WTFRC INTERNAL PROJECT – BUDGET SHARED FOR INFORMATIONAL PURPOSES ONLY

FINAL REPORT **PROJECT LENGTH (CROP YEARS)**: 2023-2025

Project Title: Pesticide residues of WA apples

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Project Duration: 3 Years

Total Project Request for Year 1 Funding: $ 6600
Total Project Request for Year 2 Funding: $ 6825
Total Project Request for Year 3 Funding: $ 7050

Other related/associated funding sources: Most chemical products donated by registrants

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Item	2023	2024	2025
Salaries			
Benefits			
Wages1	$1,500.00	$1,600.00	$1,700.00
Benefits1	$800.00	$850.00	$900.00
RCA Room Rental			
Shipping2			
Supplies	$300.00	$300.00	$300.00
Travel3	$1,500.00	$1,525.00	$1,550.00
Plot Fees			
Miscellaneous			
Analytical lab fees	$2,500.00	$2,550.00	$2,600.00
Total	$6,600.00	$6,825.00	$7,050.00

Footnotes: Schmidt estimates 8% of his time is dedicated to this project on an annual basis
Most pesticides tested are donated by their registrants or an ag chemical supply company
1 Wages & benefits primarily for Garcia (spray applications), crew help for Garcia, and Stone (data entry & review)
2 Travel costs include hauling equipment to & from plots and driving samples to analytical lab in OR

2025 WTFRC APPLE PESTICIDE RESIDUE STUDY

Since 2011, the Washington Tree Fruit Research Commission (WTFRC) has conducted annual trials to evaluate pesticide residues on 'Gala' apples. This year, we applied fifteen insecticides/acaricides, five fungicides, and three plant growth regulators according to either an "aggressive" protocol intended to generate the highest possible residues while observing label guidelines (maximum rates at minimum retreatment and pre-harvest intervals) or a "standard" protocol following more typical industry use patterns for rates and timings. Fruit samples were collected at commercial maturity on September 11 and delivered the next day to Pacific Agricultural Labs (Sherwood, OR) and OMIC USA Laboratory (Portland, OR) for chemical residue analysis.

TRIAL DETAILS

- 18th leaf 'Pacific' Gala / M.9 Nic.29 trained to central leader/spindle on 3' x 10' spacing
- 2 x 25 gal Rears Pak-Blast sprayer calibrated to 100 gal / acre
- All pesticides applied with 8 oz Regulaid / 100 gal water / acre
- A total of 0.54 inches of rain fell on the trial block on between pink and harvest with almost no rain occurring after petal fall

Measured residues vs. maximum residue levels (MRLs) for STANDARD industry apple pesticide programs in 100 water/acre utilizing typical rates, timings, and retreatment intervals. 'Gala'/M.9 Nic.29, Rock Island, WA. WTFRC 2025.

Chemical name	Trade name	Application rate	Application timing(s)	Measured residue	US MRL[1]	India MRL[1]	Lowest export MRL[1]
		oz per acre	*dbh*	*ppm*	*ppm*	*ppm*	*ppm*
prohexadione-Ca	Kudos 27.5WDG	12	Pink & petal fall	<0.01	3	0.01*	0.01 (Tha)
Inpyrfluxam	Excalia	4	Petal fall	<0.01	0.01	0.01	0.01 (Can, Mex)
metamitron	Brevis SC	40	Petal fall & 10 mm	<0.01	0.01	0.01	0.01 (many)
ethephon (summer)	Ethephon 2SL	32	45 DAFB	<0.1	5	0.01*	0.1 (Can)
flutianil	Gatten	8	35	<0.01	0.15	0.01*	0.15 (many)
tolfenpyrad	Bexar	27	35 & 21	0.55	1	0.01*	0.01 (Twn,Tha)
indoxacarb	Avaunt	6	35 & 21	0.22	1	0.01*	0.1 (Can)
flupyradifurone	Sivanto prime	14	35 & 21	0.18	0.7	0.01*	0.5 (Twn)
fenbutatin	Vendex 50WP	32	35 & 21	1.5	15	0.01*	2 (Twn)
zeta-cypermethrin	Mustang Maxx	4	35 & 21	0.23	2	0.01*	0.7 (many)
acequinocyl	Kanemite	31	28	<0.05	0.4	0.01*	0.01 (Chn,Tha)
lambda-cyhalothrin	Warrior II	2.56	28	0.031	0.3	0.01*	0.2 (many)
flonicamid	Beleaf 50SG	2.8	28	0.051	0.2	0.01*	0.2 (many)
sulfoxaflor	Transform	2.75	28 & 14	0.067	0.5	0.01*	0.3 (many)
chlorantraniliprole	Altacor eVo	2.2	28 & 14	0.19	1.2	0.01*	0.4 (many)
spinosad	Entrust SC	10	28 & 14	0.040	0.2	0.01*	0.1 (many)
buprofezin	Centaur WDG	34.5	21	1.2	3	0.01*	1 (Twn)
lpflufenoquin	Axios 20SC	3	21 & 14	0.037	0.15	0.01*	0.01 (Tha)
phosmet**	Imidan 70-W**	92	14	2.7	10	0.01*	2 (Twn)
cyfluthrin	Baythroid XL	2.8	14	<0.05	0.5	0.01*	0.1 (many)
fenazaquin	Magister	36	14	0.39	0.6	0.2	0.3 (many)

[1] Top markets for WA apples with established MRLs; 2 December 2025. https://mrldb.nwhort.org/#top_markets

*No tolerance posted; MRL is based on national default value (0.01 ppm in India)

**Imidan 70-W was mixed with a buffering agent to reduce tank pH to 5.5 per standard industry practice

Results of this lone unreplicated trial are shared for informational purposes only and should not be construed as endorsements of any product, reflections of their efficacy against any insect, acarid, or fungal pest, or a guarantee of similar results regarding residues for any user. Apple growers should consult their extension team members, crop advisors, and warehouses to develop responsible pest control programs.

Measured residues vs. maximum residue levels (MRLs) for AGGRESSIVE apple pesticide programs in 100 gal water/acre utilizing maximum labeled rates, and minimum preharvest intervals. 'Gala'/M.9 Nic.29, Rock Island, WA. WTFRC 2025.

Chemical name	Trade name	Application rate	Application timing(s)	Measured residue	US MRL[1]	India MRL[1]	Lowest export MRL[1]
		oz per acre	*dbh*	*ppm*	*ppm*	*ppm*	*ppm*
Inpyrfluxam	Excalia	4	Pink & petal fall	<0.01	0.01	0.01	0.01 (Can, Mex)
metamitron	Brevis SC	40	80 & 72	0.02	0.01	0.01	0.01 (many)
prohexadione-Ca	Kudos 27.5WDG	12	51 & 45	0.04	3	0.01*	0.01 (Tha)
acequinocyl	Kanemite	31	35 & 21	<0.05	0.4	0.01*	0.01 (Chn,Tha)
lambda-cyhalothrin	Warrior II	2.56	28 & 21	0.048	0.3	0.01*	0.2 (many)
flonicamid	Beleaf 50SG	2.8	28 & 21	0.079	0.2	0.01*	0.2 (many)
tolfenpyrad	Bexar	27	28 & 14	0.28	1	0.01*	0.01 (Twn,Tha)
flupyradifurone	Sivanto prime	14	28 & 14	0.14	0.7	0.01*	0.5 (Twn)
fenbutatin	Vendex 50WP	32	28 & 14	0.84	15	0.01*	2 (Twn)
indoxacarb	Avaunt	6	21 & 14	0.17	1	0.01*	0.1 (Can)
flutianil	Gatten	8	21 & 14	0.013	0.15	0.01*	0.15 (many)
zeta-cypermethrin	Mustang Maxx	4	21 & 14	0.12	2	0.01*	0.7 (many)
chlorantranliprole	Altacor eVo	2.2	21 & 7	0.15	1.2	0.01*	0.4 (many)
spinosad	Entrust SC	10	21 & 7	0.035	0.2	0.01*	0.1 (many)
phosmet**	Imidan 70-W**	92	21 & 7	3.4	10	0.01*	2 (Twn)
buprofezin	Centaur WDG	34.5	14	0.76	3	0.01*	1 (Twn)
sulfoxaflor	Transform	2.75	14 & 7	0.086	0.5	0.01*	0.3 (many)
ipflufenoquin	Axios 20SC	3	14 & 7	0.026	0.15	0.01*	0.01 (Tha)
ethephon	Ethephon 2SL	48	14 & 7	1.0	5	0.01*	0.1 (Can)
fenazaquin	Magister	36	7	0.24	0.6	0.2	0.3 (many)
cyfluthrin	Baythroid XL	2.8	7	<0.05	0.5	0.01*	0.1 (many)

[1] Top markets for WA apples with established MRLs; 2 December 2025. https://mrldb.nwhort.org/#top_markets

*No tolerance posted; MRL is based on national default value (0.01 ppm in India)

**Imidan 70-W was mixed with a buffering agent to reduce tank pH to 5.5 per standard industry practice

DISCUSSION

Our 2025 trials included three plant growth regulators applied in a typical use pattern (standard) and also at the latest timings allowed by the respective product labels (aggressive); residues of metamitron, prohexadione-calcium, and ethephon were not detected in the industry standard protocol, but all three produced residues above key MRLs when sprayed at their minimum preharvest intervals. Residues were generally higher for most products when sprayed in the aggressive protocol, but that trend was not consistent. Apple producers should be mindful of the inherent variability in measuring pesticide residues and incorporate appropriate safety margins in their spray programs to allow for possible aberrant readings.

Products which produced residues in excess Maximum Residue Levels (MRLs) of key export markets in 2025 include: **Bexar, Avaunt, Centaur WDG, Axios 20SC, Imidan 70-W, Magister, Brevis SC, Kudos 27.5WDG, and Ethephon 2SL**. India has yet to post tolerances for most pesticides used by WA apple growers; in the absence of a posted MRL, the default tolerance in India is 0.01 ppm, essentially meaning that any product which produced a detectable residue would potentially violate India's standards.

Reports from previous pesticide residue studies on apple and cherry which provide a broader context for these results are available on the WTFRC website at www.treefruitresearch.org. We encourage growers and consultants to stay abreast of current information on international MRLs, which often change in response to trade negotiations and/or political developments. For more information, visit the Northwest Horticultural Council website, www.nwhort.org.

WASHINGTON TREE FRUIT RESEARCH COMMISSION

For more information, contact Tory Schmidt (509) 669-3903 or email tory@treefruitresearch.com

WTFRC APPLE PESTICIDE RESIDUE STUDIES 2011-2024

Since 2011, the Washington Tree Fruit Research Commission has conducted annual field studies to evaluate the harvest residues of numerous insecticides, acaricides, fungicides, and bioregulators commonly used in commercial apple production in WA. To provide a comprehensive overview of all measured residues, the table below summarizes all results regardless of application rates and timings or supplemental treatments such as overhead cooling, application of sunburn protectants, or simulated packing line washing, scrubbing, and waxing of fruit; values in **bold red font** highlight those residue levels which **exceed current maximum residue levels** (MRLs) for apples in some key export markets. Please note that the table does not include MRLs for India, which are currently set at 0.01 ppm for most chemicals. For more details regarding application protocols or results from specific years, please review annual reports of these studies at www.treefruitresearch.org. For more information on MRLs or other regulatory issues, please consult the Northwest Horticultural Council at www.nwhort.org.

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STUDY DETAILS

- All trials conducted on 'Pacific' Gala / M.9 Nic.29 trained to central leader/spindle on 3' x 10' spacing
- Applications made with 2 x 25 gal Rears Pak-Blast sprayer calibrated to 100 gal water + 8 oz Regulaid / acre
- Spray protocols included both standard (applications at typical commercial rates and timings) and aggressive (applications at maximum rates and minimum retreatment and pre-harvest intervals) programs

MAJOR FINDINGS

- Many residues reported as potentially problematic in earlier annual reports would now be considered acceptable due to the relaxation of some MRLs in some markets
- Higher residue levels were consistently measured with higher application rates and shorter pre-harvest intervals
- Residues of some pesticides decreased on fruit which received a simulated packing treatment, but results were too inconsistent and unpredictable to consider it a reliable method for reducing residue levels
- Sunburn protection programs with Raynox or Eclipse did not significantly affect measured pesticide residues
- Routine application of overhead cooling did not significantly impact pesticide residue levels
- Carrier volume (100 gal water/acre vs. 200 gal water/acre) effects on residue levels were inconsistent and inconclusive

Minimum, maximum, and median residues vs. MRLs of common pesticides applied to 'Gala'/M.9 Nic. 29 apples near Rock Island, WA. WTFRC 2011-2024.

Chemical name	Trade name	# years evaluated	# samples analyzed	Minimum residue	Maximum residue	Median residue	US MRL[1]	Lowest export MRL[1]
				ppm	*ppm*	*ppm*	*ppm*	*ppm*
Abamectin	AgriMek SC	4	20	0	0	0.000	0.02	0.01 (many)
Acequinocyl	Kanemite	4	20	0	0.032	0.000	0.4	0.01 (CHN, THA)
Acetamiprid	Assail 70WP	6	48	0	0.31	0.068	1	0.8 (many)
Afidopyropen	Versys	4	20	0	0	0.000	0.02	0.02 (many)
Benzovindiflupyr	Aprovia	4	16	0	0.043	0.023	0.2	0.2 (many)
Bifenazate	Acramite	8	79	0	0.43	0.029	0.7	0.2 (CHN)
Boscalid	Pristine	4	32	0.049	0.86	0.130	3	2 (many)
Buprofezin	Tourismo/Centaur	9	66	0	1.9	0.034	3	1 (TWN)
Captan	Captec 4L	2	8	0.15	1.1	0.555	25	5 (CAN)
Carbaryl (summer)	Carbaryl 4L	1	4	0.62	3.1	1.355	12	0.01 (THA)
Carbaryl (thinning)	Carbaryl 4L	2	16	0	0	0.000	12	0.01 (THA)
Chlorantraniliprole	Altacor/Altacor eVo	7	44	0	0.34	0.035	1.2	0.4 (many)
Cyantraniliprole	Exirel	6	60	0.021	0.6	0.105	1.5	0.5 (TWN)
Cyclaniliprole	Verdepryn	4	16	0	0.16	0.057	0.3	0.2 (many)
Cyflufenamid	Torino	4	20	0	0.043	0.017	0.06	0.01 (THA)
Cyflumetofen	Nealta	6	48	0	0.25	0.035	0.3	0.3 (CAN, MEX)
Cyfluthrin	Baythroid XL	3	12	0	0	0.000	0.5	0.1 (many)
Cyprodinil	Inspire Super	11	96	0	0.19	0.041	1.7	0.05 (IDN)

Chemical name	Trade name	# years evaluated	# samples analyzed	Minimum residue	Maximum residue	Median residue	US MRL[1]	Lowest export MRL[1]
				ppm	*ppm*	*ppm*	*ppm*	*ppm*
Diazinon	Diazinon 50W	7	52	0	0.12	0.019	0.5	0.1 (CAN)
Difenoconazole	Inspire Super	11	92	0	0.11	0.021	5	0.5 (CHN)
Emamectin benzoate	Proclaim	3	40	0	0	0.000	0.02	0.02 (many)
~~Endosulfan*~~	~~Thionex 50W~~	~~4~~	~~32~~	~~0~~	~~0.99~~	~~0.000~~	~~na~~	~~na~~
Ethephon (fall)	Ethephon 2SL	1	2	0.72	0.9	0.810	5	0.1 (CAN)
Ethephon (summer)	Ethephon 2SL	3	12	0	0.57	0.260	5	0.1 (CAN)
Ethephon (spring)	Ethephon 2SL	2	6	0	0.14	0.000	5	0.1 (CAN)
Etoxazole	Zeal	7	72	0	0.13	0.017	0.2	0.07 (many)
Fenazaquin	Magister	2	8	0.30	0.52	0.385	0.6	0.3 (many)
Fenbutatin	Vendex 50WP	1	4	0.83	1.1	0.970	15	2 (TWN)
Fenpropathrin	Danitol	11	94	0	0.65	0.175	5	0.01 (THA)
Flonicamid	Beleaf 50SG	3	12	0.024	0.37	0.043	0.2	0.2 (many)
Flubendiamide	Tourismo	4	42	0	0.31	0.040	1.5	0.8 (many)
Fluopyram	Luna Sensation	3	38	0	0.083	0.000	0.8	0.5 (many)
Flupyradifurone	Sivanto prime	3	12	0.089	0.39	0.170	0.7	0.5 (TWN)
Flutianil	Gatten	6	32	0	0.031	0.000	0.15	0.15 (many)
Flutriafol	Topguard	6	64	0	0.13	0.028	0.4	0.3 (many)
Fluxapyroxad	Merivon	5	52	0	0.51	0.048	0.8	0.8 (CAN, MEX)
~~Formetanate~~	~~Carzol SP~~	~~1~~	~~4~~	~~0~~	~~0~~	~~0.000~~	~~na~~	~~na~~
Hexythiazox	Onager	3	40	0.012	0.089	0.022	0.4	0.4 (many)
Imidacloprid	Nuprid 2SC	4	32	0	0.053	0.000	0.5	0.5 (many)
Indoxacarb	Avaunt	3	12	0.066	0.29	0.110	1	0.1 (CAN)
Ipflufenoquin	AXIOS	2	8	0.024	0.062	0.042	0.15	0.01 (THA)
Isofetamid	Kenja 400SC	4	24	0	0.16	0.018	0.6	0.6 (many)
Lambda-cyhalothrin	Warrior II	7	54	0	0.053	0.000	0.3	0.2 (many)
Mancozeb	Penncozeb 75DF	1	4	0	1.8	0.750	0.6	0.6 (MEX)
Mefentrifluconazole	Cevya	4	16	0.057	0.37	0.140	1.5	0.9 (TWN)
Methoxyfenozide	Intrepid	4	32	0	0.21	0.030	2	1.5 (CAN, TWN)
Metrafenone	Vivando	2	28	0	0	0.000	1.5	1 (many)
Myclobutanil	Rally 40WSP	7	68	0	0.73	0.099	0.5	0.5 many)
Novaluron	Rimon	4	34	0.09	0.63	0.325	3	2 (CAN, TWN)
Penthiopyrad	Fontelis	4	42	0	0.034	0.017	0.5	0.4 (many)
Phosmet	Imidan 70-W	6	32	1.1	6.1	2.700	10	2 (TWN)
Pydiflumetofen	Miravis	4	16	0.011	0.071	0.030	0.2	0.2 (many)
Pyraclostrobin	Pristine/Merivon	9	84	0	0.47	0.045	1.5	0.5 (many)
Pyridaben	Nexter	3	40	0	0.044	0.029	0.75	0.01 (THA)
Spinetoram	Delegate WG	9	74	0	0.084	0.011	0.2	0.05 (many)
Spinosad	Entrust	7	64	0	0.11	0.024	0.2	0.1 (many)
Spiridoclofen	Envidor 2SC	4	52	0	0.35	0.042	0.8	0.5 (China)
Spirotetramat	Ultor	4	52	0	0.19	0.020	0.7	0.7 (many)
Sulfoxaflor	Transform	3	12	0.051	0.17	0.097	0.5	0.3 (many)
Thiacloprid	Calypso	1	8	0.081	0.15	0.091	0.3	0.3 (CAN, THA)
Thiophanate-methyl**	Topsin 4.5FL	7	62	0	0.83	0.086	2	2 (MEX)
Tolfenpyrad	Bexar	7	40	0.096	1.1	0.345	1	0.01 (TWN, THA)
Trifloxylstrobin	Luna Sensation	5	46	0	0.033	0.000	0.7	0.5 (CAN)
Triflumizole	Procure 480SC	5	46	0	0.049	0.000	0.5	0.01 (THA)
Zeta-cypermethrin	Mustang Maxx	1	4	0.061	0.11	0.087	2	0.7 (many)
Ziram***	Ziram 76DF	7	68	0	2.8	0.510	7	0.1 (CAN)

[1] Top markets for WA apples excluding India; 11 Oct 2024. https://nwhort.org/export-manual/comparisonmrls/apple-mrls/, https://bcglobal.bryantchristie.com/

* Endosulfan values reported are sum totals of Endosulfan I, Endosulfan II, and Endosulfan sulfate residues

** Thiophanate-methyl values reported are sum totals of thiophanate-methyl and carbenzadim residues

*** Dithiocarbamate residues cannot be directly measured; total Ziram values are estimates based on analysis of the degradation product CS_2

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Results of these unreplicated trials are shared for informational purposes only and should not be construed as endorsements of any product, reflections of their efficacy against any insect, acarid, or fungal pest, or a guarantee of similar results regarding residues for any user. Apple growers should consult their university extension staff, crop advisors, and warehouse representatives to develop responsible pest control programs.

EXECUTIVE SUMMARY

Project Title: Pesticide Residues of WA Apples

Keywords: MRL, pesticide, residue, apple

Abstract: The Washington Tree Fruit Research Commission (WTFRC) has conducted annual pesticide residue studies in apple and cherry since 2011 to provide basic data to the tree fruit industry regarding residue levels of commonly used pesticides. This information is used by growers, consultants, and fruit sales desks to help guide management decisions regarding spray programs for fruit being exported to foreign markets which may have more stringent Maximum Residue Level (MRL) tolerances than those allowed for fruit sold domestically.

For these studies, various fungicides, insecticides, acaricides, and plant growth regulators were sprayed at typical rates and timings used by the WA apple industry, as well as in a "worst case scenario" in which products were applied at maximum rates and minimum preharvest and retreatment intervals in an effort to generate the highest possible residues while still following product label guidelines. Applications were made to a high density 'Gala' orchard with an airblast sprayer calibrated to 100 gallons water/acre. Fruit were then sampled at standard harvest timing and submitted to commercial labs for residue analysis.

Results have consistently found that residue levels of nearly all pesticides applied were safely below tolerances set for the United States market by the Environmental Protection Agency (EPA), but many residues have exceeded MRLs for some important apple export markets. Most of these potentially problematic cases have been for countries that have either set their MRLs at the minimum limit of detection for those particular products, or have not posted MRLs for those pesticides, such as India; in those cases, imported fruit in those markets cannot have residues which exceed that nation's default level for MRLs, which is frequently a very stringent limit such as 0.1 or 0.01 ppm.

In response to apple industry interest, our 2025 trial protocols included the plant growth regulators ethephon, prohexadione calcium, and the newly registered chemical thinner, metamitron. No residues of these products were detected when applied at typical industry rates and timings, but residues exceeding MRLs for key export markets were found when those products were applied in our "aggressive" protocol.

Reports of all WTFRC pesticide studies on apple and cherry since 2011 are available at www.treefruitresearch.org.