Foods, Flavors & Fragrances

Comprehensive Pesticide Residue Analysis by LC/MS/MS

Using an Ultra Aqueous C18 Column

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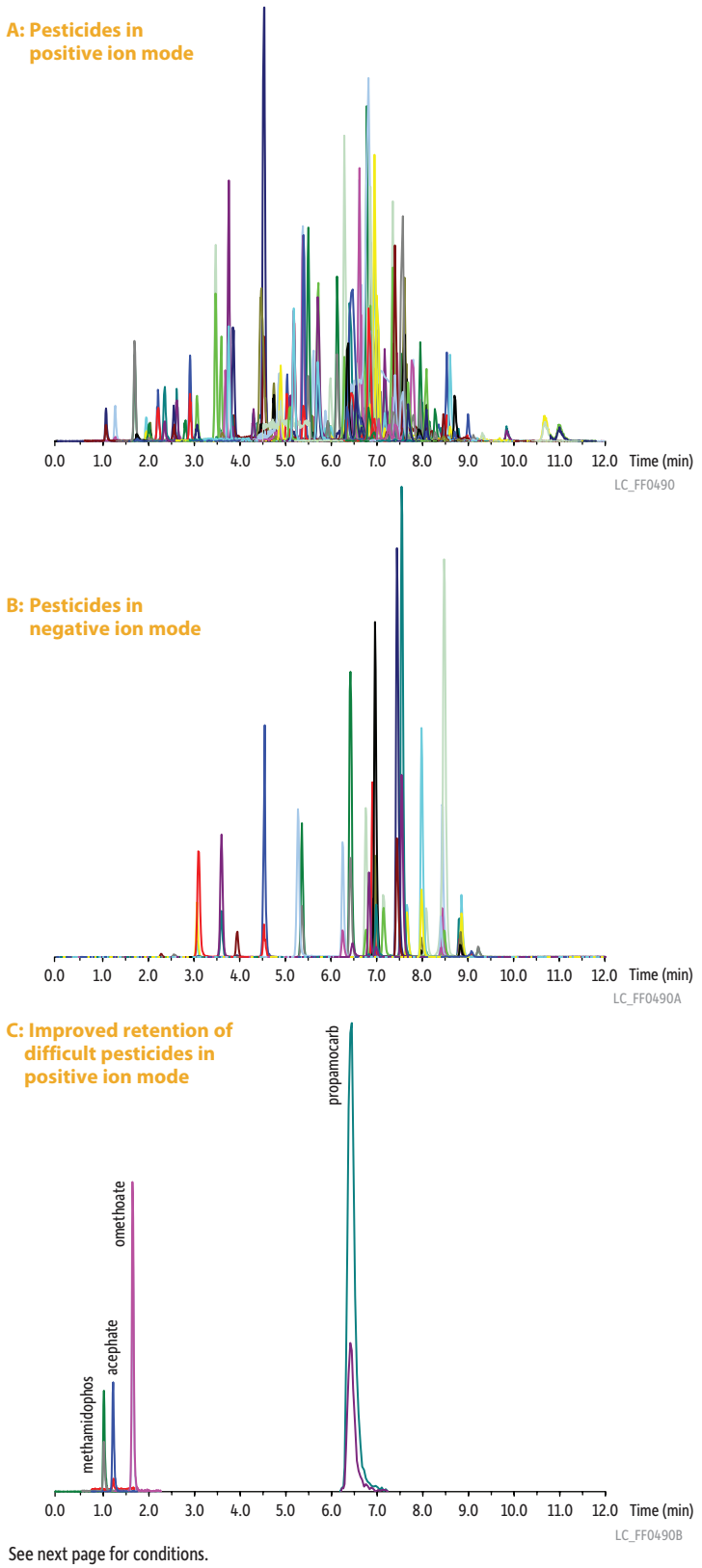
- Easily resolve and quantify more than 280 pesticide species.
- Use LC/MS/MS to reliably monitor difficult polar and/or thermally unstable species.
- Aqueous C18 phase offers optimal selectivity and retention.

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.



See next page for conditions.

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_4OAc in water
B: 10 mM NH_4OAc 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

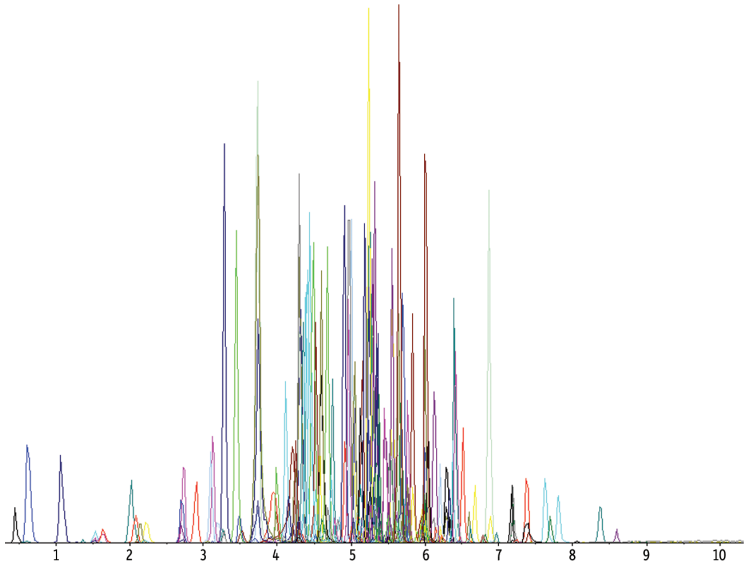
Table I Peak list for pesticides in negative ion mode.

Compound ID	Retention Time (min)	Transition 1	Transition 2
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
Diflubenzuron	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.



Compounds analyzed are a subset of those in Figure 1; data are shown for a qualitative overall run time comparison only.

Sample: multicomponent pesticide standard
Inj.: 5µL
Conc.: 33.3ppb each pesticide
Sample diluent: water

Column: Pinnacle® DB Aqueous C18
Cat.#: 9418252
Dimensions: 50mm x 2.1mm
Particle size: 1.9µm
Pore size: 140Å

Conditions:
Mobile phase: A: 10mM NH_4OAc in water
B: 10mM NH_4OAc in methanol

Time (min.)	%B
0.0	10
1.0	10
8.0	90
10.0	90
11.0	10

Flow: 600µL/min.
Temp.: 35°C
Instrument: Shimadzu Prominence® UFLCXR
Det.: Applied Biosystems 4000 QTRAP® LC/MS/MS system
Ion Source: TurboIonSpray®, ESI+
IonSpray Voltage, ESI voltage: 5kV (ESI+)
Gas 1: 40psi
Gas 2: 60psi
Source Temp.: 500°C;
max pressure ~7,200psi

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 Time (min)	Transition 1	Transition 2
Acephate	1.27	184.1 → 143	184.1 → 125
Acetamiprid	4.44	223.2 → 126.1	223.2 → 99.1
Acibenzolar-S-methyl	7.22	211 → 136	211 → 140
Alanycarb	7.91	400.1 → 238.2	400.1 → 91.1
Aldicarb	4.49	208.2 → 116.1	208.2 → 89.1
Aldicarbsulfone	2.03	223.1 → 86.1	223.1 → 148
Aldicarbsulfoxide	2.2	207.1 → 132.1	207.1 → 89.1
Ametryn	6.96	228.1 → 186.1	228.1 → 96
Aminocarb	5.37	209.1 → 137.1	209.1 → 152.1
Avermectin B1a	11.2	890.5 → 305	890.5 → 145
Avermectin B1b	11.4	876.5 → 291	876.5 → 145
Azoxystrobin	6.78	404.1 → 372.1	404.1 → 344.1
Benalaxyl	7.78	326.2 → 148.2	326.2 → 91.1
Bendiocarb	5.1	224.2 → 109.2	224.2 → 167.2
Benfuracarb	8.33	411.2 → 195.1	411.2 → 252.1
Benthiavalicarb	6.87	382.1 → 116	382.1 → 180.1
Benthiavalicarb-isopropyl	6.87	382.1 → 196.8	382.1 → 179.9
Benzoximate	7.98	364 → 199	364 → 105
Bitertanol	7.98	338 → 70	338 → 269
Boscalid	6.98	343 → 307	343 → 140
Bromuconazole (isomer 1)	7.36	378 → 159.1	378 → 161
Bromuconazole (isomer 2)	8.05	378.1 → 159.1	378.1 → 161
Bufencarb	5.18	222.2 → 95.1	222.2 → 71
Bupirimate	7.65	317 → 166	317 → 108
Buprofezin	8.53	306.2 → 201.1	306.2 → 116.2
Butafenacil	7.08	492.2 → 331.1	492.2 → 180.1
Butocarboxim	4.4	191.1 → 75	191.1 → 116
Butocarboximsulfoxid	2.1	207 → 74.9	207 → 90
Butoxycarboxim	1.95	223.1 → 106	223.1 → 166
Carbaryl	5.63	202.1 → 145	202.1 → 127
Carbendazim	4.52	192.2 → 160.2	192.2 → 132.1
Carbetamide	4.74	237 → 192	237 → 118
Carbofuran	5.18	222.2 → 123.1	222.2 → 165.2
Carboxine	5.61	236 → 143	236 → 87
Carfentrazone-ethyl	7.53	412 → 346	412 → 366
Chlorfluazuron	9.18	540 → 158	540 → 383
Chloroxuron	7.53	291 → 72	291 → 218
Chlorpyrifos	8.35	350 → 198	350 → 96.9
Chlorpyrifos-methyl	7.88	324 → 125.1	322 → 125.1
Chlortoluron	6.31	213.1 → 72.2	213.1 → 46.2
Cinidon-ethyl	8.71	394.1 → 348.1	394.1 → 107
Clethodim	5.81	360 → 164	360 → 268
Clofentezine	8.27	303 → 138	303 → 102
Clomazone	7.04	240.1 → 125	240.1 → 89.1
Clothianidin	3.35	250 → 169.1	250 → 132
Cyanazine	5.51	241.2 → 214.2	241.2 → 104.1
Cyazofamid	7.4	325 → 108	325 → 261
Cycluron	6.71	199.1 → 89.1	199.1 → 89
Cymoxanil	3.91	199 → 128	199 → 111
Cyproconazole (isomer 1)	7.45	292.2 → 70.2	292.2 → 125.2
Cyproconazole (isomer 2)	7.44	292.1 → 70.2	292.1 → 125.2
Cyprodinil	8.15	226 → 93	226 → 77
Cyromazine	2.63	167.2 → 85.1	167.2 → 68.25
Demeton-S-methyl	2.9	230.9 → 89.1	230.9 → 61
Demeton-S-methyl-sulfon	5.6	262.9 → 108.9	262.9 → 169
Desethyl-atrazine	3.9	188.1 → 146.2	188.1 → 104.1
Desisopropyl-atrazine	3.2	174.1 → 104.1	174.1 → 96.1
Desmedipham	6.23	318 → 182	318 → 136
Desmethyl-pirimicarb	5.11	225 → 72	225 → 168.1
Diazinon	7.88	305.1 → 169.2	305.1 → 97
Dichlorvos	5.36	221 → 109.1	223.1 → 109.1
Diclobutrazol	7.58	328 → 70	328 → 160
Dicrotophos	3.47	238 → 112	238 → 193
Diethofencarb	6.56	268 → 226	268 → 180
Difenoconazole (isomer 1)	8.35	406.2 → 251.1	408.2 → 253.1
Difenoconazole (isomer 2)	8.35	406.1 → 251.1	408.1 → 253.1
Difenoxuron	6.78	287.2 → 123.2	287.2 → 72
Diflubenzuron	7.62	311 → 158.2	311 → 141.2
Dimethenamide	6.9	276.2 → 244.1	276.2 → 168.3
Dimethoate	3.58	230 → 125	230 → 199.1
Dimethomorph	7.22	388.2 → 301.1	388.2 → 165.2
Dimoxystrobin	7.6	327.1 → 205	327.1 → 116
Diniconazole	8.07	326 → 70	326 → 159
Dinotefuran	2.02	203.1 → 114.1	203.1 → 129
Dioxacarb	3.68	224 → 123	224 → 167.1
Diphenylamin	7.03	170.1 → 93	170.1 → 92
Disulfoton	6.08	275.1 → 89	275.1 → 61
Diuron	6.7	233.1 → 72	235.1 → 72.1
Edifenphos	6.66	311 → 283	328 → 283
EPN	6.72	324 → 157.1	324 → 296
Epoxiconazole	7.65	330 → 121	330 → 101
Etaconazole	7.57	328.2 → 159.1	328.2 → 123
Ethiofencarb	5.58	226.1 → 106.9	226.1 → 164.1
Ethiofencarbsulfoxid	3.48	242 → 107	242 → 185.1
Ethion	7.9	385 → 199	385 → 171
Ethiprole	6.62	397.3 → 351	397.3 → 255.5
Ethofenprox	9.66	394.1 → 107.1	394.1 → 177.2
Ethofumesate	6.54	304 → 121	304 → 161
Ethoprophos	5.98	243 → 131	243 → 97
Ethoxyquin	7.4	218.1 → 174	218.1 → 160
Etoxazole	9	360.1 → 141	360.1 → 57.2
Famoxadone	7.72	392 → 331	392 → 238
Fenamidone	6.65	312.1 → 92.1	312.1 → 65
Fenamiphos	7.5	304.2 → 217.1	304.2 → 202.1
Fenarimol	7.3	331 → 268	331 → 81
Fenazaquin	9.91	307 → 161	307 → 147
Fenbuconazole	7.57	337 → 125	337 → 70
Fenhexamid	7.04	302 → 97	302 → 55
Fenitrothion	6.4	278 → 125.2	278 → 109
Fenoxycarb	7.53	302.2 → 88.1	302.2 → 116.2
Fenpropimorph	9.84	304 → 147	304 → 117
Fenpyroximate	9.29	422 → 366.1	442 → 135.1
Fenthion	6.9	278.9 → 169	278.9 → 246.9
Fenuron	3.85	165.1 → 72.1	165.1 → 46
Flonicamid	2.25	230.1 → 203.1	230.1 → 174
Flucarbazone	2.81	397.1 → 130.1	397.1 → 115
Flufenacet	7.17	364.1 → 152.2	364.1 → 194.2
Flufenoxuron	8.98	489.1 → 158.2	489.1 → 141.2
Fluometuron	5.98	233.1 → 72.1	233.1 → 46
Fluopicolid	7.2	385 → 174.8	383 → 173
Fluoxastrobin	7.34	459.2 → 427.2	459.2 → 188
Fluquinconazole	7.31	376 → 349	376 → 307
Flusilazole	7.6	316 → 247	316 → 165
Flutolanil	6.81	341.1 → 242.1	341.1 → 262.1
Flutriafol	5.99	302 → 123	302 → 109
Fonophos	5.9	247 → 183	247 → 201
Forchlorfenuron	6.37	248 → 93.1	248 → 165.1
Formetanate	4.48	222 → 165.1	222 → 120
Fuberidazole	5.5	185 → 157	185 → 65
Furalaxyl	6.62	302.1 → 95.1	302.1 → 242.1
Furathiocarb	8.42	383.2 → 195.2	383.2 → 252.2
Hexaconazole	7.95	314 → 70	314 → 159
Hexaflumuron	8.42	461.1 → 158.2	461.1 → 141.1
Hexythiazox	8.77	353 → 228	353 → 168
Hydramethylnon	9.2	495.2 → 323.1	495.2 → 151
Imazalil	8.1	297.1 → 159.2	299.1 → 161.2
Imazapyr	7.3	262.2 → 217.2	262.2 → 202.2
Imidacloprid	3.82	256.2 → 209	256.2 → 175.2
Indoxacarb	8.03	528 → 203	528 → 56
Ipconazole	8.33	334.2 → 70	334.2 → 125
Iprodion	7.6	330.1 → 244.9	332.1 → 247
Iprovalicarb	6.98	321.2 → 119	321.2 → 203.2
Irgarol	7.72	254.2 → 198.1	254.2 → 83.2
Isofenphos	6.66	314 → 120	314 → 162.1
Isoprocarb	5.87	194.2 → 95.1	194.2 → 137.2
Isoproturon	6.42	207.2 → 72.1	207.2 → 46.1
Isoxaflutole	5.87	360.1 → 251.1	360.1 → 220.1
Kresoxim-methyl	7.53	314 → 116	314 → 206
Lenacil	6.5	235.3 → 153.2	235.3 → 136.2
Linuron	6.99	249.1 → 160	249.1 → 182.1
Lufenuron	8.83	511.1 → 158.1	511.1 → 141.2
Malathion	6.83	331 → 99.1	331 → 127.1
Mandipropamid	6.81	412.1 → 328.1	412.1 → 355.9
Mefenacet	7.35	299 → 148.1	299 → 120.1
Mepanipyrim	7.57	224 → 106	224 → 77
Mepronil	6.86	270.1 → 119.1	270.1 → 228
Metalaxyl	6.13	280.2 → 220.2	280.2 → 192.3
Metconazole	8.01	320 → 70	320 → 125
Methabenzthiazuron	6.56	222.1 → 165.2	222.1 → 150.3
Methamidophos	1.06	142 → 94	142 → 125
Methiocarb	6.82	226.1 → 169.2	226.1 → 121.1
Methomyl	2.62	163.1 → 88.1	163.1 → 106
Methoprotryne	6.95	272.2 → 240.2	272.2 → 198
Methoxyfenozide	6.9	369 → 149	369 → 133
Metobromuron	6.22	259 → 170.2	259 → 148.2
Metolachlor	7.5	284.2 → 252.2	284.2 → 176.2
Metoxuron	5.1	229 → 72.1	229 → 156.1
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
Mevinphos	4.29	225 → 127	225 → 193
Mexacarbate	7.02	223.2 → 166.2	223.2 → 151
Milbemectin A3	10.3	546.4 → 511.3	546.4 → 493.3
Milbemectin A4	10.5	560.4 → 525.4	560.4 → 55.2
Molinate	7.3	188.2 → 126.2	188.2 → 55.1
Monocrotophos	2.9	224 → 127	224 → 98
Monolinuron	5.93	215.1 → 126.1	215.1 → 99
Monuron	5.7	199.2 → 72.2	199.2 → 126.3
Myclobutanil	7.17	289 → 70	289 → 125
Neburon	7.65	275 → 88	275 → 114
Nitenpyram	2.55	271.2 → 126.1	271.2 → 237.2
Novaluron	8.38	493 → 158.1	493 → 141.1
Nuarimol	6.7	315 → 252	315 → 81
Omethoate	1.69	214 → 124.9	214 → 182.8
Oxadixyl	4.85	279.2 → 219.2	279.2 → 132.1
Oxamyl	2.35	237.1 → 72.1	237.1 → 90.1
Oxydemeton-methyl	3.1	247 → 169	247 → 109
Paclobutrazol	6.82	294 → 70	294 → 125
Parathion-ethyl	6.7	292.1 → 236.2	292.1 → 94.1
Parathion-methyl	7.6	263.9 → 232.1	263.9 → 125
Penconazole	8.01	284 → 159	284 → 70
Pencycuron	8.1	329.1 → 125.1	331.2 → 127
Phenmedipham	6.35	301.1 → 136	301.1 → 168.1
Phenthoate	7	321 → 163	321 → 79
Phosmet	6.7	318 → 160	318 → 133
Phoxim	7.9	299.1 → 129.1	299.1 → 77.1
Picoxystrobin	7.44	368 → 145	368 → 205
Pinoxaden	7.99	401.3 → 317.2	401.1 → 57
Piperonyl butoxide	8.62	356.2 → 177.2	356.2 → 119
Pirimicarb	6.29	239.2 → 72.1	239.2 → 182.2
Pirimicarb-desmethylformamido	6.4	253.2 → 72.1	253.2 → 225.3
Pirimiphos-ethyl	7.48	334 → 198.1	334 → 182.1
Prochloraz	8.29	376.1 → 308	376.1 → 70.1
Promecarb	6.86	208.2 → 109.1	208.2 → 151.1
Prometon	6.86	226.1 → 142.1	226.1 → 86
Prometryn	7.4	242.2 → 200.1	242.2 → 158.1
Propachlor	6.2	212.2 → 170.1	212.2 → 94.1
Propamocarb	6.61	189.2 → 102.2	189.2 → 73.9
Propargite	8.79	368 → 231	368 → 175
Propazine	6.9	230.1 → 146.1	230.1 → 188.1
Propham	5.78	180 → 138	180 → 120
Propiconazole	7.98	342.1 → 159.1	342.1 → 69.1
Propoxur	5.03	210.1 → 111	210.1 → 168.1
Prosulfocarb	8.5	252.3 → 91.1	252.3 → 128.1
py Cinerin I	9	317.2 → 149	317.2 → 106.9
py Cinerin II	8.2	361.2 → 149	361.2 → 106.9
Pymetrozin	3.61	218 → 105	218 → 78
Pyracarbolid	5.4	218.2 → 125	218.2 → 97
Pyraclostrobin	7.95	388 → 194	388 → 163
Pyrazophos	7.8	374 → 222	374 → 194
Pyrethrin I	8.9	329.2 → 160.9	329.2 → 132.9
Pyrethrin II	8.3	373.1 → 160.9	373.1 → 308.9
Pyridaben	9.33	365 → 147	365 → 309
Pyridaphenthion	7.8	341 → 189	341 → 205
Pyrimethanil	7.24	200 → 107	200 → 82
Pyriproxyfen	8.72	322 → 96	322 → 185
Quinalphos	6.7	299 → 147	299 → 163
Quinoxyfen	9.12	308 → 197	308 → 162
Rotenone	7.61	395 → 213	395 → 192
Secbumeton	6.85	226.2 → 170.1	226.2 → 100
Siduron	6.55	233.3 → 137.2	233.3 → 94
Simetryn	6.36	214 → 124	214 → 144
Spinosyn A	11.3	732.6 → 142.1	732.6 → 98
Spinosyn D	11.6	746.6 → 142.1	746.6 → 98
Spirodiclofen	8.96	411.3 → 313.2	411.3 → 213.1
Spiromesifen	8.8	371.3 → 273	371.3 → 255
Spiroxamine (isomer 1)	10.7; 11	298.4 → 144.2	298.4 → 100.2
Spiroxamine (isomer 2)	10.7; 11	298.3 → 144.2	298.3 → 100.2
Sulfentrazone	4.77	387 → 307.1	387 → 146
Sulfotep-ethyl	7	323 → 115	323 → 171.1
Sulprofos	7	323 → 219	323 → 247
Tebuconazole	7.8	308 → 70	308 → 125
Tebufenozide	7.39	353.1 → 133.1	353.1 → 297.1
Tebufenpyrad	8.56	334 → 117	334 → 145
Tebuthiuron	5.71	229.2 → 172.4	229.2 → 116.1
Teflubenzuron	8.81	381.1 → 141.2	381.1 → 158.2
Terbufos	6.5	289 → 103	289 → 57
Terbumeton	6.84	226 → 170	226 → 114
Terbutryn	7.57	242.2 → 186.1	242.2 → 68.1
Tetraconazole	7.3	372 → 159	372 → 70
Thiabendazole	5.71	202.1 → 175.1	202.1 → 131.2
Thiacloprid	4.89	253.1 → 126.1	253.1 → 99.1
Thiamethoxam	3.06	292 → 211	292 → 181
Thidiazuron	5.18	221.2 → 102.1	221.2 → 127.9
Thiobencarb	8.09	258.1 → 125	258.1 → 89
Thiofanox	5.7	219 → 57.1	219 → 60.9
Thiofanoxsulfon	3.4	251.1 → 75.9	251.1 → 57
Thiofanoxsulfoxid	3.6	235.1 → 104.1	235.1 → 57
Thiophanate-methyl	5.1	343 → 151	343 → 192
Tolclofos-methyl	8	301 → 175	301 → 268.9
Topramezone	1.73	364.1 → 334.1	364.1 → 125
Triadimefon	6.94	294 → 197	294 → 225
Triadimenol	7.04	296.1 → 70.1	296.1 → 227.2
Tricyclazole	5.18	190 → 163	190 → 136
Trifloxystrobin	8.09	409 → 186	409 → 206
Triflumizole	8.47	346 → 278	346 → 73
Triflumuron	7.94	359.1 → 156.2	359.1 → 139
Triticonazole	7.38	318 → 70	318 → 125
Uniconazole	7.4	292.2 → 70.1	292.2 → 43
Vamidothion	3.75	288 → 146	288 → 118
Zoxamide	7.7	336.1 → 186.9	338.1 → 188.7

HPLC Columns (USP L1)

Ultra Aqueous C18 Columns

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

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

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

Pinnacle® DB Aqueous C18 Columns

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

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

RESTEK
Pure Chromatography

Questions about this or any other Restek product?
Contact us or your local Restek representative (www.restek.com/contact-us).

www.restek.com

Lit. Cat.# FFFF1185A-US