without your efforts, this historical data would not exist.*

Table 1. Insecticide chemistries used on fall and spring lettuce, 2023-2024

Insecticide Chemistry	IRAC group	Fall Lettuce, 2023		Spring Lettuce, 2024	
		% PCA's Using Products	Treated [1] acres	% PCA's Using Products	Treated [1] acres
Carbamates	1A	10.3	2,680	62.1	20,884
Organophosphates	1B	57.1	15,032	17.2	3,390
OP/Carbamates - Total			17,712		24,274
Pyrethroids - Foliar	3A	100	148,350	100	108,295
Pyrethroids - Chemigation	3A	92.9	31,879	65.5	19,877
Pyrethroids - Total			180,227		128,172
Neonicotinoids -Soil	4A	82.8	28,562	69	26,681
Neonicotinoids -Foliar	4A	20.7	17,970	24.1	18,075
Neonicotinoids -Total			46,532		44,756
Sulfoxamines	4C	37.9	5,627	89.7	30,004
Butenolides	4D	27.6	4,920	79.3	18,950
Spinosyns	5	100	104,206	100	86,000
Avermectins	6	75.9	31,633	62.1	12,987
Juenile hormone mimics	7C	0	0	0	0
TRPV channel modulators	9B	17.2	1850	65.5	12,022
TRPV channel modulators	9D	20.7	6337	58.6	15,377
Chitin biosynthesis inhibitors-1	16	0	0	0	0
Ecdysone receptor agonists	18	31	12,860	13.8	3,855
METI inhibitors	21	0	0	3.4	625
Na channel blockers	22	6.9	230	3.4	80
Tetramic acid derivatives	23	37.9	11,159	89.7	60,191
Diamides -Soil	28	24.1	5,900	10.3	1,850
Diamides- Foliar	28	79.3	46,499	62.1	41,209
Diamides- Total			52,399		43,059
Nicotinamidase inhibitors	29	31	7,670	75.9	23,382

*[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, 2023.

Insecticide Product	*Fall Lettuce, 2023*				
	IRAC group	**% PCA's Using Product *(n=29)***	**% Treated acres**	**Avg. no. applications**	**Treated [1] acres**
Pyrethroids - Foliar	3A	100	98.8	3.3	*130,623*
Radiant	5	100	99.9	2.5	*104,206*
Pyrethroids – Chemigation	3A	92.9	73.5	1.1	*31,877*
Imidacloprid -Soil	4A	82.8	71.0	1.0	*28,562*
Proclaim	6	75.9	52.4	1.1	*24,163*
Harvanta	28	34.5	22.8	1.5	*17,565*
Lannate (methomyl)	1A	57.1	27.5	1.2	*15,032*
Besiege	28+3A	62.1	27.1	1.1	*14,037*
Intrepid	18	31.0	22.9	1.2	*12,860*
Movento	23	37.9	16.4	1.3	*11,159*
Exirel (foliar)	28	55.2	14.8	1.1	*9,131*
Coragen (Foliar)	28	37.9	11.9	1.3	*8,528*
Beleaf	29	31	14.5	1.5	*7,670*
Minecto Pro	28+6	34.5	18.0	1.0	*7,470*
Versys	9D	20.7	8.0	1.3	*6,337*
Sequoia	4C	37.9	9.7	1.1	*5,627*
Venom / Scorpion (foliar)	4A	6.9	5.1	1.8	*5,105*
Sivanto	4D	27.6	7.8	1.4	*4,920*
Coragen (Soil)	28	17.2	10.1	1.0	*4,200*
Trigard	17	3.4	9.6	2.5	*4,000*
Endigo	4A+3A	17.2	8.9	1.0	*3,690*
Assail	4A	10.3	4.8	1.3	*3,375*
Actara	4A	10.3	4.5	1.3	*3,250*
Orthene (acephate)	1B	6.9	3.7	1.5	*2,600*
Imidacloprid (foliar)	4A	6.9	6.1	1.0	*2550*
PQZ	9B	17.2	4.5	1.0	*1,850*
Verimark (soil)	28	6.9	2.9	1.0	*1,700*
Avaunt	22	6.9	0.6	1.0	*230*
Senstar	23+7C	3.4	0.4	1.0	*150*
Malathion	1B	3.4	0.2	1.0	*80*
Agri-Mek (abamectin)	6	0	0.0	0.0	*0*
Courier	16	0	0.0	0.0	*0*
Torac	21	0	0.0	0.0	*0*
Oberon	23	0	0.0	0.0	*0*
Dimethoate	1B	0	0.0	0.0	*0*
Venom / Scorpion (soil)	4A	0	0.0	0.0	*0*
Knack	7C	0	0.0	0.0	*0*
Fulfill	9B	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 3. Insecticides applied to Spring Lettuce, 2024

	Spring Lettuce, 2024				
Insecticide Product	***IRAC group***	***% PCA's Using Product (n=29)***	***% Treated acres***	***Avg. no. applications***	***Treated [1] acres***
Pyrethroids - *Foliar*	*3A*	*100*	*93.1*	*2.8*	*96,609*
Radiant	*5*	*100*	*98.8*	*2.3*	*86,600*
Movento	*23*	*89.7*	*89.9*	*1.7*	*60,191*
Sequoia	*4C*	*89.7*	*57.2*	*1.2*	*30,004*
Imidacloprid *-Soil*	*4A*	*69*	*68.1*	*1.0*	*26,681*
Beleaf	*29*	*75.9*	*38.1*	*1.4*	*23,382*
Lannate *(methomyl)*	*1A*	*58.6*	*37.3*	*1.3*	*20,884*
Pyrethroids *– Chemigation*	*3A*	*65.5*	*49.2*	*1.0*	*19,877*
Sivanto	*4D*	*79.3*	*36.9*	*1.2*	*18,950*
Versys	*9D*	*58.6*	*24.8*	*1.2*	*15,377*
PQZ	*9B*	*65.5*	*30.1*	*1.0*	*12,022*
Coragen *(Foliar)*	*28*	*34.5*	*12.5*	*1.4*	*10,499*
Besiege	*28+3A*	*51.7*	*21.0*	*1.1*	*9,961*
Exirel *(foliar)*	*28*	*37.9*	*12.8*	*1.2*	*8,994*
Proclaim	*6*	*51.7*	*19.8*	*1.0*	*7,737*
Harvanta	*28*	*27.6*	*10.7*	*1.4*	*6,505*
Imidacloprid *(foliar)*	*4A*	*103*	*13.1*	*1.2*	*5625*
Minecto Pro	*28+6*	*27.6*	*13.4*	*1.0*	*5,250*
Venom / Scorpion *(foliar)*	*4A*	*6.9*	*5.4*	*1.8*	*5,100*
Intrepid	*18*	*13.8*	*7.8*	*1.1*	*3,855*
Orthene (acephate)	*1B*	*17.2*	*5.3*	*1.2*	*3,060*
Actara	*4A*	*10.3*	*4.2*	*1.5*	*2,850*
Assail	*4A*	*17.2*	*4.0*	*1.3*	*2,775*
Trigard	*17*	*3.4*	*3.1*	*2.0*	*2400*
Endigo	*4A+3A*	*13.8*	*4.4*	*1.0*	*1,725*
Verimark (soil)	*28*	*6.9*	*3.1*	*1.4*	*1,700*
Torac	*21*	*3.4*	*1.6*	*1.0*	*625*
Senstar	*23+7C*	*10.3*	*1.6*	*1.0*	*625*
Dimethoate	*1B*	*3.4*	*0.6*	*1.0*	*250*
Coragen *(Soil)*	*28*	*3.4*	*0.4*	*1.0*	*150*
Avaunt	*22*	*3.4*	*0.2*	*1.0*	*80*
Malathion	*1B*	*3.4*	*0.2*	*1.0*	*80*
Agri-Mek *(abamectin)*	*6*	*0*	*0.0*	*0.0*	*0*
Courier	*16*	*0*	*0.0*	*0.0*	*0*
Oberon	*23*	*0*	*0.0*	*0.0*	*0*
Venom / Scorpion (soil)	*4A*	*0*	*0.0*	*0.0*	*0*
Knack	*7C*	*0*	*0.0*	*0.0*	*0*
Fulfill	*9B*	*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.*

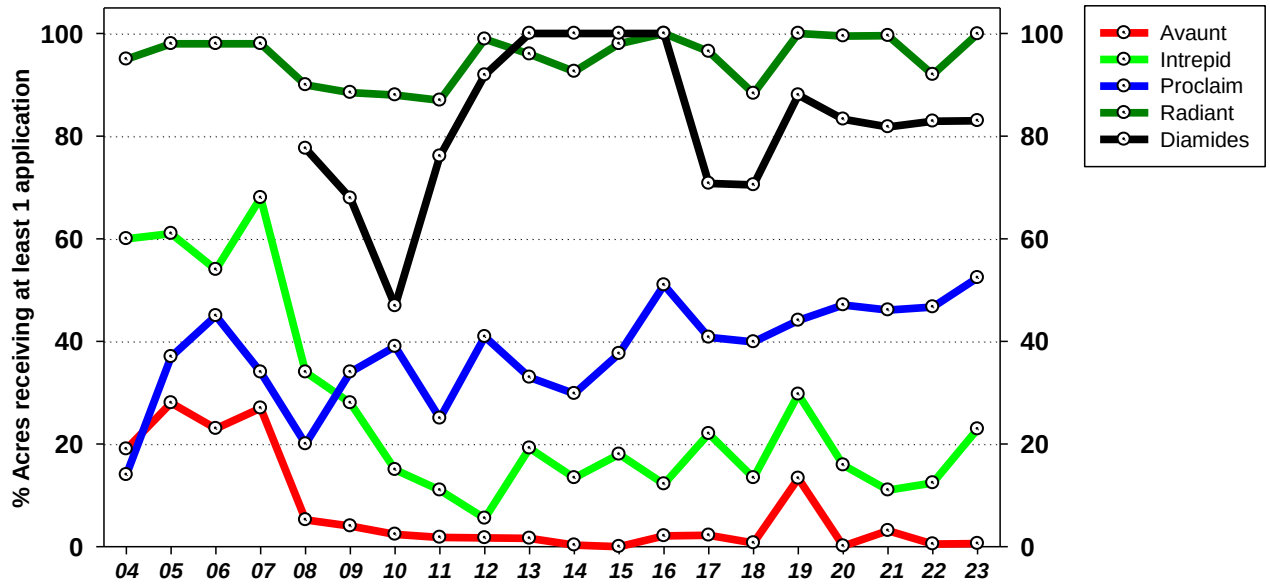

Figure 1. Trends in insecticide use for control of **Lepidopterous larvae** in Fall lettuce, 2004-2023.

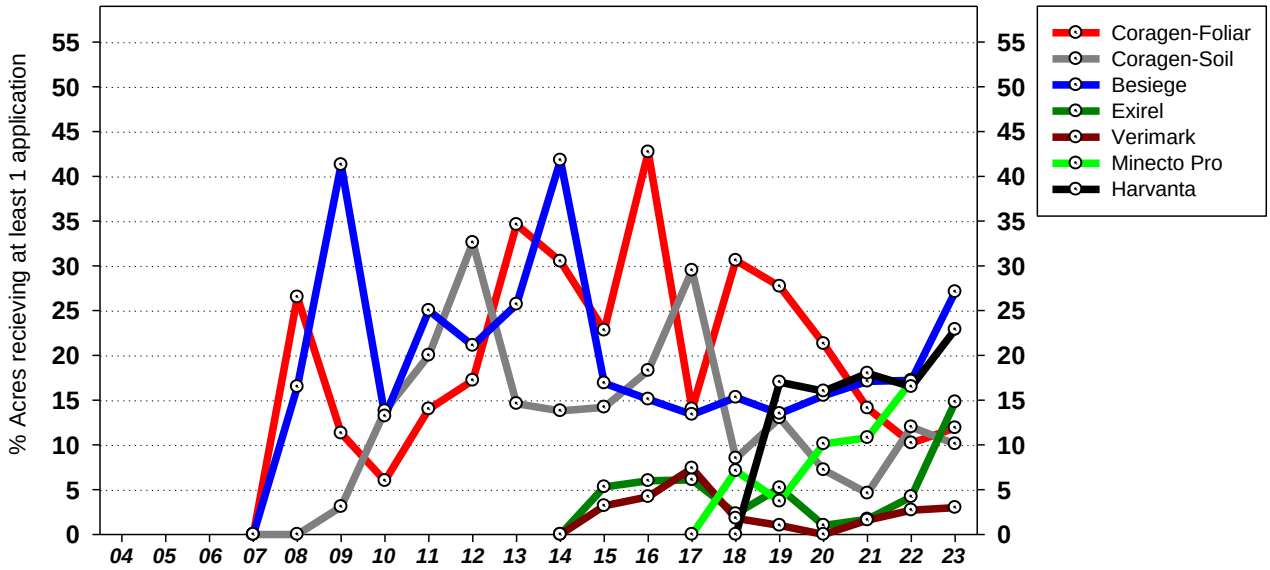

Figure 2. Trends in **Diamide** insecticide use for control of **Lepidopterous larvae** in Fall lettuce, 2004-2023.

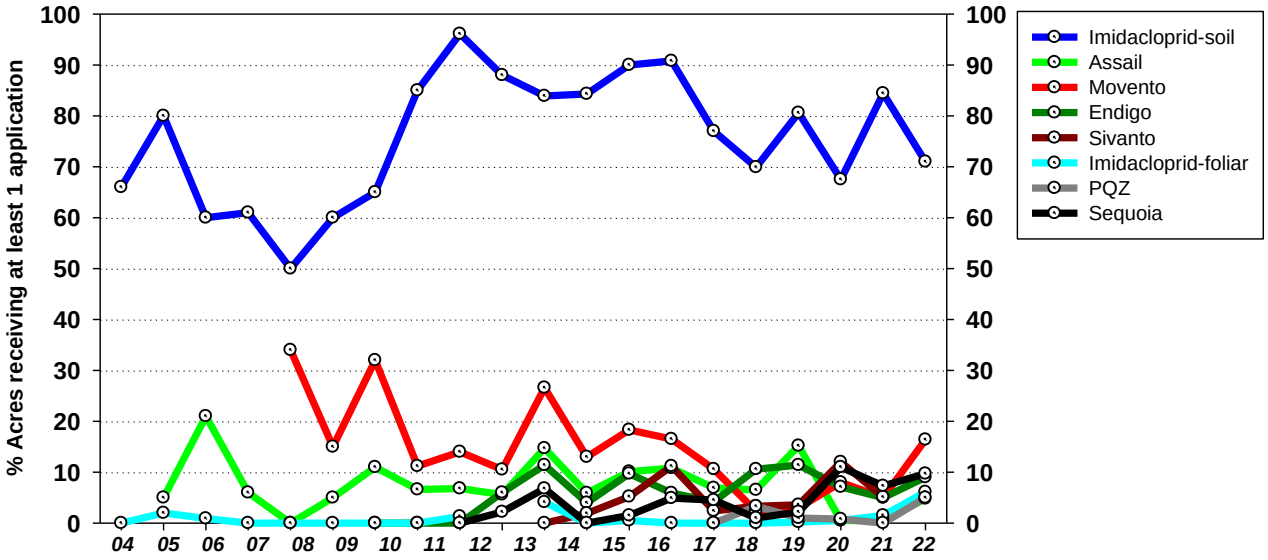

Figure 3. Trends in insecticide use for control of ***Bemisia*** **Whiteflies and other sucking pests** in Fall lettuce, 2004-2023.

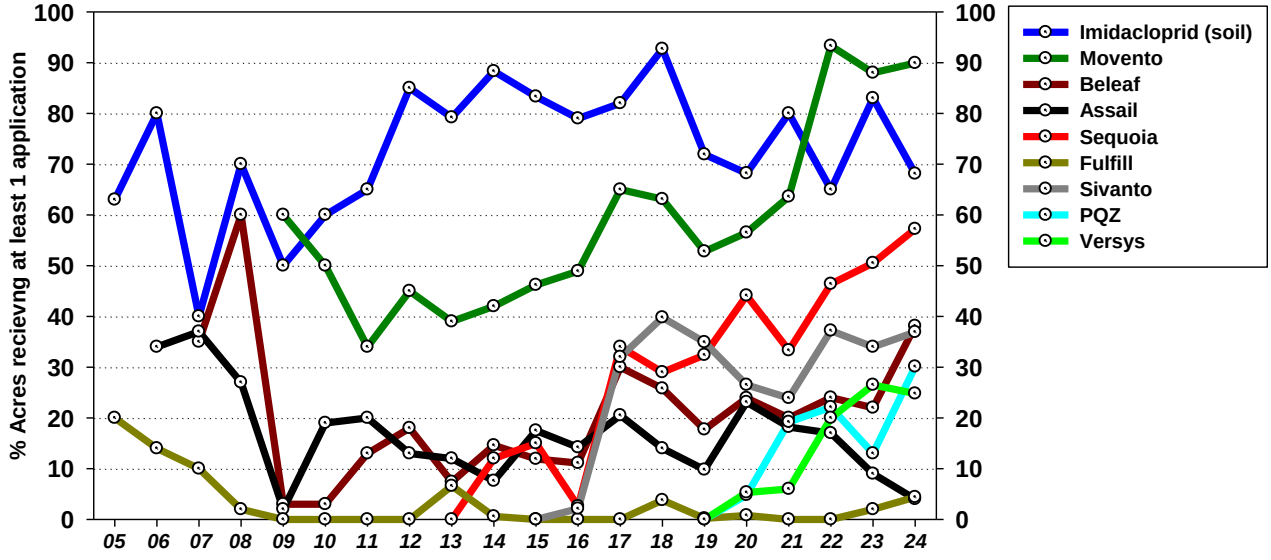

Figure 4. Trends in insecticide use for control of **Aphids** in Spring lettuce, 2005-2024.

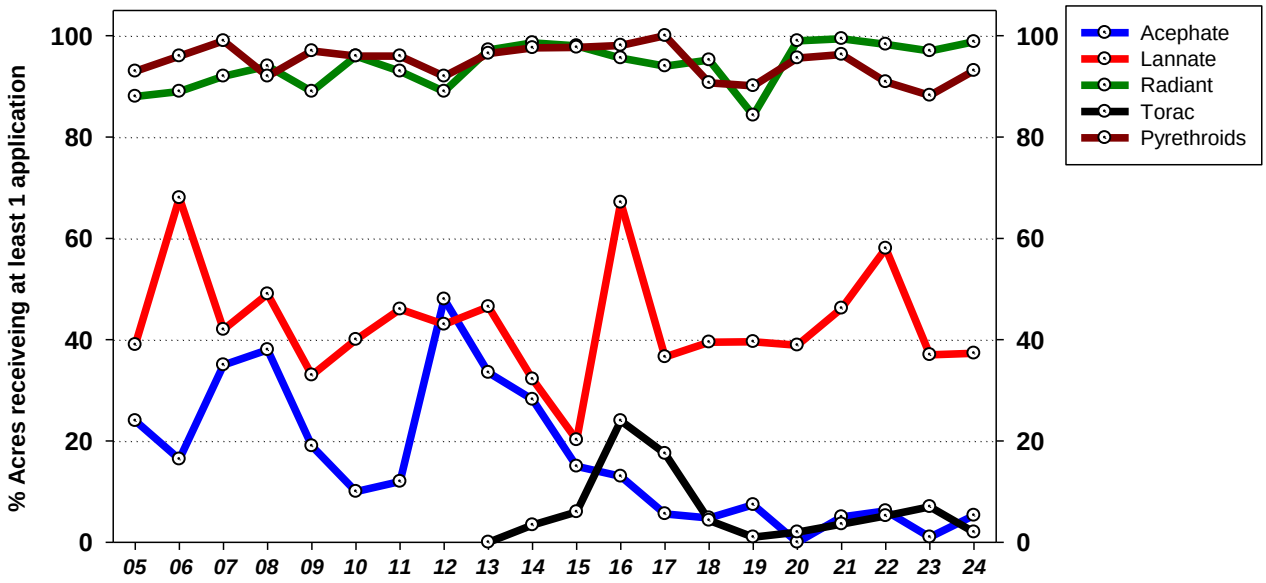

Figure 5. Trends in insecticide use for control of **Western Flower Thrips** in Spring lettuce, 2005-2024.

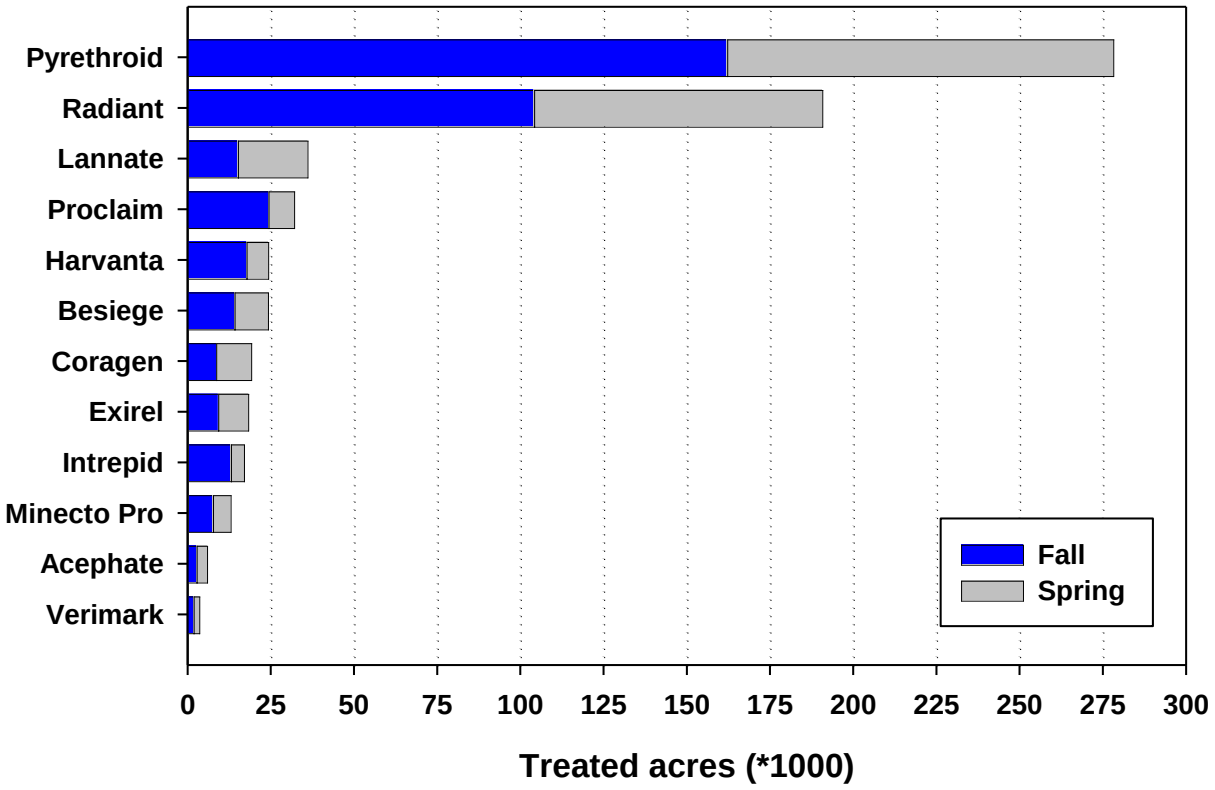

Figure 6. Estimates of insecticide use for Chewing and Contact insect control on Lettuce, 2023-2024

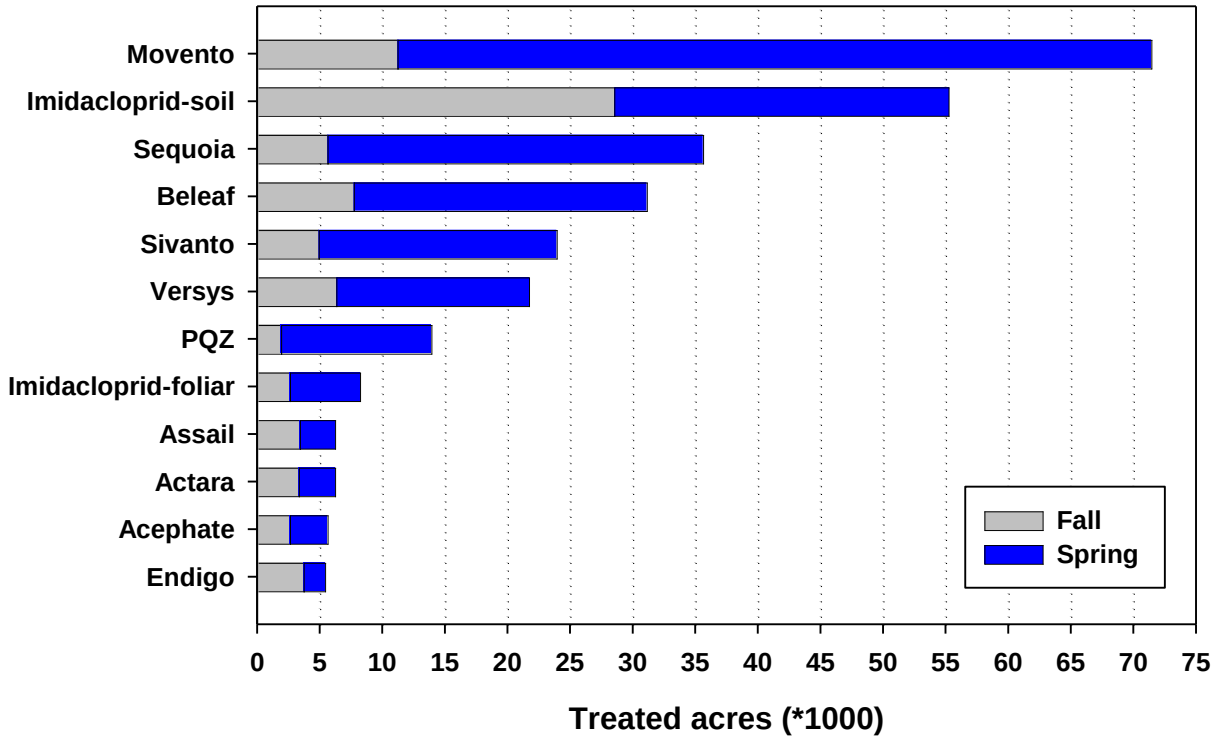

Figure 7. Estimates of insecticide use for sucking insect control on Lettuce, 2023-2024

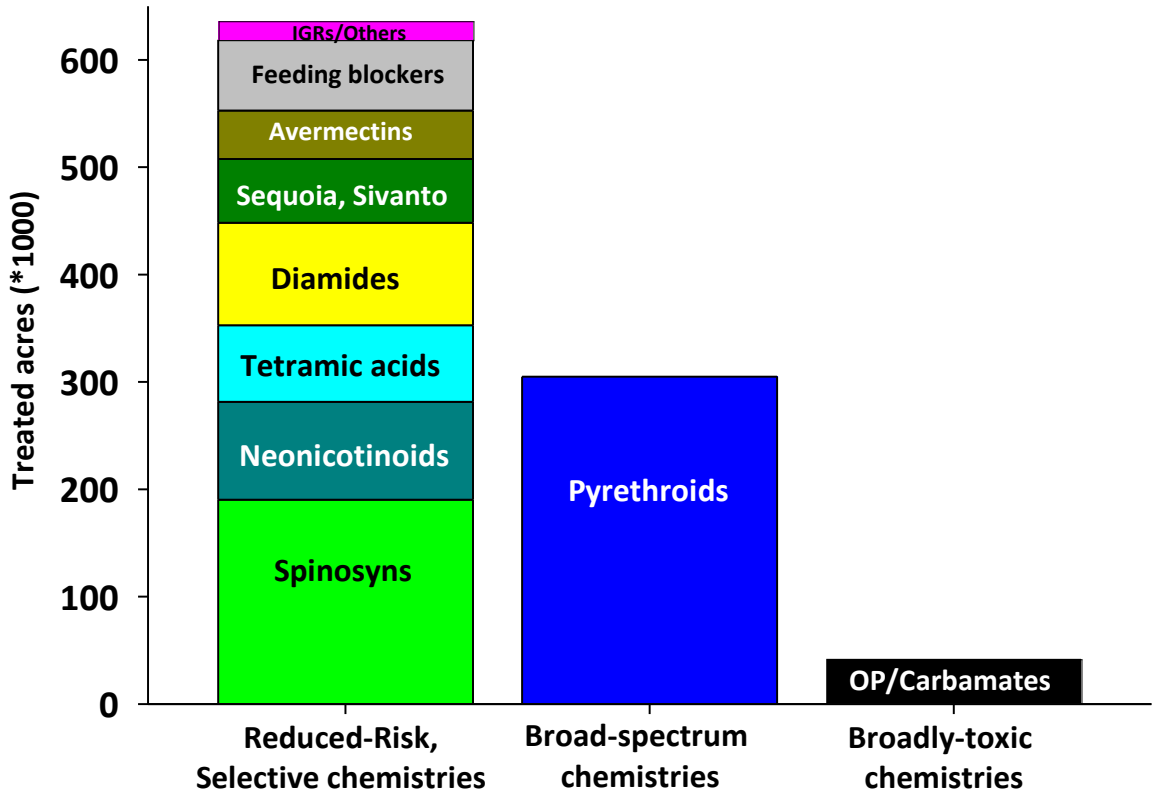

Figure 8. Estimates of total insecticide use for seasonal insect control on Lettuce, 2023-2024.

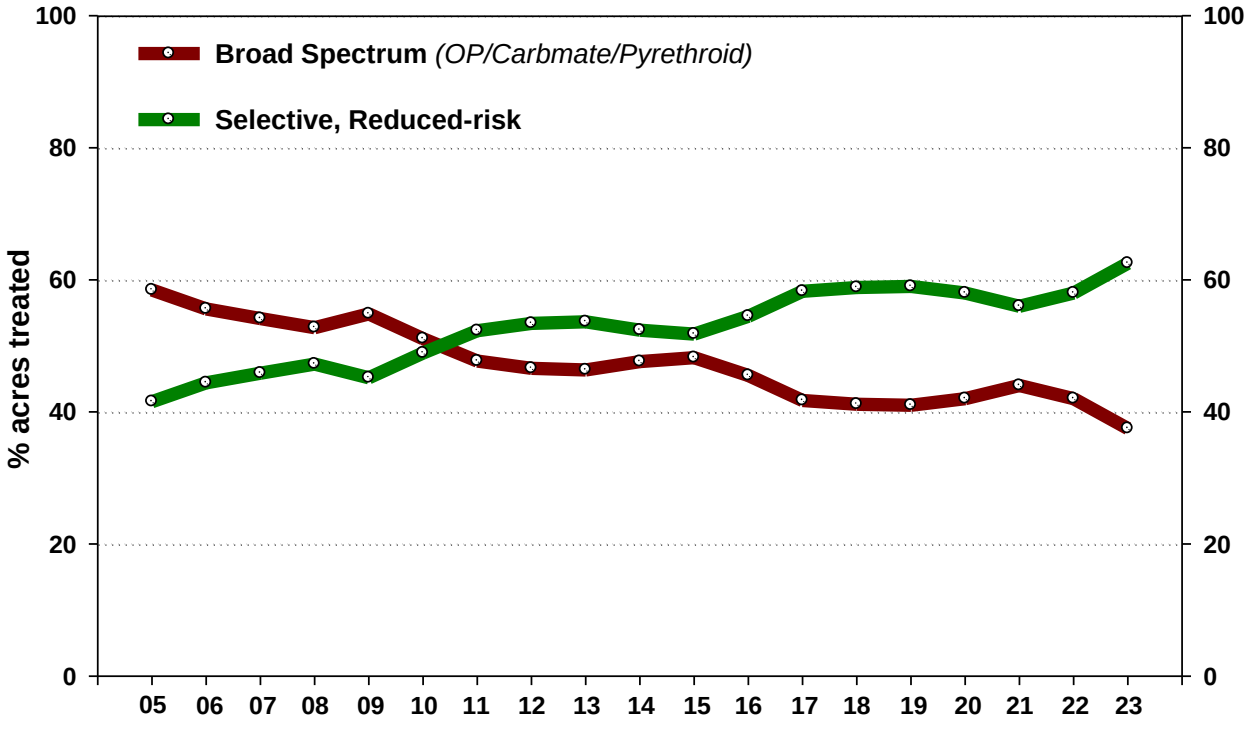

Figure 9. Percentage acreage treated with broad spectrum, and selective, reduced -risk insecticides on desert lettuce, 2005-2024.

Table 4. Insecticides applied to **Organic Fall Lettuce**, 2023.

Insecticide	IRAC group	Fall Lettuce - 2023			
		% PCA using Product (n=16)	Acres (%) treated with this product	Avg no. of applications	Treated acers
Entrust	**5**	100.0	98.4	2.3	11,780
Bt (*Bacillus thuringiensis)*	**11**	75.0	73.0	1.6	6,517
Pyganic	**3**	75.0	61.9	1.6	5,605
Azadirachtin/Neem	**UN**	50.0	51.7	1.7	5,147
M-Pede	**UN**	50.0	38.7	1.5	4,450
Celite	**UN**	6.3	11.7	2.0	1,200
Keyplex AWP Plus	**Oil**	12.5	11.5	1.5	1,090
Cinnaction	**Oil**	6.3	6.8	2.0	700
Venerate	**UN**	6.3	5.5	2.0	560
Captiva Prime	**Garlic**	6.3	5.5	1.0	280
Ecotec Plus	**OII**	6.3	4.1	1.0	210

[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 Spring Lettuce**, 2024.

Insecticide	IRAC group	Spring Lettuce - 2024			
		% PCA using Product (n=16)	Acres (%) treated with this product	Avg no. of applications	Treated acers
Entrust	**5**	100.0	95.3	2.4	11,746
Azadirachtin/Neem	**UN**	68.8	58.0	2.4	7,814
Bt (*Bacillus thuringiensis)*	**11**	81.3	67.7	1.5	5,983
Pyganic	**3**	75.0	58.0	1.5	5,395
M-Pede	**UN**	50.0	35.1	1.6	4,570
Cinnaction	**Oil**	6.3	10.2	3.0	1,539
Keyplex AWP Plus	**Oil**	12.5	11.6	1.5	1,080
Venerate	**UN**	6.3	10.2	2.0	1,026
Celite	**UN**	6.3	8.0	2.0	800
Captiva Prime	**Garlic**	6.3	10.2	1.0	513
Ecotec Plus	**OII**	6.3	10.2	1.0	513

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

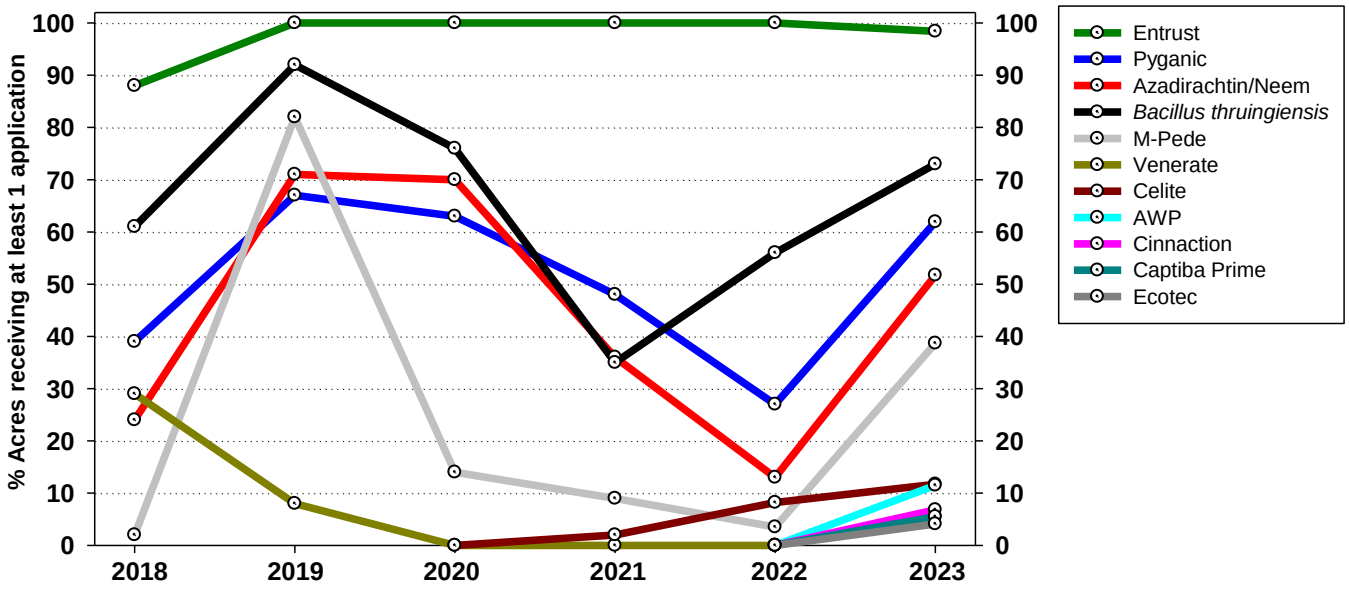

Figure 10. Percentage organic acreage treated with biopesticides in fall lettuce, 2018-2023.

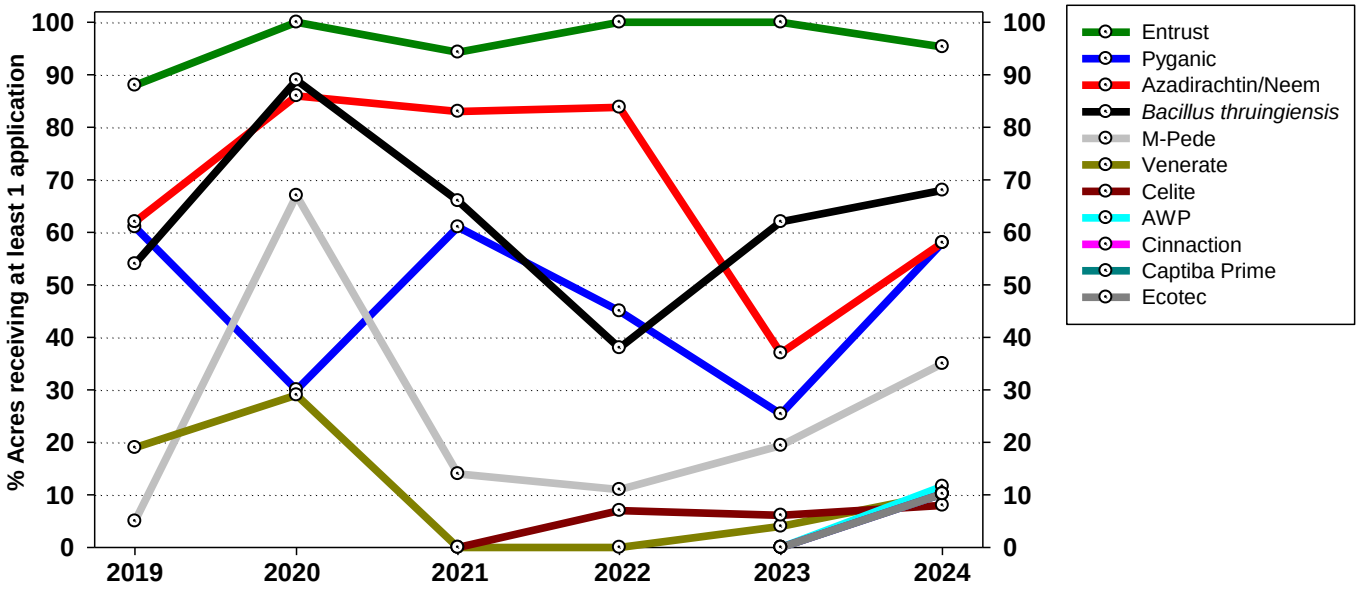

Figure 11. Percentage organic acreage treated with biopesticides in spring lettuce, 2019-2024.

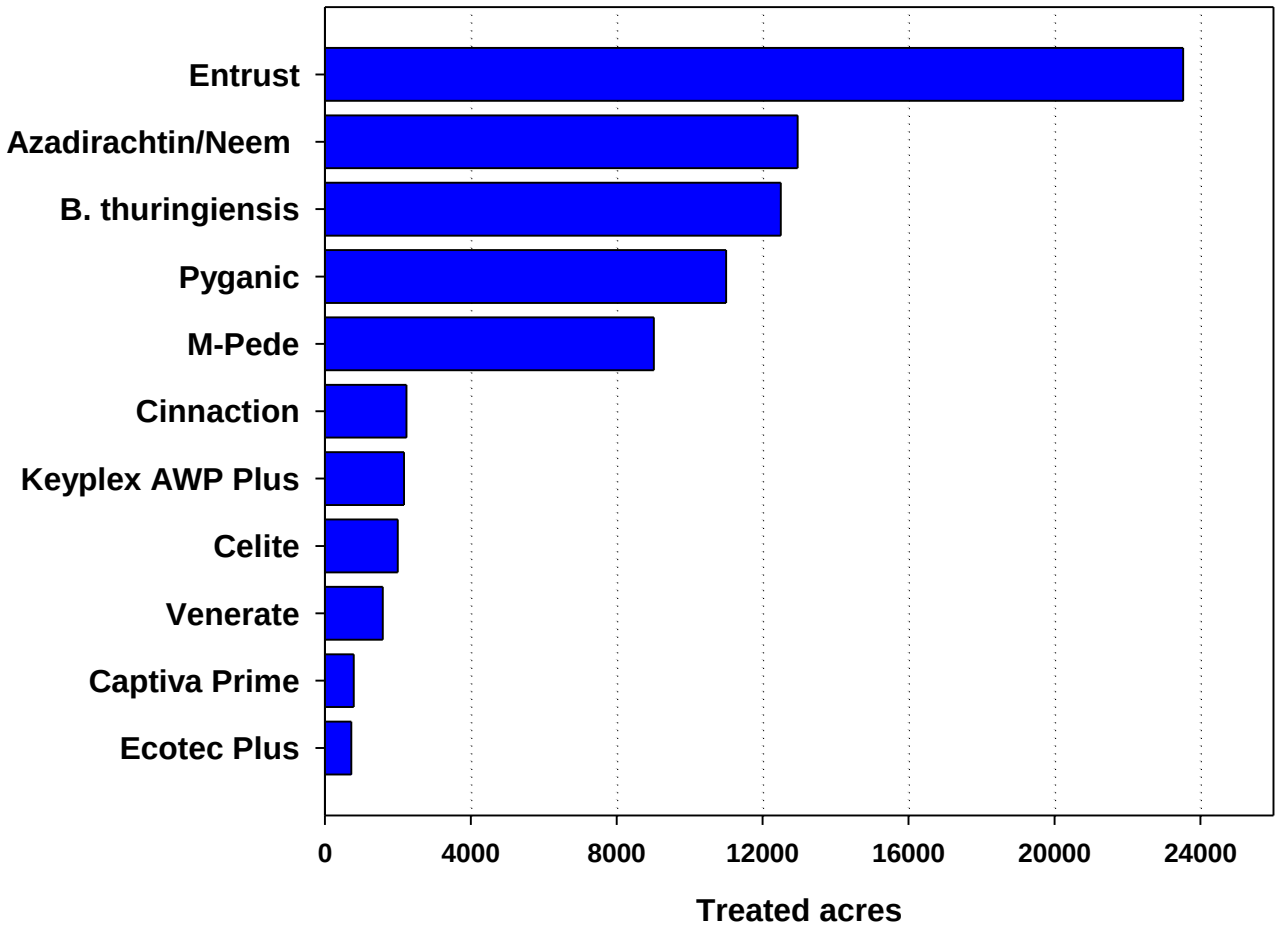

Figure 12. Estimates of total insecticide use for seasonal insect control on **Organic Lettuce**, 2023-24.