

Comprehensive Pesticide Residue Analysis by LC/MS/MS Using an Ultra Aqueous C18 Column

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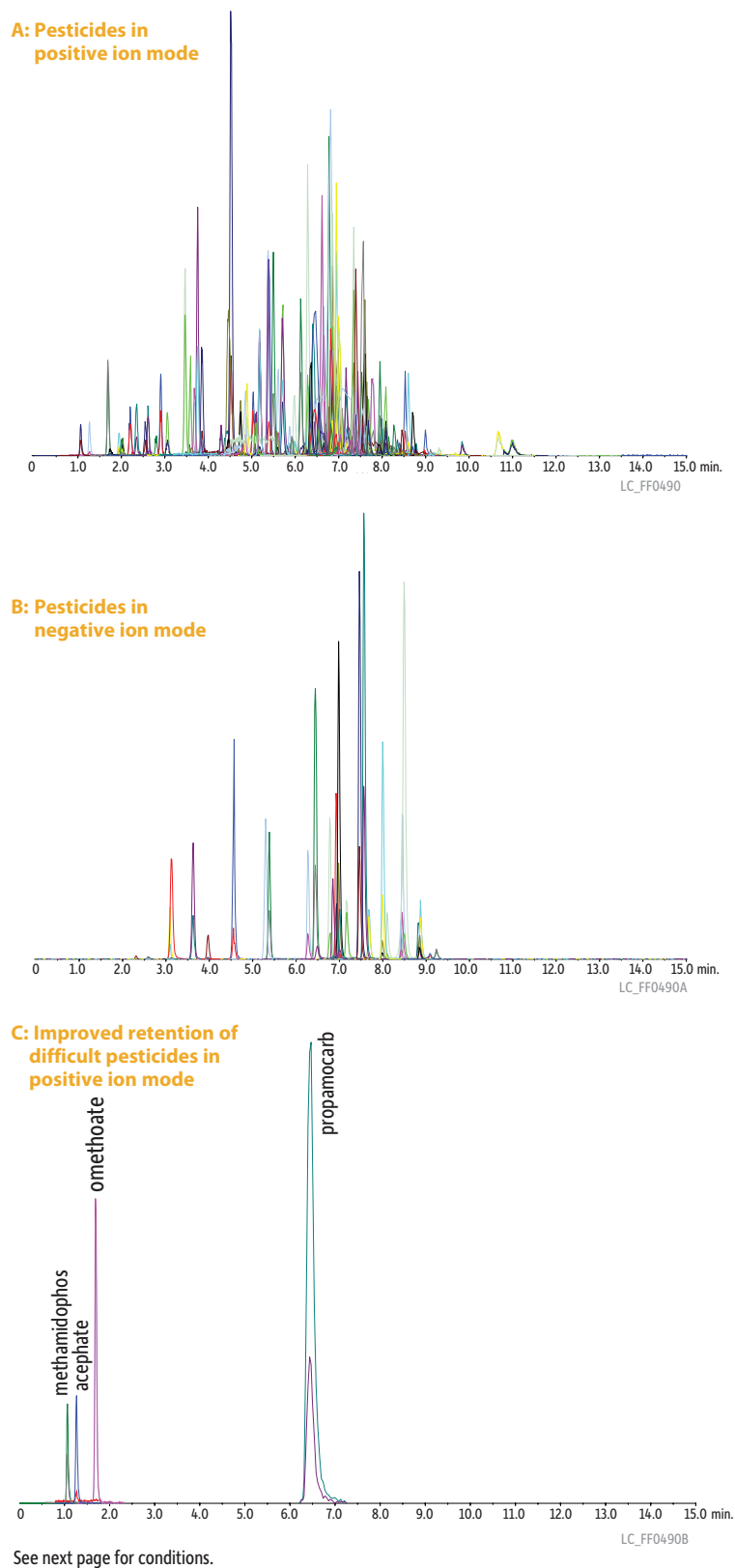
- Easily resolve and quantify more than 280 pesticide species.
- Use LC/MS/MS to reliably monitor difficult polar and/or thermally unstable species.
- Aqueous C18 phase offers optimal selectivity and retention.

Food safety is a topic of great interest globally. With recent contamination issues in a wide range of commodities, ensuring the quality of our food supply is becoming increasingly important. Pesticide residue content is one area of concern. While pesticides have typically been monitored by gas chromatography, polar and/or thermally unstable pesticides are difficult or impossible to monitor using this approach. Thus, traditional HPLC techniques are used for select pesticide classes, such as the carbamate and phenylurea pesticides.

With recent advances in LC/MS/MS instrumentation, this technique is quickly gaining acceptance for pesticide residue testing. LC/MS/MS can be used to simultaneously monitor hundreds of potential contaminants—including those difficult to detect by GC. Using both LC/MS/MS and GC approaches allows for a faster, more complete picture of pesticide residues. MS/MS technology also permits identification of the target pesticides through the selection of specific MRM transitions for each compound. For example, aldicarb, a carbamate pesticide, uses two MRM transitions of 208.2→89.1amu and 208.2→116.1amu.

While the MS/MS detector allows for specific, sensitive detection of the pesticide species, the LC separation is still important to ensure the highest quality data. Conventional C18 stationary phases are typically used for pesticide monitoring, but the selectivity and retention is poor for more polar species. In contrast, Ultra Aqueous C18 columns are ideal for multi-pesticide residue monitoring methods. In Figure 1, the analysis of more than 280 pesticides using the 3µm Ultra Aqueous C18 is shown. Optimized stationary phase selectivity

Figure 1 More than 280 pesticide residues—including difficult polar species—show excellent peak shape and retention on a 3µm Ultra Aqueous C18 column.



Conditions for Figure 1 (previous page):

Sample:	multicomponent pesticide standard
Inj.:	10µL
Conc.:	1ppb each pesticide
Sample diluent:	water
Column:	Ultra Aqueous C18
Cat. #:	9178312
Dimensions:	100mm x 2.1mm
Particle size:	3µm
Pore size:	100Å
Conditions:	
Instrument:	Shimadzu Prominence® UFLCxR
Mobile phase:	A: 10 mM NH ₄ OAc in water B: 10 mM NH ₄ OAc in methanol
	Time (min.) %B
	0.0 20
	8.0 90
	12.0 100
	14.8 100
	14.9 20
Flow:	500µL/min
Temp.:	35°C
Det.:	Applied Biosystems 4000 QTRAP® LC/MS/MS system
Ion Source:	TurboIonSpray® A & C: ESI+ B: ESI-
IonSpray Voltage:	5kV (ESI+), -4.2kV (ESI-)
Gas 1:	50psi
Gas 2:	60psi
Source Temp.:	600°C

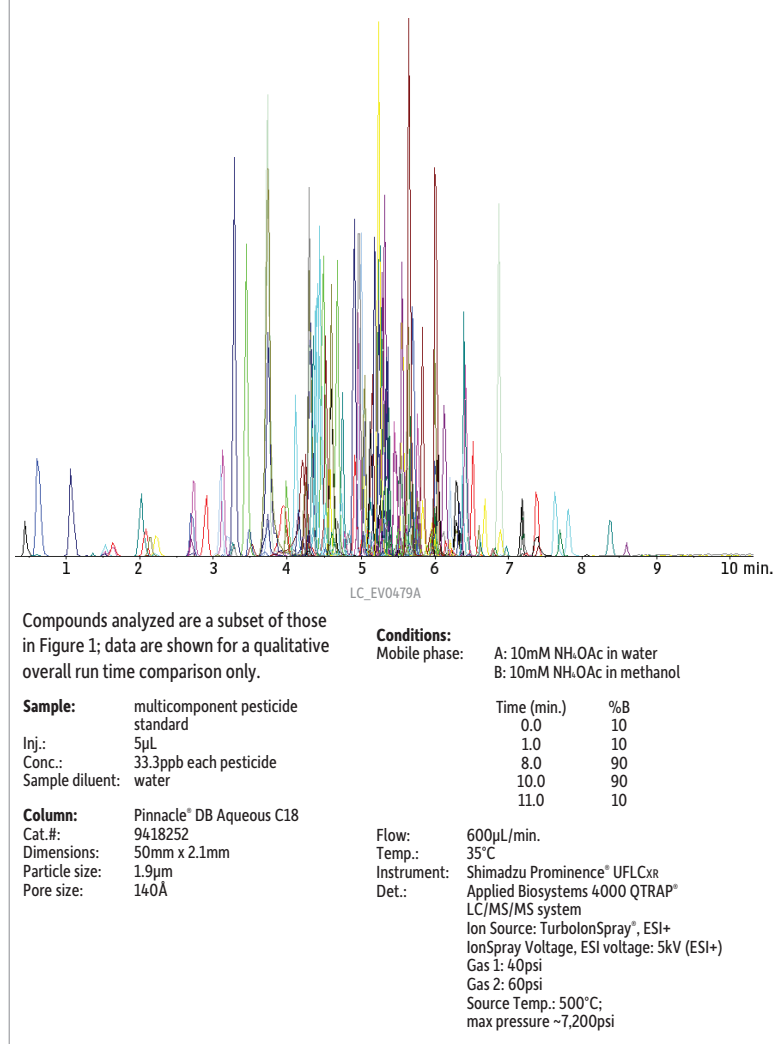
Table I Peak list for pesticides in negative ion mode.

Compound ID	Retention		Transition 2
	Time (min)	Transition 1	
Acrinathrin	9.09	540 → 372	540 → 299.9
Chlorfluazuron	9.24	539.9 → 356.8	539.9 → 519.7
Clothianidin	3.63	249.9 → 58	247.9 → 59
Diflufenzuron	7.68	309 → 156.1	310 → 288.9
Diuron	6.78	230.9 → 185.8	230.9 → 149.8
Fluazinam	7.99	462.5 → 415.8	462.5 → 397.9
Fludioxonil	6.93	246.9 → 179.9	246.9 → 125.9
Forchlorfenuron	6.44	246 → 126.9	246 → 91.2
Hexaflumuron	8.45	459 → 438.8	459 → 174.9
Imibenconazol	8.82	409 → 250.9	411 → 253
Lufenuron	8.87	509 → 325.9	509 → 175
Metaflumizon	8.5	505.1 → 301.9	505.1 → 140.9
Metamitron	3.97	201 → 184.8	201 → 116.9
Methoxyfenozid	6.98	366.9 → 104.9	366.9 → 148.9
Nitenpyram	2.59	269.2 → 221.6	269.2 → 100.8
Novaluron	8.42	491.1 → 470.7	493.1 → 472.7
Profoxydim	7.57	464.3 → 277.9	464.3 → 126.8
Propoxycarbazon	3.09	396.9 → 156	396.9 → 112.9
Prothioconazol	7.16	342 → 100.1	343.9 → 99.9
Tebufenozid	7.46	350.9 → 149	350.9 → 105
Teflubenzuron	8.85	378.6 → 338.8	378.6 → 195.9
Tepraloxydim	4.57	340 → 248	340 → 220.1
Terbacil	5.38	214.9 → 158.9	216.9 → 160.9
Tralkoxydim	6.28	328.1 → 253.8	328.1 → 281.8
Triadimefon	7.01	292 → 67.9	292 → 234.9
Triflumuron	8	356.9 → 153.8	358.9 → 155.9

allows for an even distribution of the compounds throughout the retention time window (Tables I and II). As well, retention of more polar pesticides is greatly improved, as demonstrated in Figure 1C. The Ultra Aqueous C18 column, in a 100 x 2.1mm, 3µm configuration is the column of choice for LC/MS/MS pesticide monitoring methods.

Ultra-high pressure LC (UHPLC) can also be used with MS/MS detection for monitoring pesticide residues. UHPLC allows for higher sample throughput when used in conjunction with a highly efficient <2µm particle size column. The 1.9µm Pinnacle® DB Aqueous C18, in a 50 x 2.1mm configuration, is ideally suited for this application, as shown in Figure 2.

Figure 2 Higher sample throughput can be achieved using UHPLC and MS/MS with a 1.9µm Pinnacle® DB Aqueous C18 column.



Using LC/MS/MS technology and Aqueous C18 columns, in combination with gas chromatography, results in the most comprehensive monitoring of pesticide residues. Labs interested in more complete multi-residue analysis of pesticides in food matrices, including difficult polar or thermally unstable compounds, should consider adding LC/MS/MS and Aqueous C18 columns to routine testing procedures. The Aqueous C18 phase is also available on 1.9µm Pinnacle® DB silica for UHPLC platforms.

Acknowledgements

The authors wish to thank the US FDA for their collaboration and recognize the participation of multiple FDA labs in this work.

Table II Peak list for pesticides in positive ion mode (continued on next page).

Compound ID	Retention			Compound ID	Retention		
	Time (min)	Transition 1	Transition 2		Time (min)	Transition 1	Transition 2
Acephate	1.27	184.1 → 143	184.1 → 125	EPN	6.72	324 → 157.1	324 → 296
Acetamiprid	4.44	223.2 → 126.1	223.2 → 99.1	Epoxiconazole	7.65	330 → 121	330 → 101
Acibenzolar-S-methyl	7.22	211 → 136	211 → 140	Etaconazole	7.57	328.2 → 159.1	328.2 → 123
Alanycarb	7.91	400.1 → 238.2	400.1 → 91.1	Ethiofencarb	5.58	226.1 → 106.9	226.1 → 164.1
Aldicarb	4.49	208.2 → 116.1	208.2 → 89.1	Ethiofencarb-sulfoxid	3.48	242 → 107	242 → 185.1
Aldicarb-sulfone	2.03	223.1 → 86.1	223.1 → 148	Ethion	7.9	385 → 199	385 → 171
Aldicarb-sulfoxide	2.2	207.1 → 132.1	207.1 → 89.1	Ethiprole	6.62	397.3 → 351	397.3 → 255.5
Ametryn	6.96	228.1 → 186.1	228.1 → 96	Ethofenprox	9.66	394.1 → 107.1	394.1 → 177.2
Aminocarb	5.37	209.1 → 137.1	209.1 → 152.1	Ethofumesate	6.54	304 → 121	304 → 161
Avermectin B1a	11.2	890.5 → 305	890.5 → 145	Ethoprophos	5.98	243 → 131	243 → 97
Avermectin B1b	11.4	876.5 → 291	876.5 → 145	Ethoxyquin	7.4	218.1 → 174	218.1 → 160
Azoxystrobin	6.78	404.1 → 372.1	404.1 → 344.1	Etoxazole	9	360.1 → 141	360.1 → 57.2
Benalaxyl	7.78	326.2 → 148.2	326.2 → 91.1	Famoxadone	7.72	392 → 331	392 → 238
Bendiocarb	5.1	224.2 → 109.2	224.2 → 167.2	Fenamidone	6.65	312.1 → 92.1	312.1 → 65
Benfuracarb	8.33	411.2 → 195.1	411.2 → 252.1	Fenamiphos	7.5	304.2 → 217.1	304.2 → 202.1
Benthiavalcab	6.87	382.1 → 116	382.1 → 180.1	Fenarimol	7.3	331 → 268	331 → 81
Benthiavalcab-isopropyl	6.87	382.1 → 196.8	382.1 → 179.9	Fenazaquin	9.91	307 → 161	307 → 147
Benzoximate	7.98	364 → 199	364 → 105	Fenbuconazole	7.57	337 → 125	337 → 70
Bitertanol	7.98	338 → 70	338 → 269	Fenhexamid	7.04	302 → 97	302 → 55
Boscalid	6.98	343 → 307	343 → 140	Fenitrothion	6.4	278 → 125.2	278 → 109
Bromuconazole (isomer 1)	7.36	378 → 159.1	378 → 161	Fenoxycarb	7.53	302.2 → 88.1	302.2 → 116.2
Bromuconazole (isomer 2)	8.05	378.1 → 159.1	378.1 → 161	Fenpropimorph	9.84	304 → 147	304 → 117
Bufenecarb	5.18	222.2 → 95.1	222.2 → 71	Fenpyroximate	9.29	422 → 366.1	442 → 135.1
Bupirimate	7.65	317 → 166	317 → 108	Fenthion	6.9	278.9 → 169	278.9 → 246.9
Buprofezin	8.53	306.2 → 201.1	306.2 → 116.2	Fenuron	3.85	165.1 → 72.1	165.1 → 46
Butafenacil	7.08	492.2 → 331.1	492.2 → 180.1	Fonicamid	2.25	230.1 → 203.1	230.1 → 174
Butocarboxim	4.4	191.1 → 75	191.1 → 116	Flucarbazone	2.81	397.1 → 130.1	397.1 → 115
Butocarboxim-sulfoxid	2.1	207 → 74.9	207 → 90	Flufenacet	7.17	364.1 → 152.2	364.1 → 194.2
Butoxy-carboxim	1.95	223.1 → 106	223.1 → 166	Flufenoxuron	8.98	489.1 → 158.2	489.1 → 141.2
Carbaryl	5.63	202.1 → 145	202.1 → 127	Fluometuron	5.98	233.1 → 72.1	233.1 → 46
Carbendazim	4.52	192.2 → 160.2	192.2 → 132.1	Fluopicolid	7.2	385 → 174.8	383 → 173
Carbetamide	4.74	237 → 192	237 → 118	Fluoxastrobin	7.34	459.2 → 427.2	459.2 → 188
Carbofuran	5.18	222.2 → 123.1	222.2 → 165.2	Fluquinconazole	7.31	376 → 349	376 → 307
Carboxine	5.61	236 → 143	236 → 87	Flusilazole	7.6	316 → 247	316 → 165
Carfentrazone-ethyl	7.53	412 → 346	412 → 366	Flutolanil	6.81	341.1 → 242.1	341.1 → 262.1
Chlorfluazuron	9.18	540 → 158	540 → 383	Flutriafol	5.99	302 → 123	302 → 109
Chloroxuron	7.53	291 → 72	291 → 218	Fonophos	5.9	247 → 183	247 → 201
Chlorpyrifos	8.35	350 → 198	350 → 96.9	Forchlorfenuron	6.37	248 → 93.1	248 → 165.1
Chlorpyrifos-methyl	7.88	324 → 125.1	322 → 125.1	Formetanate	4.48	222 → 165.1	222 → 120
Chlortoluron	6.31	213.1 → 72.2	213.1 → 46.2	Fuberidazole	5.5	185 → 157	185 → 65
Cinidon-ethyl	8.71	394.1 → 348.1	394.1 → 107	Furalaxyl	6.62	302.1 → 95.1	302.1 → 242.1
Clethodim	5.81	360 → 164	360 → 268	Furathiocarb	8.42	383.2 → 195.2	383.2 → 252.2
Clofentezine	8.27	303 → 138	303 → 102	Hexaconazole	7.95	314 → 70	314 → 159
Clomazone	7.04	240.1 → 125	240.1 → 89.1	Hexaflumuron	8.42	461.1 → 158.2	461.1 → 141.1
Clothianidin	3.35	250 → 169.1	250 → 132	Hexythiazox	8.77	353 → 228	353 → 168
Cyanazine	5.51	241.2 → 214.2	241.2 → 104.1	Hydramethylnon	9.2	495.2 → 323.1	495.2 → 151
Cyazofamid	7.4	325 → 108	325 → 261	Imazalil	8.1	297.1 → 159.2	299.1 → 161.2
Cyfluron	6.71	199.1 → 89.1	199.1 → 89	Imazapyr	7.3	262.2 → 217.2	262.2 → 202.2
Cymoxanil	3.91	199 → 128	199 → 111	Imidacloprid	3.82	256.2 → 209	256.2 → 175.2
Cyproconazole (isomer 1)	7.45	292.2 → 70.2	292.2 → 125.2	Indoxacarb	8.03	528 → 203	528 → 56
Cyproconazole (isomer 2)	7.44	292.1 → 70.2	292.1 → 125.2	Ipronazole	8.33	334.2 → 70	334.2 → 125
Cyprodinil	8.15	226 → 93	226 → 77	Iprodion	7.6	330.1 → 244.9	332.1 → 247
Cyromazine	2.63	167.2 → 85.1	167.2 → 68.25	Iprovalicarb	6.98	321.2 → 119	321.2 → 203.2
Demeton-S-methyl	2.9	230.9 → 89.1	230.9 → 61	Irgarol	7.72	254.2 → 198.1	254.2 → 83.2
Demeton-S-methyl-sulfon	5.6	262.9 → 108.9	262.9 → 169	Isafenphos	6.66	314 → 120	314 → 162.1
Desethyl-atrazine	3.9	188.1 → 146.2	188.1 → 104.1	Isoprocab	5.87	194.2 → 95.1	194.2 → 137.2
Desisopropyl-atrazine	3.2	174.1 → 104.1	174.1 → 96.1	Isoproturon	6.42	207.2 → 72.1	207.2 → 46.1
Desmedipham	6.23	318 → 182	318 → 136	Isoxaflutole	5.87	360.1 → 251.1	360.1 → 220.1
Desmethyl-pirimicarb	5.11	225 → 72	225 → 168.1	Kresoxim-methyl	7.53	314 → 116	314 → 206
Diazinon	7.88	305.1 → 169.2	305.1 → 97	Lenacil	6.5	235.3 → 153.2	235.3 → 136.2
Dichlorvos	5.36	221 → 109.1	223.1 → 109.1	Linuron	6.99	249.1 → 160	249.1 → 182.1
Diclobutrazol	7.58	328 → 70	328 → 160	Lufenuron	8.83	511.1 → 158.1	511.1 → 141.2
Dicrotophos	3.47	238 → 112	238 → 193	Malathion	6.83	331 → 99.1	331 → 127.1
Diethofencarb	6.56	268 → 226	268 → 180	Mandipropamid	6.81	412.1 → 328.1	412.1 → 355.9
Difenoconazole (isomer 1)	8.35	406.2 → 251.1	408.2 → 253.1	Mefenacet	7.35	299 → 148.1	299 → 120.1
Difenoconazole (isomer 2)	8.35	406.1 → 251.1	408.1 → 253.1	Mepanipyrim	7.57	224 → 106	224 → 77
Difenoxyuron	6.78	287.2 → 123.2	287.2 → 72	Mepronil	6.86	270.1 → 119.1	270.1 → 228
Diflubenzuron	7.62	311 → 158.2	311 → 141.2	Metalaxyl	6.13	280.2 → 220.2	280.2 → 192.3
Dimethenamide	6.9	276.2 → 244.1	276.2 → 168.3	Metconazole	8.01	320 → 70	320 → 125
Dimethoate	3.58	230 → 125	230 → 199.1	Methabenzthiazuron	6.56	222.1 → 165.2	222.1 → 150.3
Dimethomorph	7.22	388.2 → 301.1	388.2 → 165.2	Methamidophos	1.06	142 → 94	142 → 125
Dimoxystrobin	7.6	327.1 → 205	327.1 → 116	Methiocarb	6.82	226.1 → 169.2	226.1 → 121.1
Diniconazole	8.07	326 → 70	326 → 159	Methomyl	2.62	163.1 → 88.1	163.1 → 106
Dinotefuran	2.02	203.1 → 114.1	203.1 → 129	Methoprotryne	6.95	272.2 → 240.2	272.2 → 198
Dioxacarb	3.68	224 → 123	224 → 167.1	Methoxyfenozide	6.9	369 → 149	369 → 133
Diphenylamin	7.03	170.1 → 93	170.1 → 92	Metobromuron	6.22	259 → 170.2	259 → 148.2
Disulfoton	6.08	275.1 → 89	275.1 → 61	Metolachlor	7.5	284.2 → 252.2	284.2 → 176.2
Diuron	6.7	233.1 → 72	235.1 → 72.1	Metoxuron	5.1	229 → 72.1	229 → 156.1
Edifenphos	6.66	311 → 283	328 → 283	Metribuzin	5.14	215.1 → 187.2	215.1 → 84.1

Table II Peak list for pesticides in positive ion mode (continued from previous page).

Compound ID	Retention Time (min)	Transition 1	Transition 2	Compound ID	Retention Time (min)	Transition 1	Transition 2
Mevinphos	4.29	225 → 127	225 → 193	Pyrethrin II	8.3	373.1 → 160.9	373.1 → 308.9
Mexacarbate	7.02	223.2 → 166.2	223.2 → 151	Pyridaben	9.33	365 → 147	365 → 309
Milbemectin A3	10.3	546.4 → 511.3	546.4 → 493.3	Pyridaphenthion	7.8	341 → 189	341 → 205
Milbemectin A4	10.5	560.4 → 525.4	560.4 → 55.2	Pyrimethanil	7.24	200 → 107	200 → 82
Molinate	7.3	188.2 → 126.2	188.2 → 55.1	Pyriproxyfen	8.72	322 → 96	322 → 185
Monocrotophos	2.9	224 → 127	224 → 98	Quinalphos	6.7	299 → 147	299 → 163
Monolinuron	5.93	215.1 → 126.1	215.1 → 99	Quinoxifen	9.12	308 → 197	308 → 162
Monuron	5.7	199.2 → 72.2	199.2 → 126.3	Rotenone	7.61	395 → 213	395 → 192
Myclobutanil	7.17	289 → 70	289 → 125	Secbumeton	6.85	226.2 → 170.1	226.2 → 100
Neburon	7.65	275 → 88	275 → 114	Siduron	6.55	233.3 → 137.2	233.3 → 94
Nitenpyram	2.55	271.2 → 126.1	271.2 → 237.2	Simetryn	6.36	214 → 124	214 → 144
Novaluron	8.38	493 → 158.1	493 → 141.1	Spinosyn A	11.3	732.6 → 142.1	732.6 → 98
Nuarimol	6.7	315 → 252	315 → 81	Spinosyn D	11.6	746.6 → 142.1	746.6 → 98
Omethoate	1.69	214 → 124.9	214 → 182.8	Spirodiclofen	8.96	411.3 → 313.2	411.3 → 213.1
Oxadixyl	4.85	279.2 → 219.2	279.2 → 132.1	Spiromesifen	8.8	371.3 → 273	371.3 → 255
Oxamyl	2.35	237.1 → 72.1	237.1 → 90.1	Spiroxamine (isomer 1)	10.7; 11	298.4 → 144.2	298.4 → 100.2
Oxydemeton-methyl	3.1	247 → 169	247 → 109	Spiroxamine (isomer 2)	10.7; 11	298.3 → 144.2	298.3 → 100.2
Paclobutrazol	6.82	294 → 70	294 → 125	Sulfentrazone	4.77	387 → 307.1	387 → 146
Parathion-ethyl	6.7	292.1 → 236.2	292.1 → 94.1	Sulfotep-ethyl	7	323 → 115	323 → 171.1
Parathion-methyl	7.6	263.9 → 232.1	263.9 → 125	Sulprofos	7	323 → 219	323 → 247
Penconazole	8.01	284 → 159	284 → 70	Tebuconazole	7.8	308 → 70	308 → 125
Pencycuron	8.1	329.1 → 125.1	331.2 → 127	Tebufenozide	7.39	353.1 → 133.1	353.1 → 297.1
Phenmedipham	6.35	301.1 → 136	301.1 → 168.1	Tebufenpyrad	8.56	334 → 117	334 → 145
Phenthoate	7	321 → 163	321 → 79	Tebuthiuron	5.71	229.2 → 172.4	229.2 → 116.1
Phosmet	6.7	318 → 160	318 → 133	Teflubenzuron	8.81	381.1 → 141.2	381.1 → 158.2
Phoxim	7.9	299.1 → 129.1	299.1 → 77.1	Terbufos	6.5	289 → 103	289 → 57
Picoxystrobin	7.44	368 → 145	368 → 205	Terbumeton	6.84	226 → 170	226 → 114
Pinoxaden	7.99	401.3 → 317.2	401.1 → 57	Terbutryn	7.57	242.2 → 186.1	242.2 → 68.1
Piperonyl butoxide	8.62	356.2 → 177.2	356.2 → 119	Tetraconazole	7.3	372 → 159	372 → 70
Pirimicarb	6.29	239.2 → 72.1	239.2 → 182.2	Thiabendazole	5.71	202.1 → 175.1	202.1 → 131.2
Pirimicarb-desmethylformamido	6.4	253.2 → 72.1	253.2 → 225.3	Thiacloprid	4.89	253.1 → 126.1	253.1 → 99.1
Pirimiphos-ethyl	7.48	334 → 198.1	334 → 182.1	Thiamethoxam	3.06	292 → 211	292 → 181
Prochloraz	8.29	376.1 → 308	376.1 → 70.1	Thidiazuron	5.18	221.2 → 102.1	221.2 → 127.9
Promecarb	6.86	208.2 → 109.1	208.2 → 151.1	Thiobencarb	8.09	258.1 → 125	258.1 → 89
Prometon	6.86	226.1 → 142.1	226.1 → 86	Thiofanox	5.7	219 → 57.1	219 → 60.9
Prometryn	7.4	242.2 → 200.1	242.2 → 158.1	Thiofanoxsulfon	3.4	251.1 → 75.9	251.1 → 57
Propachlor	6.2	212.2 → 170.1	212.2 → 94.1	Thiofanoxsulfoxid	3.6	235.1 → 104.1	235.1 → 57
Propamocarb	6.61	189.2 → 102.2	189.2 → 73.9	Thiophanate-methyl	5.1	343 → 151	343 → 192
Propargite	8.79	368 → 231	368 → 175	Tolclofos-methyl	8	301 → 175	301 → 268.9
Propazine	6.9	230.1 → 146.1	230.1 → 188.1	Topramezone	1.73	364.1 → 334.1	364.1 → 125
Propham	5.78	180 → 138	180 → 120	Triadimefon	6.94	294 → 197	294 → 225
Propiconazole	7.98	342.1 → 159.1	342.1 → 69.1	Triadimenol	7.04	296.1 → 70.1	296.1 → 227.2
Propoxur	5.03	210.1 → 111	210.1 → 168.1	Tricyclazole	5.18	190 → 163	190 → 136
Prosulfocarb	8.5	252.3 → 91.1	252.3 → 128.1	Trifloxystrobin	8.09	409 → 186	409 → 206
py Cinerin I	9	317.2 → 149	317.2 → 106.9	Triflumizole	8.47	346 → 278	346 → 73
py Cinerin II	8.2	361.2 → 149	361.2 → 106.9	Triflumuron	7.94	359.1 → 156.2	359.1 → 139
Pymetrozin	3.61	218 → 105	218 → 78	Triticonazole	7.38	318 → 70	318 → 125
Pyracarbolid	5.4	218.2 → 125	218.2 → 97	Uniconazole	7.4	292.2 → 70.1	292.2 → 43
Pyraclostrobin	7.95	388 → 194	388 → 163	Vamidothion	3.75	288 → 146	288 → 118
Pyrazophos	7.8	374 → 222	374 → 194	Zoxamide	7.7	336.1 → 186.9	338.1 → 188.7
Pyrethrin I	8.9	329.2 → 160.9	329.2 → 132.9				

HPLC Columns (USP L1)

Ultra Aqueous C18 Columns

pore size: 100Å pH range: 2.5 to 8
 carbon load: 15% temperature limit: 80°C
 endcap: no

3µm Column, 2.1mm	cat. #
100mm	9178312
100mm (with Trident Inlet Fitting)	9178312-700

Pinnacle® DB Aqueous C18 Columns

pore size: 140Å pH range: 2.5 to 8
 carbon load: 6% temperature limit: 80°C

1.9µm Column, 2.1mm	cat. #
50mm	9418252

PATENTS & TRADEMARKS

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For guard cartridges for these columns, visit www.restek.com



Lit. Cat.# FFFF1185A-US

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