

Are red sunflower seed weevils resistant to additional pyrethroid active ingredients?

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Red sunflower seed weevils

- Annual pest of SD and sunflowers
- Severe infestations can result in 50-80% of achenes being infested
 - Larvae feed on developing seed
- Primarily managed using foliar insecticides



The problem?



The problem?



The problem?

- Field outbreaks 10-1000x over threshold
- Reported pyrethroid failures
- Need to document if due to resistance



2020 vs 2021 Summary

- Reduced susceptibility:
 - Lambda-cyhalothrin: 2 of 12 (17%) vs 17 of 24 (71%) locations
 - Esfenvalerate: 2 of 12 (17%) vs 11 of 24 (46%) locations
 - Zeta-cypermethrin: 7 of 12 (58%) vs 20 of 24 (83%) locations
- ND sites showed no signs of reduced susceptibility



2021 vs 2022 Summary

- Reduced susceptibility:
 - Lambda-cyhalothrin: 17 of 24 (71%) vs 29 of 30 (97%) locations
 - Esfenvalerate: 11 of 24 (46%) vs 27 of 30 (90%) locations
- ND sites showed no signs of reduced susceptibility



Dose Response Experimental Design

- 5 treatments with six doses per active ingredient:
 - Acetone
 - Asana XL (ug/vial): 2.65, 5.295, 10.59, 21.18, 42.365, 84.725
 - Warrior II (ug/vial): 1.67, 3.34, 6.675, 13.35, 26.705, 53.405
 - Baythroid XL (ug/vial): 1.17, 2.34, 4.68, 9.36, 18.72, 37.44 (2023 only)
 - Delta Gold (ug/vial): 0.94, 1.88, 3.76, 7.52, 15.04, 30.09 (2023 only)
 - 0.125x, 0.25x, 0.5x, 1x, 2x, 4x highest labeled rate
- RSSW adults collected at the onset of flowering to R5.3
- 20 adults placed in vials 24 hr after collection
- Evaluated 24 hr after being placed into vials
- Calculate LD50 and LD90 values



Glass Vial Bioassay Method



2021 Dose response results

Year	Location	Chemical	LD50	LD90	1x Rate
2021	North Dakota	Asana XL	0.11	0.9	21.18
		Warrior II	0.07	0.6	13.35
	Hughes Co.	Asana XL	2.77	33	21.18
		Warrior II	5.44	39	13.35
	Hyde Co.	Asana XL	5.94	37	21.18
		Warrior II	15	220	13.35
	Sully Co.	Asana XL	10.6	96	21.18
		Warrior II	10.5	144	13.35



2022 Dose response results

Year	Location	Chemical	LD50	LD90	1x Rate
2022	North Dakota	Asana XL	0.11	0.9	21.18
		Warrior II	0.07	0.6	13.35
	Hughes Co.	Asana XL	7.5	127	21.18
		Warrior II	20	180	13.35
	DLRF	Asana XL	1.43	127	21.18
		Warrior II	2.71	68	13.35
	WRRF	Asana XL	0.66	4.1	21.18
		Warrior II	0.27	4.68	13.35



Resistance Ratios

- LD50 test population/LD50 susceptible population
- $RR < 5$: population is susceptible
- RR 5-10: population is moderately resistant
- $RR > 10$: population is highly resistant



Resistance Ratios

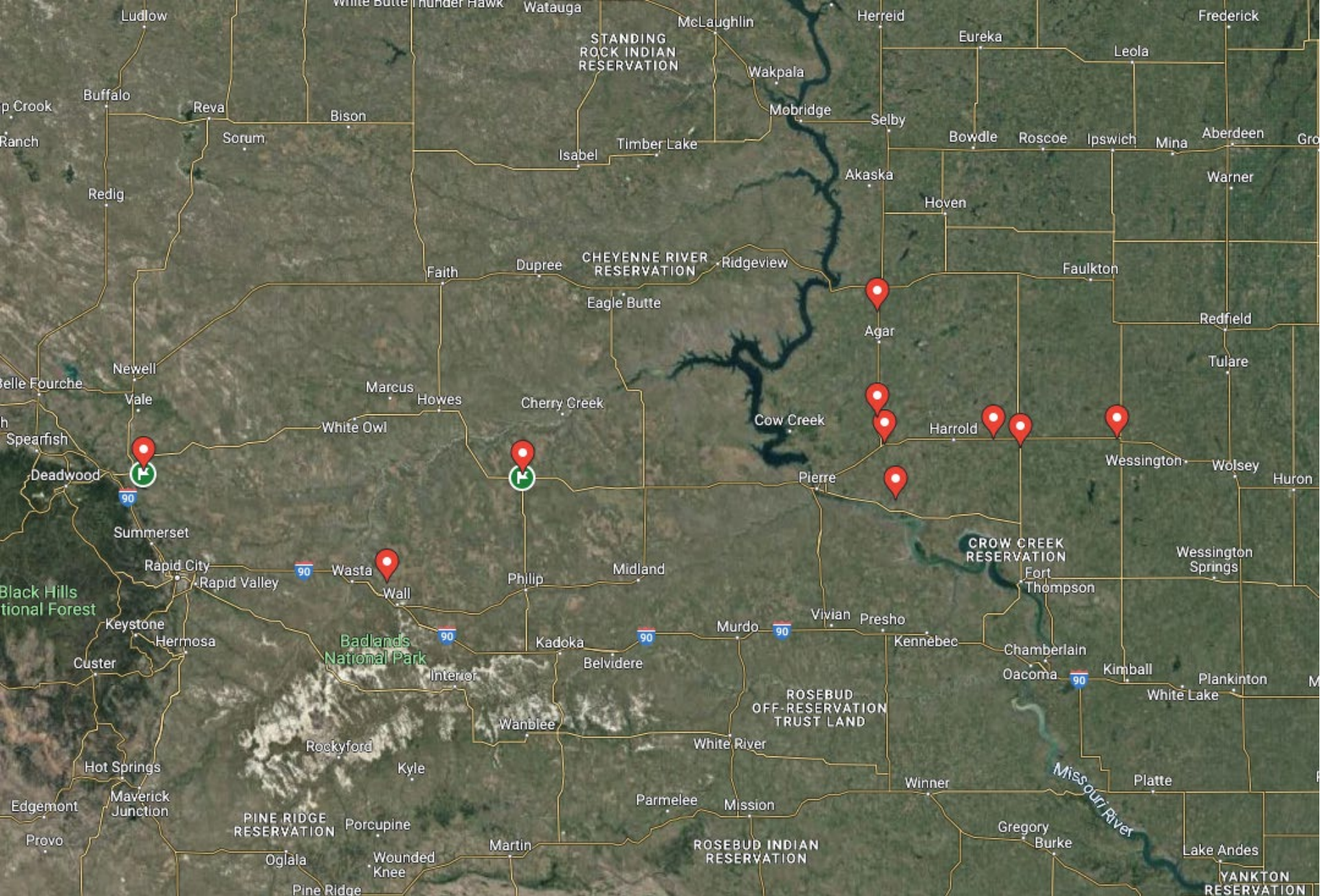
Year	Location	Chemical	Resistance Ratio
2021	Hughes Co.	Asana XL	26
		Warrior II	81
	Hyde Co.	Asana XL	56
		Warrior II	229
	Sully Co.	Asana XL	99
		Warrior II	157
2022	WRRF	Asana XL	6
		Warrior II	4
	DLRF	Asana XL	13
		Warrior II	40
	Hughes Co.	Asana XL	70
		Warrior II	293



2022 Conclusions

- Reduced susceptibility:
 - Lambda-cyhalothrin: 29 locations
 - Esfenvalerate: 27 locations
 - 1 SD location and all ND locations susceptible to both
- Resistance confirmed for Asana XL and Warrior II
- Cross-resistance could be an issue for pyrethroids





2023 Dose response results

Year	Location	Chemical	LD50	LD90	1x Rate
2023	North Dakota	Asana XL	1.97	2.34	21.18
		Warrior II	1.24	1.47	13.35
		Baythroid XL	0.86	1.03	9.36
		Delta Gold	0.7	0.83	7.52
	Hyde Co. 1	Asana XL	9.95	102	21.18
		Warrior II	11	112	13.35
		Baythroid XL	0.248	116	9.36
		Delta Gold	1.14	184	7.52
	Hyde Co. 2	Asana XL	11	91	21.18
		Warrior II	14	63	13.35
		Baythroid XL	5.33	23.6	9.36
		Delta Gold	0.02	0.31	7.52



2023 Dose response results

Year	Location	Chemical	LD50	LD90	1x Rate
2023	Potter Co.	Asana XL	36	284	21.18
		Warrior II	32	181	13.35
		Baythroid XL	12	51	9.36
		Delta Gold	58	1708	7.52
	Sully Co.	Asana XL	40	1491	21.18
		Warrior II	37	156	13.35
		Baythroid XL	11	43	9.36
		Delta Gold	60	1136	7.52
	83-14 Junction	Asana XL	1.4	52	21.18
		Warrior II	26	204	13.35
		Baythroid XL	2.59	24	9.36
		Delta Gold	8.1	183	7.52



2023 Dose response results

Year	Location	Chemical	LD50	LD90	1x Rate
2023	Pennington Co.	Asana XL	23	106	21.18
		Warrior II	9.58	106	13.35
		Baythroid XL	0.94	15	9.36
		Delta Gold	166	44462	7.52
	Haakon Co.	Asana XL	12.4	44	21.18
		Warrior II	20	116	13.35
		Baythroid XL	4.7	26	9.36
		Delta Gold	25	291	7.52



2023 Dose response results

Year	Location	Chemical	LD50	LD90	1x Rate
2023	Hand Co.	Asana XL	23	106	21.18
		Warrior II	9.58	106	13.35
		Baythroid XL	0.94	15	9.36
		Delta Gold	166	44462	7.52
	DLRF	Asana XL	12.4	44	21.18
		Warrior II	20	116	13.35
		Baythroid XL	4.7	26	9.36
		Delta Gold	25	291	7.52
	WRRF	Asana XL	0.32	5.4	21.18
		Warrior II	0.04	3.41	13.35
		Baythroid XL	0.07	2.45	9.36
		Delta Gold	.007	2.79	7.52



Resistance Ratios

Year	Location	Chemical	Resistance Ratio
2023	Hyde Co. 1	Asana XL	28
		Warrior II	275
		Baythroid XL	4
		Delta Gold	163
	Hyde Co. 2	Asana XL	31
		Warrior II	350
		Baythroid XL	76
		Delta Gold	3



Resistance Ratios

Year	Location	Chemical	Resistance Ratio
2023	Potter Co.	Asana XL	103
		Warrior II	800
		Baythroid XL	171
		Delta Gold	8,286
	Sully Co.	Asana XL	114
		Warrior II	925
		Baythroid XL	157
		Delta Gold	8,571



Resistance Ratios

Year	Location	Chemical	Resistance Ratio
2023	83-14 Junction	Asana XL	4
		Warrior II	650
		Baythroid XL	37
		Delta Gold	1,157
	Hand Co.	Asana XL	66
		Warrior II	240
		Baythroid XL	13
		Delta Gold	23,714



Resistance Ratios

Year	Location	Chemical	Resistance Ratio
2023	Pennington Co.	Asana XL	66
		Warrior II	240
		Baythroid XL	13
		Delta Gold	23,714
	Haakon Co.	Asana XL	35
		Warrior II	500
		Baythroid XL	67
		Delta Gold	3,571



Resistance Ratios

Year	Location	Chemical	Resistance Ratio
2023	DLRF	Asana XL	35
		Warrior II	500
		Baythroid XL	67
		Delta Gold	3,571
	WRRF	Asana XL	0
		Warrior II	0
		Baythroid XL	0
		Delta Gold	0



2023 Dose response summary

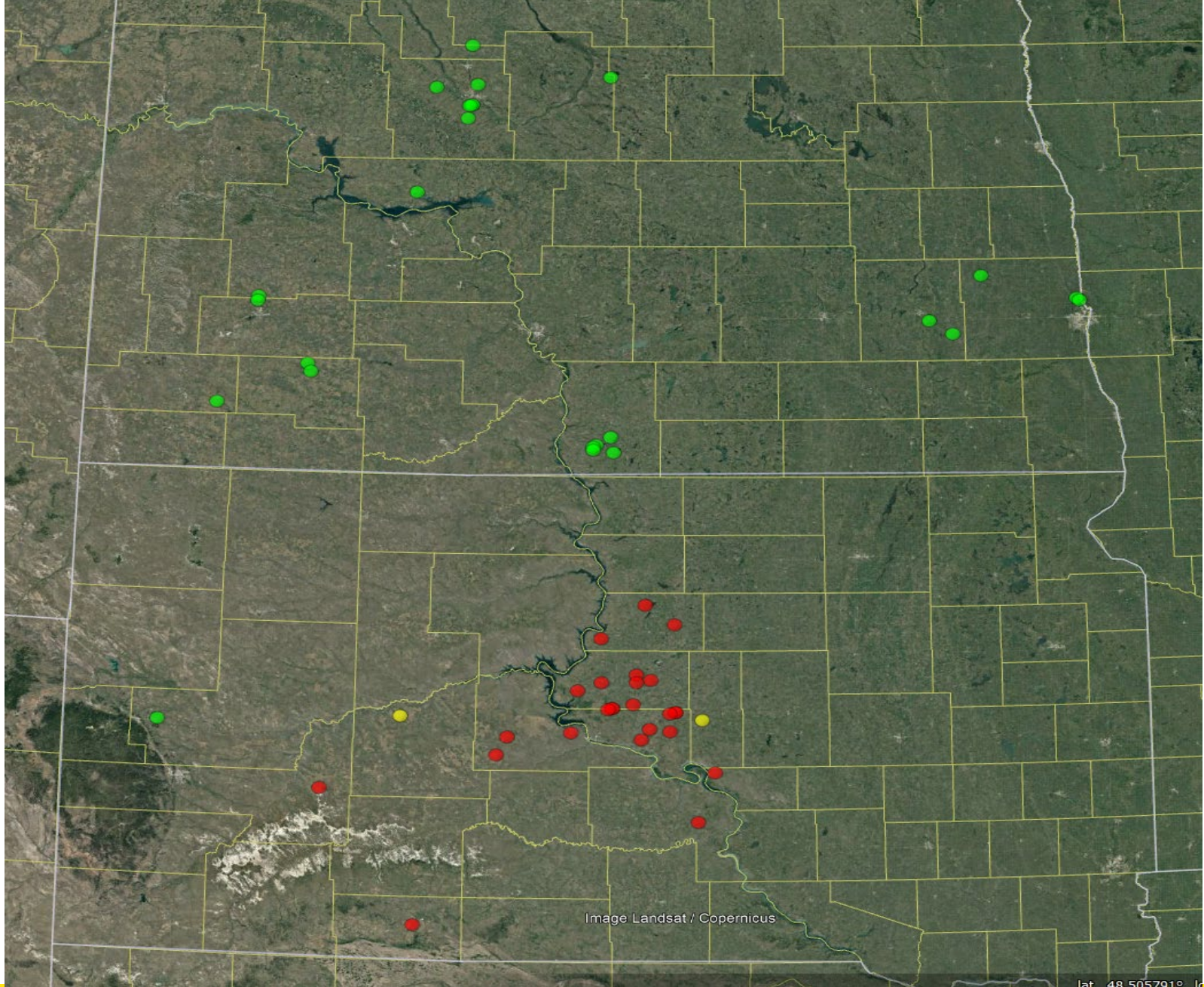
- Confirmed resistance to:
 - Asana XL (8 of 10 locations)
 - Warrior II (9 of 10 locations)
 - Baythroid XL (8 of 10 locations)
 - Delta Gold (8 of 10 locations)
- Is it cross-resistance?
 - Can we prove Baythroid XL and Delta Gold haven't been used extensively?



The continued problem

- Failures: 2017, 2018, 2019, 2020, 2021, 2022, 2023
- Reduced pyrethroid susceptibility observed in 2020, 2021
- Pyrethroid resistance confirmed in 2021, 2022, 2023
- Large RSW populations persist in SD





lat: 48.505791° N



Illegal applications?



Illegal applications?

SPECIFIC USES – FIELD CROPS (continued)

Crop	Insect	Application Rate		Acres treated per gal of <i>Asana</i> XL	Last Application (days to harvest)
		lb ai/acre	fl oz/acre		
Sunflower	Sunflower Beetle (except CA)	0.0075 - 0.03	1.45 - 5.8	88 - 22	28
	Banded Sunflower Moth	0.03 - 0.05	5.8 - 9.6	22 - 13	
	Beet Armyworm* Cutworms Grasshoppers <i>Heliothis</i> (complex) Leafhoppers Sunflower Maggot Sunflower Moth Sunflower Seed Weevil Sunflower Stem Weevil				
	Grasshopper – For control of first and second instar grasshopper nymphal stages a rate range of 3.9 to 5.8 fluid ounces of product per acre (0.02 - 0.03 lb ai/A) can be used. Correct timing of spray applications to the first and second instar nymphal stages and thorough coverage is critical to achieve optimum control. For grasshopper nymph stages larger than second instar, use <i>Asana</i> XL at use rates of 5.8 to 9.6 fluid ounces of product per acre (0.03 - 0.05 lb ai/A). *Aids in control. Do not apply more than 0.2 lb ai/acre per season.				



Crop	Target Pests	Rate	
		lb ai/A	fl oz/A
SUNFLOWER			
	Cutworm species Sunflower Beetle	0.015 – 0.025	0.96 – 1.60
	Banded Sunflower Moth Fall Armyworm ¹ Grasshopper species Head-Clipper Weevil (Adult) Japanese Beetle (Adult) Leafhopper species Meadow Spittlebug Painted Lady (Thistle) Caterpillar Seed Weevil (Adult) Spotted Cabbage Looper Stem Weevil (Adult) Stink Bug species Sunflower Maggot (Adult) Sunflower Moth Woollybear Caterpillar	0.02 – 0.03	1.28 – 1.92
	Beet Armyworm ^{2,3} Spider Mite species ²	0.03	1.92

Remarks

- Apply as required by scouting, usually at intervals of 5 or more days. Timing and frequency of applications should be based upon insect populations reaching locally determined economic thresholds.
- Apply with ground or air equipment using sufficient water to obtain full coverage of sunflower heads and/or foliage. When applying by air, apply in a minimum of 2 gal of water per acre.
- Do not apply within 45 days of harvest.
- Do not apply more than 0.12 lb ai (7.68 fl oz or 0.48 pt of product) per acre per season.
- Do not apply more than 0.09 lb ai (5.76 fl oz or 0.36 pt of product) per acre per season after bloom initiation.
- Do not apply as an ultra-low volume (ULV) spray.

¹Use higher rates for large larvae.

²Suppression only

³See Resistance statement under General Directions for Use.



2023 Malathion

- Malathion received an emergency crisis exemption
- 1.6 pints/acre, maximum of 2 applications 5 days apart
- August 16-31, 2023
- Highly toxic to bees (6 PM-12 AM applications)



So what for 2024?

- None of the labeled products will work in every county/field
 - Pyrethroids shouldn't be used in SD in 2024
 - Exponent (synergist) increased mortality ~10-15% compared to Asana XL alone in the lab
 - Lab tests always show better efficacy than field
- Section 18 for chlorpyrifos?
- Planting date
 - Planting date with insecticide



Acknowledgements

- Funding Sources:



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