

WTFRC APPLE PESTICIDE RESIDUE STUDIES 2011-2021

Since 2011, the Washington Tree Fruit Research Commission has conducted annual field studies to evaluate the harvest residues of numerous insecticides, acaricides, and fungicides 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 usually calibrated to 100 gal / acre
- All pesticides applied with 8 oz Regulaid / 100 gal water / acre
- Spray protocols each year included both standard (applications at typical commercial rates and timings) and aggressive (applications at maximum rates and minimum retreatment and pre-harvest intervals) programs
- Additional treatments in some years included: application in dilute (200 gal water/acre) vs. concentrated (100 gal water/acre) sprays, application of sunburn suppressants (Raynox or Eclipse), standard overhead cooling practices, or simulated packing line rinsing, washing, scrubbing, and waxing of fruit

MAJOR FINDINGS

- With one exception, residues measured for all treatments in all years complied with domestic tolerances set by US EPA
- Residues which exceeded foreign MRLs frequently occurred in markets which set their tolerances at the limit of quantitation (LOQ), the smallest amount which standard laboratory instruments can accurately measure
- 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
- Increased residue levels were consistently observed with higher application rates and shorter pre-harvest intervals
- While summer application of carbaryl (i.e. in typical programs against leafhopper) produced residues which could be problematic in many foreign markets, no traces of carbaryl were detected when used only as a chemical thinner at petal fall and 10mm fruitlet size
- Residues of some pesticides were 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 2011-2021.

Chemical name	Trade name	# of years evaluated	# of samples analyzed	Minimum residue	Maximum residue	Median residue	US MRL ¹	Lowest export MRL ¹
				ppm	ppm	ppm	ppm	ppm
Abamectin	AgriMek SC	2	12	<0.01	<0.01	<0.01	0.02	0.01 (many)
Acequinocyl	Kanemite	1	8	<0.025	<0.025	<0.025	0.4	0.01 (Thailand)
Acetamiprid	Assail 70WP	6	48	<0.01	0.31	0.068	1	0.8 (many)
Afidopyropen	Versys	2	12	<0.05	<0.05	<0.05	0.02	0.01 (many)
Benzovindiflupyr	Aprovia	1	4	<0.01	0.015	0.0125	0.2	0.2 (many)
Bifenazate	Acramite	8	79	<0.01	0.43	0.029	0.7	0.2 (China)

Chemical name	Trade name	# of years evaluated	# of samples analyzed	Minimum residue	Maximum residue	Median residue	US MRL ¹	Lowest export MRL ¹
				ppm	ppm	ppm	ppm	ppm
Boscalid	Pristine	4	32	0.049	0.86	0.13	3	2 (many)
Buprofezin	Centaur WDG	6	54	<0.1	1.3	0.0235	3	1 (Taiwan)
Captan	CapteC 4L	2	8	0.15	1.1	0.555	25	5 (Canada)
Carbaryl (summer)	Carbaryl 4L	1	4	0.62	3.1	1.355	12	0.01 (many)
Carbaryl (thinning)	Carbaryl 4L	2	16	<0.01	<0.01	<0.01	12	0.01 (many)
Chlorantraniliprole	Altacor	4	32	<0.01	0.18	0.031	1.2	0.4 (many)
Cyantraniliprole	Exirel	6	60	0.021	0.6	0.105	1.5	0.8 (many)
Cyclaniliprole	Verdepryn	1	4	<0.05	0.061	0.0525	0.3	0.01 (many)
Cyflufenamid	Torino	2	12	<0.01	0.036	0.014	0.06	0.01 (Thailand)
Cyflumetofen	Nealta	3	36	<0.01	0.079	0.023	0.3	0.3 (Canada)
Cyprodinil	Inspire Super	11	92	<0.01	0.19	0.043	1.7	0.05 (Indonesia)
Diazinon	Diazinon 50W	7	52	<0.01	0.12	0.019	0.5	0.1 (Canada)
Difenoconazole	Inspire Super	11	92	<0.01	0.11	0.0205	5	0.5 (China)
Emamectin benzoate	Proclaim	3	40	<0.01	<0.01	<0.01	0.02	0.02 (many)
Endosulfan*	Thionex 50W	4	32	<0.01	0.99	<0.01	na	na
Ethephon (summer)	Ethephon 2SL	1	8	0.19	0.57	0.335	5	0.8 (many)
Ethephon (spring)	Ethephon 2SL	1	4	<0.1	0.14	<0.1	5	0.8 (many)
Etoxazole	Zeal	7	72	<0.01	0.13	0.017	0.2	0.07 (many)
Fenpropathrin	Danitol	11	94	<0.02	0.65	0.175	5	0.01 (many)
Flubendiamide	Tourismo	4	42	<0.02	0.31	0.04	1.5	0.8 (many)
Fluopyram	Luna Sensation	3	38	<0.01	0.083	<0.01	0.8	0.5 (many)
Flutianil	Gatten	3	20	<0.01	0.026	<0.01	0.15	0.01 (many)
Flutriafol	Topguard	6	64	<0.01	0.13	0.0275	0.4	0.2 (Hong Kong)
Fluxapyroxad	Merivon	5	52	<0.01	0.51	0.0475	0.8	0.8 (Canada)
Formetanate	Carzol-SP	1	4	<0.01	<0.01	<0.01	na	na
Hexythiazox	Onager	3	40	0.012	0.089	0.0215	0.4	0.4 (many)
Imidacloprid	Nuprid 2SC	4	32	<0.01	0.053	<0.01	0.5	0.5 (many)
Isofetamid	Kenja 400SC	3	20	<0.01	0.16	0.022	0.6	0.6 (many)
Lambda-cyhalothrin	Warrior II	4	42	<0.01	<0.01	<0.01	0.3	0.2 (many)
Mefenfluproconazole	Cevya	1	4	0.077	0.37	0.2095	1.5	0.01 (many)
Methoxyfenozide	Intrepid	4	32	<0.01	0.21	0.0295	2	1.5 (CAN, TAI)
Metrafenone	Vivando	2	28	<0.01	<0.01	<0.01	1.5	1 (many)
Myclobutanil	Rally 40WSP	7	68	<0.01	0.73	0.099	0.5	0.5 (many)
Novaluron	Rimon	4	34	0.09	0.63	0.325	3	2 (CAN, TAI)
Penthiopyrad	Fontelis	4	42	<0.01	0.034	0.0165	0.5	0.4 (many)
Phosmet	Imidan 70-W	3	20	1.1	6.1	3	10	2 (Taiwan)
Pydiflumetofen	Miravis	1	4	0.011	0.036	0.018	0.2	0.01 (many)
Pyraclostrobin	Pristine/Merivon	9	84	<0.01	0.47	0.045	1.5	0.5 (many)
Pyridaben	Nexter	3	40	<0.01	0.044	0.029	0.75	0.01 (Thailand)
Spinetoram	Delegate WG	9	74	<0.01	0.084	0.0105	0.2	0.05 (many)
Spinosad	Entrust	7	64	<0.01	0.11	0.024	0.2	0.1 (many)
Spiridoclofen	Envidor 2SC	4	52	<0.01	0.35	0.0415	0.8	0.5 (China)
Spirotetramat	Ultor	4	52	<0.01	0.19	0.0195	0.7	0.7 (many)
Thiacloprid	Calypso	1	8	0.081	0.15	0.091	0.3	0.3 (CAN, TAI)
Thiophanate-methyl**	Topsin 4.5FL	7	62	<0.01	0.83	0.0855	2	3 (many)
Tolfenpyrad	Bexar	4	28	0.096	1.1	0.275	1	0.01 (many)
Trifloxystrobin	Luna Sensation	5	46	<0.01	0.033	<0.01	0.5	0.5 (Canada)
Triflumizole	Procure 480SC	5	46	<0.01	0.049	<0.01	0.5	0.01 (Thailand)
Ziram***	Ziram 76DF	7	68	<0.1	2.8	0.51	7	2.5 (Taiwan)

¹ Top markets for WA apples excluding India; 18 Oct 2021. <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 CS₂



****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.**