

# GC-MS/MS 法同时分析葡萄基质中 213 种农药残留

## GCMSMS-064

**摘要：**参考标准《植物源性食品中 200 种农药残留量的测定气相色谱 - 串联质谱法》草稿，利用岛津的 GCMS-TQ8040 结合农药残留的 Smart MRM 数据库，使用岛津特有的 AART 功能，无需使用标准品建立 GC-MS/MS 同时分析葡萄基质中 213 种农药残留的方法。葡萄空白基质用乙腈提取后，用 QuEChERS 方法净化、氮气吹干后复溶于乙酸乙酯中，分别加内标环氧七氯（浓度 50  $\mu\text{g/L}$ ）和 213 种农药混标（加标浓度为 10  $\mu\text{g/L}$ ），采用 GC-MS/MS 的方法对多种农药残留进行灵敏度和重现性考察。结果表明：葡萄基质中 213 种农药残留色谱峰峰形好，信噪比高，连续进 6 针进行重复性实验，其峰面积相对标准偏差 (RSD%) 均在 13% 以下。

**关键词：**GC-MS/MS 农药残留 葡萄

农药残留问题是目前影响食品安全的首要问题，一直被世界各国政府和组织所关注。随着世界各国对食品中农药残留种类的要求越来越多、最高农药残留限量标准的要求越来越低，研究和建立食品中低浓度 (0.01 mg/kg) 多组分农药的同时分析方法以保证食品的质量与安全促进农产品的出口贸易十分必要。

本文参考即将出台的标准《植物源性食品中 200 种

农药残留量的测定气相色谱 - 串联质谱法》草稿，利用岛津的 GCMS-TQ8040 结合岛津农药残留的 Smart MRM 数据库，使用岛津特有的 AART 功能，无需使用标准品即可建立葡萄中 213 种农药残留的同时检测方法。结果表明，使用岛津 GCMS-TQ8040 同时分析葡萄中 213 种农药（加标浓度为 10  $\mu\text{g/L}$ ）时获得较高灵敏度和较好的重复性。

## 实验部分

### 1.1 仪器

三重四极杆气质联用仪：GCMS-TQ8040

### 1.2 分析条件

色谱柱：VF-1701 ms (30 m $\times$ 0.25 mm $\times$ 0.25  $\mu\text{m}$ )

进样口温度：280 $^{\circ}\text{C}$

柱温程序：40 $^{\circ}\text{C}$  (1 min)-(40 $^{\circ}\text{C}$  /min)-120 $^{\circ}\text{C}$  -

(5 $^{\circ}\text{C}$  /min) -240 $^{\circ}\text{C}$  - (12 $^{\circ}\text{C}$  /min)-300 $^{\circ}\text{C}$  (6 min)

控制方式：恒线速度控制

进样方式：不分流进样

进样时间：1.5 min

进样量：1  $\mu\text{L}$

流速：1.0 mL/min

高压进样：250 kpa(1.5 min)

接口温度：280 $^{\circ}\text{C}$

离子源温度：230 $^{\circ}\text{C}$

检测器电压：调谐电压 +0.8 kv

采集方式：MRM，特征离子见表 1

表1 213种农药组分名称、保留时间及MRM参数

No.	中文名称	英文名称	CAS号	保留时间	定量离子对	CE	定性离子对	CE
1	苯胺	Aniline	62-53-3	5.133	93>66	10	93>65	20
2	硫草敌	Ethiolate	2941-55-1	7.009	161.00>72.10	15	161.00>100.10	9
3	敌敌畏	Dichlorvos	62-73-7	8.716	185.0>93.0	14	185.0>109.0	14
4	乃力松(二溴磷)	Naled	300-76-5	8.717	109.0>79.0	8	184.9>93.0	14
5	联苯	Biphenyl	92-52-4	10.116	154.1>128.1	22	154.1>115.1	24
6	甲胺磷	Methamidophos	10265-92-6	10.532	141.0>95.0	8	141.0>79.0	22
7	敌草腈	Dichlobenil	1194-65-6	11.086	170.9>100.0	24	170.9>136.0	14
8	美文松(速灭磷)	Mevinphos-1	7786-34-7	12.920	192.0>127.0	12	192.0>164.0	4
9	虫螨畏	Methacrifos	62610-77-9	13.232	240.0>208.0	4	240.0>180.0	10
10	地茂散(氯苯甲醚)	Chloroneb	2675-77-6	13.348	206.0>191.0	12	206.0>141.0	20
11	四氯硝基苯	Tecnazene	117-18-0	14.924	260.9>202.9	14	214.9>179	10
12	草灭特(环草敌)	cycloate	1134-23-2	15.264	154>83	10	154>55	20
13	乙酯甲胺磷	Acephate	30560-19-1	15.630	136.0>94.0	14	136.0>42	5
14	六氯苯	Hexachlorobenzene	118-74-1	15.824	283.8>248.8	24	283.8>213.8	28
15	虫线磷	Thionazin		16.008	143.00>79.10	12	175.00>79.10	12
16	灭克磷(灭线磷)	Ethoprophos	13194-48-4	16.349	200.0>158.0	6	158.0>97.0	18
17	梨内二苯胺(二苯胺)	Diphenylamine	122-39-4	16.528	169.1>66.0	24	169.1>77.0	28
18	丁氟消草(乙丁烯氟灵)	Ethalfuralin	55283-68-6	16.713	316.1>276.0	10	276.0>202.0	18
19	丁基灭必虱(仲丁威)	Fenobucarb	3766-81-2	16.786	121>77	20	150.1>121.1	10
20	杀虫唑	chlordimeform free base	6164-98-3	16.877	196>181	10	181>140	15
21	氟草胺(乙丁氟灵)	Benfluralin	1861-40-1	17.142	292.1>264.0	8	292.1>206.0	12
22	残杀威	Propoxur	114-26-1	17.350	152.1>110.1	8	152.1>64.0	28
23	甲拌磷	Phorate	298-02-2	17.452	260.0>75.0	8	231.0>175.0	12

24	硫特普(治螟磷)	Sulfotep	3689-24-5	17,480	322.0>202.0	10	322.0>294.0	4
25	氯苯胺灵	Chlorpropham	101-21-3	17,759	213.1>171.1	6	213.1>127.1	14
26	alpha-六六六	alpha-HCH	319-84-6	18,043	218.9>182.9	8	218.9>144.9	20
27	五氯硝基苯	Quintozene	82-68-8	18,139	294.8>236.8	16	264.8>236.8	10
28	甲基乙拌磷	Thiometon	640-15-3	18,370	125.0>47.0	14	125.0>79.0	10
29	氧化乐果	Omethoate	1113-02-6	18,837	156.0>110.0	8	110.0>79.0	10
30	内吸磷	demeton(O&S)	8065-48-3	18,950	88>60	5	126>65	10
31	阿特拉拉通	Atraton	1610-17-9	18,955	211.00>169.20	6	211.00>154.10	15
32	二嗪农(二嗪磷)	Diazinon	333-41-5	18,973	304.1>179.1	10	179.1>137.1	18
33	杀螨特	Aramite-1	140-57-8	18,985	135.0>107.0	12	135.0>77.0	22
34	野麦畏	Tri-allate	2303-17-5	19,116	268.1>226.0	14	268.1>184.0	20
35	广灭灵(异噁草酮)	Clomazone	81777-89-1	19,163	204.1>107.0	20	204.1>78.0	26
36	环丙氟灵	Profluralin	26399-36-0	19,250	318.00>199.10	18	318.00>55.10	18
37	百治磷	Dicrotophos	141-66-2	19,352	127.1>109.0	12	127.1>95.0	18
38	大福松(地虫磷)	Fonofos	944-22-9	19,419	246.0>109.1	18	246.0>137.1	6
39	噁霉胺	Pyrimethanil	53112-28-0	19,450	198.1>183.1	14	198.1>158.1	18
40	噁丙磷(丁基噁啉磷)	Tebupirimfos	96182-53-5	19,505	318.1>152.1	14	318.1>234.1	12
41	gamma-六六六(林丹)	gamma-HCH (Lindane)	58-89-9	19,720	218.9>182.9	8	218.9>144.9	20
42	敌杀磷(敌噁磷)	Dioxathion	78-34-2	19,730	125>97	5	153>97	10
43	益多松(乙噁硫磷)	Etrimfos	38260-54-7	19,870	292.1>181.1	8	292.1>153.1	20
44	扑灭津	Propazine	139-40-2	19,920	229.1>187.1	6	229.1>58.0	14
45	加保扶(克百威)	Carbofuran	1563-66-2	19,949	164.1>149.1	8	149.1>121.1	10
46	莠去津	Atrazine	1912-24-9	20,053	215.1>58.0	14	215.1>200.1	6
47	西玛津	Simazine	122-34-9	20,163	201.1>173.1	6	201.1>186.1	6
48	氯硝胺	Dicloran	99-30-9	20,165	206.0>176.0	10	176.0>148.0	12
49	巴胺磷(胺丙畏)	Propentamphos	31218-83-4	20,259	236.1>194.0	6	236.1>166.0	16

50	特丁津	Terbutylazine	5915-41-3	20.323	214.00>71.10	18	229.00>173.10	6
51	八甲磷	Schradan	152-16-9	20.337	243.00>153.10	12	199.00>135.10	18
52	氟谷隆	monolinuron	1746-81-2	20.615	214>61	10	126>99	15
53	异稻瘟净(丙基喜乐松)	Kitazine (Iprobenfos)	26087-47-8	20.742	204.0>91.0	8	204.0>122.0	12
54	异丙三唑硫磷(氯唑磷)	Isazofos	42509-80-8	20.851	257.0>162.0	8	257.0>119.0	18
55	除线磷	Dichlofenthion	97-17-6	20.852	279.0>222.9	14	222.9>204.9	14
56	五氯苯胺	Pentachloroaniline	527-20-8	20.872	262.80>191.90	21	264.80>193.90	21
57	抗蚜威	Pirimicarb	23103-98-2	20.931	238.1>166.1	12	166.1>55.0	20
58	炔敌稗(炔苯酰草胺)	Propyzamide	23950-58-5	21.034	172.9>144.9	16	172.9>74.0	28
59	亚素灵(久效磷)	Monocrotophos	6923-22-4	21.235	127.1>109.0	12	127.1>95.0	16
60	甲基毒死蜱	Chlorpyrifos-methyl	5598-13-0	21.341	285.9>93.0	22	285.9>270.9	14
61	乐果	Dimethoate	60-51-5	21.513	125.0>79.0	8	125.0>47.0	14
62	艾氏剂	Aldrin	309-00-2	21.617	262.9>193.0	28	254.9>220.0	20
63	乙草胺	Acetochlor	34256-82-1	21.784	223.1>132.1	22	174.1>146.1	12
64	皮蝇磷	Fenchlorphos	299-84-3	21.838	284.9>269.9	16	284.9>93.0	24
65	敌草净	Desmetryn	1014-69-3	21.927	213.00>171.10	6	213.00>58.10	18
66	甲基立枯磷	Tolclofos-methyl	57018-04-9	21.985	264.9>249.9	14	264.9>93.0	24
67	异丙草胺	Propisochlor	86763-47-5	22.166	162.00>120.10	18	162.00>147.10	18
68	拉草(甲草胺)	Alachlor	15972-60-8	22.178	188.1>160.1	10	188.1>132.1	18
69	甲基噁啶磷	Pyrimiphos-methyl	29232-93-7	22.355	305.1>180.1	8	305.1>290.1	12
70	扑草净	Prometryn	7287-19-6	22.379	241.2>199.1	6	241.2>58.0	14
71	莠灭净	Ametryn	834-12-8	22.542	227.1>170.1	14	227.1>185.1	6
72	免克宁(乙炔菌核利)	Vinclozolin	50471-44-8	22.643	285.0>212.0	12	212.0>172.0	16
73	beta-六六六	beta-HCH	319-85-7	22.768	218.9>182.9	8	218.9>144.9	20
74	噁草酮	Metribuzin	21087-64-9	22.824	198.1>82.0	14	198.1>110.1	10
75	毒死蜱	Chlorpyrifos	2921-88-2	22.881	313.9>257.9	14	313.9>285.9	8

76	去草净(特丁净)	Terbutryn	886-50-0	22.900	241.2>185.1	6	241.2>170.1	14
77	甲霜灵	Metaxyl (Mefenoxam)	57837-19-1	22.912	249.2>190.1	8	206.1>132.1	20
78	杀丹(禾草丹)	Thiobencarb	28249-77-6	23.059	257.1>100.0	8	125.0>89.0	18
79	毒壤磷	Trichloronat	327-98-0	23.226	297.00>269.00	15	299.00>271.00	15
80	异丙净	Dipropetryn	4147-51-7	23.271	255.00>222.20	9	255.00>180.20	18
81	磷胺	Phosphamidon	13171-21-6	23.388	264.1>127.1	14	127.1>109.1	12
82	异丙甲草胺	Metolachlor (S-Metolachlor)	51218-45-2	23.562	238.1>162.1	12	238.1>133.1	26
83	乙基虫螨磷/啉啉磷	pirimiphos-ethyl	23505-41-1	23.625	304>168	10	318>166	15
84	delta-六六六	delta-HCH	319-86-8	23.669	218.9>182.9	10	218.9>144.9	20
85	福木松(安果)(安硫磷)	Formothion	2540-82-1	23.676	224.0>125.0	18	170.0>93.0	8
86	三氯杀螨醇 分解物	Dicofol deg. (DCBP)	0-00-0	23.799	250.0>139.0	14	139.0>111.0	16
87	倍硫磷	Fenthion	55-38-9	23.875	278.0>109.0	20	278.0>125.0	20
88	马拉硫磷	Malathion	121-75-5	23.912	173.1>99.0	14	173.1>127.0	6
89	溴硫磷	Bromophos	2104-96-3	23.922	330.9>315.9	14	330.9>285.9	28
90	乙霉威	Diethofencarb	87130-20-9	23.971	267.1>225.1	8	267.1>168.1	18
91	杀螟硫磷	Fenitrothion	122-14-5	24.142	277.0>260.0	6	277.0>109.1	14
92	啞菌环胺	Cyprodinil	121552-61-2	24.249	224.1>208.1	16	224.1>197.1	22
93	环氧七氯 (exo)	Heptachlor-exo-epoxide	1024-57-3	24.3	352.8>262.9	14	352.8>281.9	12
94	乙味草黄(乙氧味草黄)	Ethofumesate	26225-79-6	24.425	286.1>207.1	8	207.1>161.1	8
95	氧异柳磷	Isofenphos oxon	31120-85-1	24.676	229.1>201.0	10	229.1>121.0	26
96	二甲戊乐灵(二甲戊灵)	Pendimethalin	40487-42-1	24.732	252.1>162.1	10	251.8>161.1	15
97	三泰芬(三唑酮)	Triadimefon	43121-43-3	24.734	208.1>181.0	10	208.1>127.0	14
98	对硫磷	Parathion	56-38-2	24.896	291.1>109.0	14	291.1>137.0	6
99	(E)-毒虫畏	(E)-Chlorfenvinphos	470-90-6	24.905	323.0>267.0	16	267.0>159.0	18
100	o,p'-DDE	o,p'-DDE	3424-82-6	24.922	246.0>176.0	30	246.0>211.0	22
101	甲基异柳磷	Isofenphos-methyl	99675-03-3	24.947	199.0>121.0	14	241.1>121.1	22

102	乙基溴硫磷	Bromophos-ethyl	4824-78-6	25.190	358.9>302.9	16	358.9>330.9	10
103	亚芬松(异柳磷)	Isofenphos	25311-71-1	25.273	213.1>121.1	14	213.1>185.1	6
104	alpha-硫丹	alpha-Endosulfan	959-98-8	25.318	194.9>160.0	8	194.9>125.0	24
105	敌稗	Propanil	709-98-8	25.438	160.9>99.0	24	160.9>90.0	22
106	啶硫磷	Quinalphos	13593-03-8	25.450	157.1>129.0	14	146.1>118.0	10
107	(Z)-毒虫畏	(Z)-Chlorfenvinphos	470-90-6	25.460	323.0>267.0	16	267.0>159.0	18
108	水胺硫磷	Isocarbophos	24353-61-5	25.508	289.1>136.0	14	230.0>212.0	10
109	反-氯丹	trans-Chlordane	5103-74-2	25.539	372.8>336.8	10	374.8>265.9	26
110	平克座(戊菌唑)	Penconazole	66246-88-6	25.731	248.1>192.1	14	248.1>157.1	26
111	甲拌磷砒	甲拌磷砒	2588-04-7	26.039	125>97	9	153.00>125.00	6
112	四克利(四氟醚唑)	Tetraconazole	112281-77-3	26.069	336.0>218.0	14	336.0>204.0	28
113	丁基拉草(丁草胺)	Butachlor	23184-66-9	26.102	188.1>160.1	12	176.1>147.1	14
114	噻唑磷-1	Fosthiazate-1	98886-44-3	26.204	195.0>103.0	10	195.0>139.0	6
115	p,p'-DDE	p,p'-DDE	72-55-9	26.213	246.0>176.0	30	246.0>211.0	22
116	噻唑磷-2	Fosthiazate-2	98886-44-3	26.304	195.0>103.0	10	195.0>139.0	6
117	普硫松(丙硫磷)	Prothiofos	34643-46-4	26.305	309.0>238.9	14	309.0>280.9	10
118	苯硫威	Fenothiocarb	62850-32-2	26.377	160.1>72.0	10	160.1>106.1	12
119	加护松(丙虫磷)	Propaphos	7292-16-2	26.607	304.1>140.1	26	304.1>220.1	14
120	噁菌胺/灭派林	mepanipyrim	110235-47-7	26.614	222>207	20	223>207	25
121	巴毒磷	Crotoxypfos	7700-17-6	26.622	193.00>127.00	9	127.00>109.00	15
122	脱叶磷	Tribufos	78-48-8	26.637	258.0>202.0	4	258.0>147.0	10
123	杀虫威	Tetrachlorvinphos	22248-79-9	26.674	328.9>109.0	20	328.9>313.9	18
124	狄氏剂(地特灵)	Dieldrin	60-57-1	26.726	276.9>241.0	8	262.9>193.0	34
125	特丁硫磷砒	Terbufos sulfone	13071-79-9	26.813	153.00>97.00	21	199.00>97.00	21
126	腐霉利	Procymidone	32809-16-8	26.880	283.0>96.0	10	283.0>255.0	12
127	氟丁酰草胺	Beflubutamid	113614-08-7	26.903	176.00>91.10	15	221.00>193.00	12

128	除草定	Bromacil	314-40-9	26.916	204.9>187.9	14	204.9>162.0	14
129	三唑乙醇-1(三唑醇)	Triadimenol-1	55219-65-3	26.990	168.1>70.0	10	128.1>65.0	22
130	溴苯烯磷	Bromfeninfos	33399-00-7	26.995	267.00>159.00	15	269.00>161.00	21
131	杀扑磷	Methidathion	950-37-8	27.038	145.0>85.0	8	145.0>58.0	14
132	丙溴磷	Profenofos	41198-08-7	27.089	336.9>266.9	14	338.9>268.9	18
133	普拉草(丙草胺)	Pretilachlor	51218-49-6	27.132	262.1>202.1	10	262.1>174.1	18
134	o,p'-DDD	o,p'-DDD	53-19-0	27.300	235.0>165.0	24	237.0>165.0	28
135	萘丙酰草胺(敌草胺)	Napropamide	15299-99-7	27.327	128.1>72.0	6	128.1>57.0	12
136	甲基克收欣(醚菌酯)	Kresoxim-methyl	143390-89-0	27.366	206.1>116.1	6	206.1>131.1	14
137	异狄氏剂	Endrin	72-20-8	27.450	262.9>191.0	30	244.9>173.0	32
138	乐灭草(噁草酮)	Oxadiazon	19666-30-9	27.460	258.0>175.0	8	258.0>112.0	28
139	己唑醇	Hexaconazole	79983-71-4	27.462	214.0>172.0	20	214.0>159.0	20
140	丁胺磷(抑草磷)	Butamifos	36335-67-8	27.485	286.1>202.1	14	286.1>185.0	30
141	杀螨脂	Chlorfenson	80-33-1	27.749	301.9>175.0	8	301.9>111.0	24
142	克线磷(苯线磷)	Fenamiphos	22224-92-6	27.757	303.1>195.1	8	303.1>154.1	18
143	o,p'-DDT	o,p'-DDT	789-02-6	27.792	235.0>165.0	24	235.0>199.0	16
144	烯菌灵(抑霉唑)	Imazalil	35554-44-0	27.853	215.0>173.0	6	217.0>175.0	6
145	吡氟禾草灵	Fluazifop-butyl	69806-50-4	27.860	282.00>91.10	18	282.00>238.10	18
146	多效唑	Pacllobutrazol	76738-62-0	27.868	236.1>125.0	14	236.1>167.0	10
147	虫螨磷-1	Chlorthiophos-1	60238-56-4	27.914	256.9>239.0	14	256.9>193.0	22
148	稻瘟灵	Isoprothiolane	50512-35-1	28.028	290.1>118.0	14	290.1>204.1	6
149	地胺磷	Mephosfolan	950-10-7	28.090	256.00>170.10	21	256.00>212.20	15
150	甲氧丙净	Methoprotryne	841-06-5	28.092	256.00>170.10	21	256.00>212.10	15
151	硫环磷	Phosfolan	947-02-4	28.179	255.0>227.0	6	255.0>140.0	22
152	虫螨磷-2	Chlorthiophos-2	60238-56-4	28.201	324.9>268.9	14	324.9>296.9	8
153	布瑞莫(乙啶酚磺酸酯)	Bupirimate	41483-43-6	28.290	273.1>193.1	8	273.1>150.1	8

154	杀磷酯(乙酯杀磷醇)	Chlorobenzilate	510-15-6	28.404	251.0>139.0	14	251.0>111.0	28
155	乙氧氟草醚	Oxyfluorfen	42874-03-3	28.589	361.0>300.0	14	252.0>196.0	22
156	除草醚	Nitrofen	18336-75-5	28.628	282.9>162.0	24	202.0>139.0	24
157	虫螨磷-3	Chlorthiophos-3	60238-56-4	28.648	324.9>268.9	14	324.9>296.9	8
158	萎锈灵	Carboxin	5234-68-4	28.703	235.1>143.0	12	235.1>87.0	24
159	福多宁(氟酰胺)	Flutolanil	66332-96-5	28.739	173.0>145.0	14	173.0>95.0	26
160	p,p'-DDD	p,p'-DDD	72-54-8	28.842	235.0>165.0	24	237.0>165.0	22
161	乙拌磷砒(乙拌砒)	Disulfoton sulfone	2497-06-5	28.893	213.0>153.1	6	213.0>125.0	12
162	爱杀松(乙硫磷)	Ethion	563-12-2	28.904	230.9>174.9	14	230.9>184.9	12
163	beta-硫丹	beta-Endosulfan	33213-65-9	28.955	194.9>160.0	8	194.9>125.0	24
164	硫丙磷	Sulprofos	35400-43-2	29.061	322.0>156.0	8	322.0>97.0	24
165	苯氧喹啉(啞氧灵)	Quinoxifen	124495-18-7	29.113	237.1>208.1	28	307.1>272.1	8
166	三氯硝草醚	Fluorodifen	15457-05-3	29.233	190.00>126.00	12	190.00>146.00	6
167	烯唑醇	Diniconazole	83657-24-3	29.251	268.0>232.0	12	268.0>149.0	24
168	脞菌酯	Trifloxystrobin	141517-21-7	29.281	222.1>190.1	4	222.1>162.1	10
169	p,p'-DDT	p,p'-DDT	50-29-3	29.285	235.0>165.0	24	237.0>165.0	26
170	苯草醚	Aclonifen	74070-46-5	29.296	212.00>182.10	15	264.00>194.10	18
171	三硫磷	Carbophenothion	786-19-6	29.363	341.9>157.0	14	157.0>45.0	18
172	灭克落(脞菌唑)	Myclobutanil	88671-89-0	29.429	179.1>125.0	14	179.1>152.0	8
173	环唑醇-1(环丙唑醇)	Cyproconazole-1	94361-06-5	29.451	222.1>125.1	24	222.1>82.0	12
174	本达乐(苯霜灵)	Benalaxyl	71626-11-4	29.476	148.1>105.1	16	148.1>133.1	14
175	环唑醇-2(环丙唑醇)	Cyproconazole-2	94361-06-5	29.490	222.1>125.1	24	222.1>82.0	12
176	胡椒基丁醚(增效醚)	Piperonyl butoxide	51-03-6	29.496	176.1>131.1	12	176.1>117.1	20
177	氟虫脞	Fipronil	120068-37-3	29.578	366.9>212.9	30	366.9>214.9	30
178	丙环唑-1	Propiconazole-1	60207-90-1	29.799	173.0>145.0	16	259.0>69.0	14
179	克温散(敌瘟磷)	Editfenphos	17109-49-8	29.865	310.0>173.0	14	310.0>109.0	26

180	禾草灵	Diclofop-methyl	51338-27-3	29.882	340.0>253.0	14	340.0>281.0	10
181	丙环唑-2	Propiconazole-2	60207-90-1	29.913	173.0>145.0	16	259.0>69.0	14
182	联苯菊酯(氟氯菊酯)	Bifenthrin	82657-04-3	30.103	181.1>166.1	12	181.1>153.1	8
183	三唑磷	Triazophos	24017-47-8	30.148	257.0>162.0	8	257.0>134.0	22
184	吡螨胺(吡螨胺)	Tebufenpyrad	119168-77-3	30.609	333.1>171.1	20	333.1>276.1	8
185	乙螨唑	Etoxazole	153233-91-1	30.802	359.1>187.1	14	359.1>340.1	12
186	溴螨酯	Bromopropylate	18181-80-1	30.822	340.9>182.9	18	340.9>184.9	20
187	咯菌腈	Fludioxonil	131341-86-1	30.827	248.0>182.0	14	248.0>154.0	20
188	胺菊酯-1	Tetramethrin-1	7696-12-0	30.834	164.1>107.1	14	164.1>135.1	8
189	啶杀斯(噁霜灵)	Oxadixyl	77732-09-3	30.857	163.1>132.1	8	163.1>117.1	24
190	氟环唑	Epoxiconazole	106325-08-0	30.906	192.0>138.0	14	192.0>111.0	26
191	胺菊酯-2	Tetramethrin-2	7696 - 12 - 0	31.004	164.1>107.1	14	164.1>135.1	8
192	芬普宁(甲氧菊酯)	Fenpropathrin	39515-41-8	31.057	265.1>210.1	12	181.1>152.1	22
193	戊唑醇	Tebuconazole	107534-96-3	31.073	250.1>125.1	22	250.1>153.1	12
194	吡丙醚	Pyriproxyfen	95737-68-1	31.266	136.1>96.0	14	136.1>78.0	20
195	溴苯磷	Leptophos	21609-90-5	31.323	376.9>361.9	24	376.9>268.9	36
196	呋草磷	Piperophos	24151-93-7	31.403	320.1>122.1	14	140.1>98.0	12
197	必芬松(哒嗪硫磷)	Pyridaphenthion	119-12-0	31.456	340.0>199.1	8	340.0>109.1	22
198	苯硫磷	EPN	2104-64-5	31.486	169.1>140.9	8	169.1>77.0	22
199	环磷酮	Hexazinone	51235-04-2	31.550	171.1>71.0	16	171.1>85.0	16
200	咪唑菌酮	Fenamidone	161326-34-7	31.567	268.1>180.1	16	268.1>77.0	28
201	四氯杀磷砷(三氯杀磷砷)	Tetradifon	116-29-0	31.867	355.9>228.9	12	355.9>159.0	18
202	比芬诺(甲羧除草醚)	Bifenox	42576-02-3	31.894	340.9>309.9	10	340.9>280.9	12
203	异菌脲(依普同)	Iprodione	36734-19-7	31.958	243.9>187	5	187>124	25
204	氟氧氟菊酯-1	Cyhalothrin-1	68085 - 85 - 8	32.017	197.0>161.0	8	197.0>141.0	12
205	氟氧氟菊酯-2	Cyhalothrin-2	68085 - 85 - 8	32.287	197.0>161.0	8	197.0>141.0	12

206	伏杀磷	Phosalone	2310-17-0	32.322	182.0>111.0	14	182.0>138.0	8
207	氟菊酯-1	Permethrin-1	52645-53-1	32.337	183.1>168.1	14	183.1>165.1	14
208	定菌磷(吡菌磷)	Pyrazophos	13457-18-6	32.455	221.1>149.1	14	221.1>193.1	12
209	灭芬草(苯噻酰草胺)	Mefenacet	73250-68-7	32.473	192.0>136.0	14	192.0>109.0	24
210	氟菊酯-2	Permethrin-2	52645-53-1	32.572	183.1>168.1	14	183.1>165.1	14
211	苯胺磷砒(苯线磷砒)	fenamiphos-sulfone	31972-44-8	32.623	320>292	10	320>214	15
212	氟苯嘧啶醇	Fenarimol	60168-88-9	32.635	251.0>139.0	14	251.0>111.0	26
213	吡唑硫磷	Pyraclofos	77458-01-6	32.944	360.1>194.0	14	360.1>139.0	14
214	吡蚜灵	Pyridaben	96489-71-3	32.945	147.1>117.1	22	147.1>132.1	14
215	乙基谷硫磷(益棉磷)	Azinphos-ethyl	2642-71-9	33.053	160.1>132.1	4	160.1>77.0	18
216	氟唑啞	Fluquinconazole	136426-54-5	33.495	340.0>298.0	20	340.0>313.0	14
217	氟氧氟菊酯-1	Cyfluthrin-1	68359-37-5	34.042	226.1>206.1	14	226.1>199.1	6
218	氟氧氟菊酯-2	Cyfluthrin-2	68359-37-5	34.291	226.1>206.1	14	226.1>199.1	6
219	氟氧氟菊酯-3	Cyfluthrin-3	68359-37-5	34.357	226.1>206.1	14	226.1>199.1	6
220	蝇毒磷	Coumaphos	56-72-4	34.427	362.0>109.0	16	362.0>226.0	14
221	氟氧氟菊酯-4	Cyfluthrin-4	68359 - 37 - 5	34.505	226.1>206.1	14	226.1>199.1	6
222	氟氧氟菊酯(氟氧戊菊酯)-1	Flucythrinate-1	70124-77-5	34.981	199.1>157.1	10	199.1>107.1	22
223	啶酰菌胺	Boscalid	188425-85-6	35.329	342.1>140.1	14	342.1>112.1	28
224	氟氧氟菊酯(氟氧戊菊酯)-2	Flucythrinate-2	70124-77-5	35.353	199.1>157.1	10	199.1>107.1	22
225	腈苯唑	Fenbuconazole	114369-43-6	35.607	198.1>129.1	10	198.1>102.1	24
226	氟戊菊酯-1	Fenvalerate-1	51630-58-1	35.918	419.1>225.1	6	419.1>167.1	12
227	氟戊菊酯-2	Fenvalerate-2 (Esfenvalerate)	51630-58-1	36.389	419.1>225.1	6	419.1>167.1	12
228	氟胺氟菊酯-1	Fluvalinate-1	102851-06-9	36.609	250.1>55.0	20	250.1>200.0	20
229	氟胺氟菊酯-2	Fluvalinate-2	102851-06-9	36.744	250.1>55.0	20	250.1>200.0	20
230	溴氧氟菊酯-1	Deltamethrin-1 (Tralomethrin deg.-1)	52918 - 63 - 5	37.130	252.9>93.0	20	252.9>171.9	8
231	苯醚甲环唑-1	Difenoconazole-1	119446-68-3	37.264	323.0>265.0	14	323.0>202.0	28
232	苯醚甲环唑-2	Difenoconazole-2	119446-68-3	37.352	323.0>265.0	14	323.0>202.0	28
233	溴氧氟菊酯-2	Deltamethrin-1 (Tralomethrin deg.-1)	52918 - 63 - 5	37.716	252.9>93.0	20	252.9>171.9	8

备注：中文名称中部分农药带 () 为同一农药在岛津MRM农残数据库中的名称和的农药名称

### 1.3 样品前处理

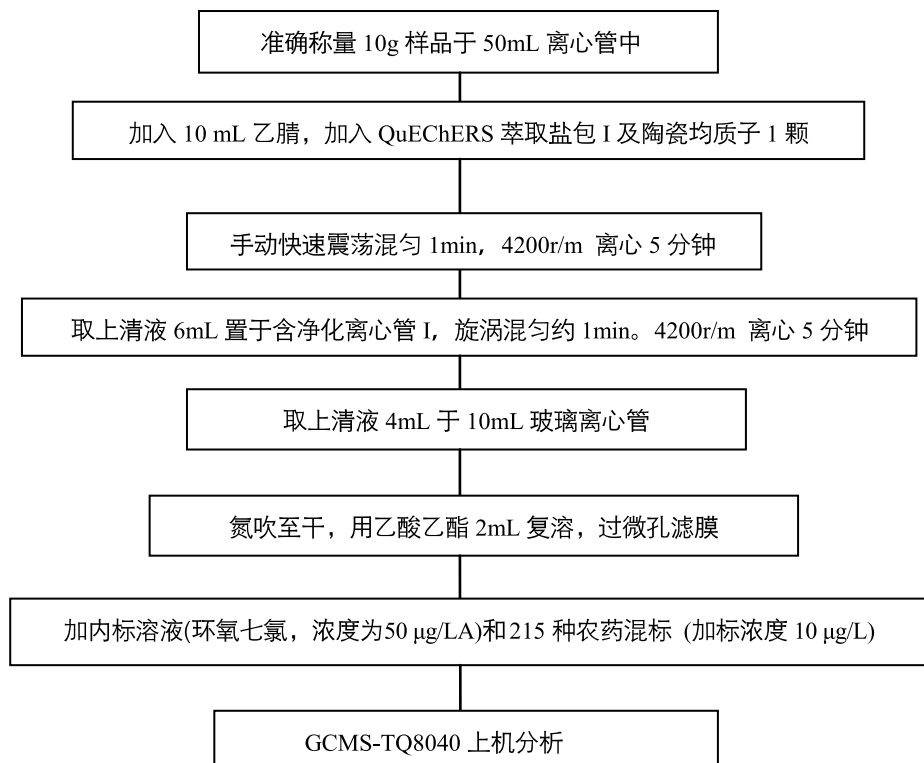


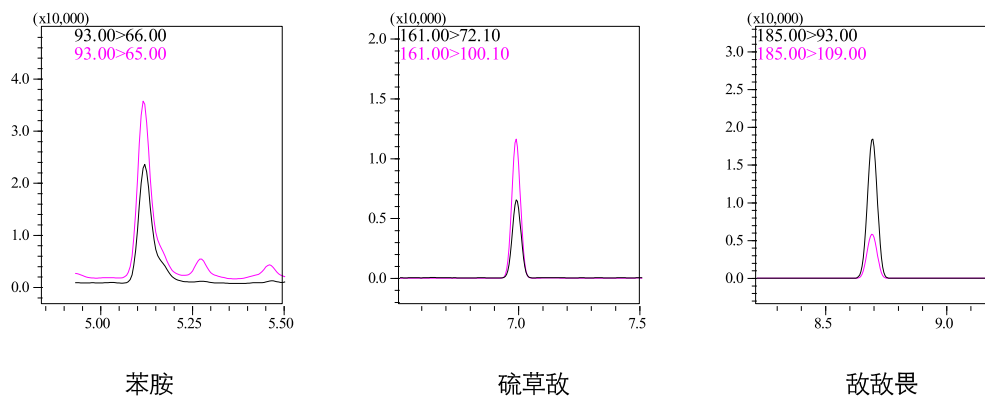
图1 前处理流程

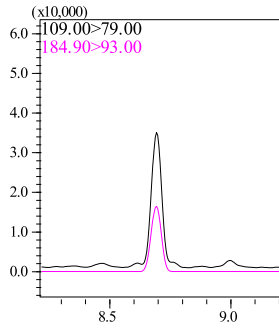
注：QuEChERS 萃取盐包 I：含无水硫酸镁 4 g、氯化钠 1 g、柠檬酸钠 1 g 及柠檬酸氢二钠 0.5 g，岛津 GL 提供；净化离心管 I：含无水硫酸镁 900 mg 及 PSA 150 mg，岛津 GL 提供。

## 结果讨论

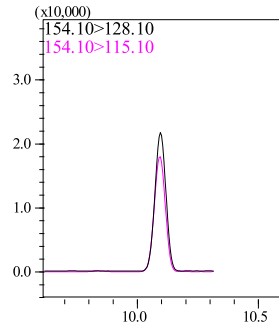
### 2.1 葡萄基质中 213 种农药残留 (浓度为 10 µg/L) 灵敏度考察

葡萄基质中 213 种农药残留 (浓度为 10 µg/L) 的质量色谱图见图 1。

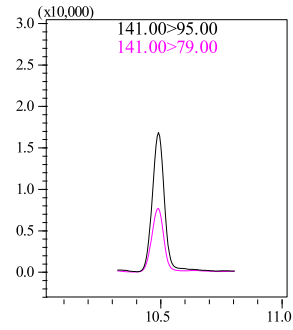




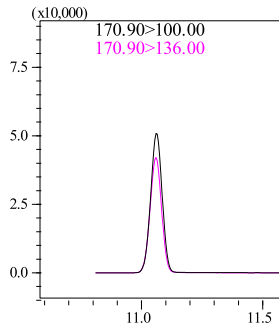
乃力松(二溴磷)



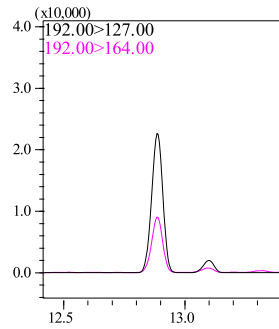
联苯



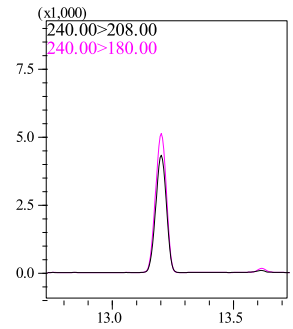
甲胺磷



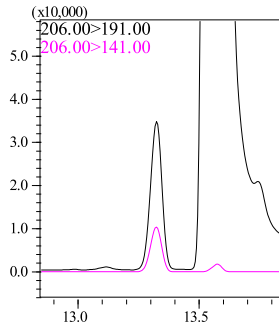
敌草腈



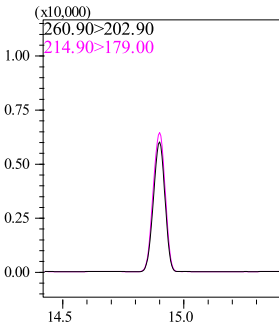
美文松



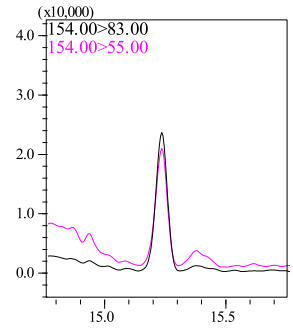
虫螨畏



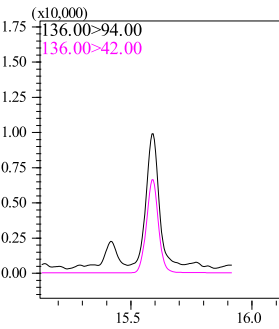
地茂散(氯苯甲醚)



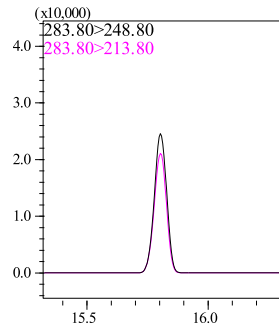
四氯硝基苯



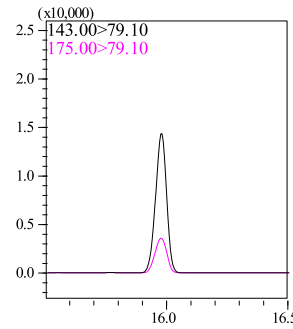
草灭特(环草敌)



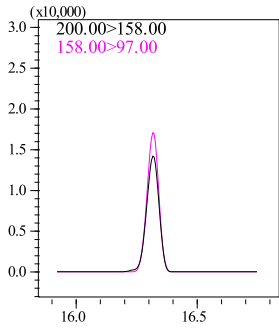
乙酰甲胺磷



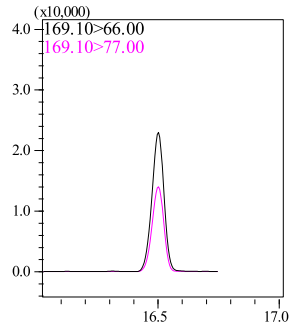
六氯苯



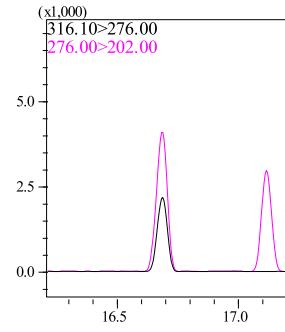
虫线磷



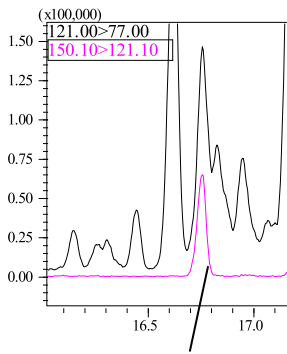
灭克磷(灭线磷)



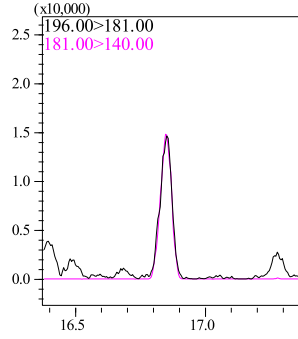
梨内二苯胺(二苯胺)



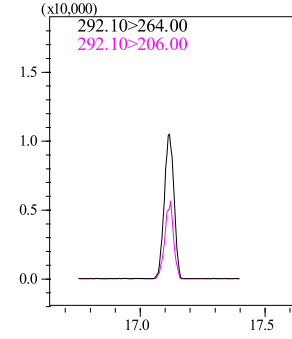
丁氟消草(乙丁烯氟灵)



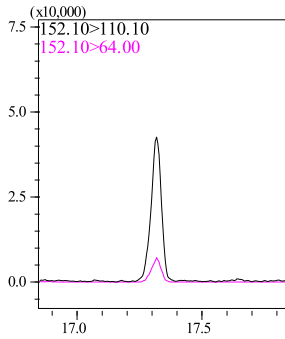
丁基灭必虱(仲丁威)



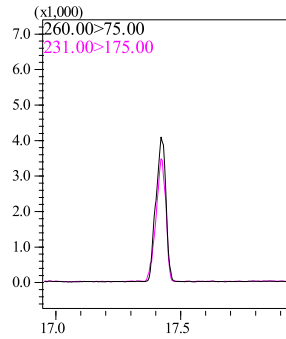
杀虫脒



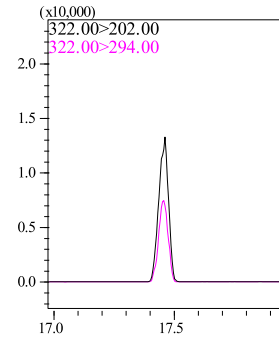
氟草胺(乙丁氟灵)



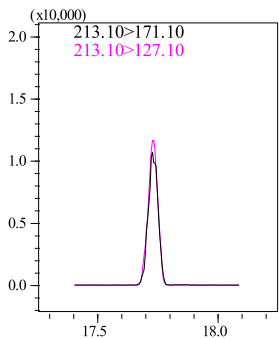
残杀威



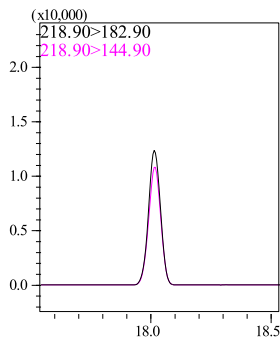
甲拌磷



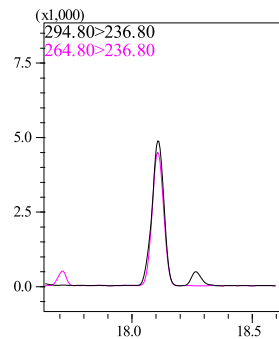
硫特普(治螟磷)



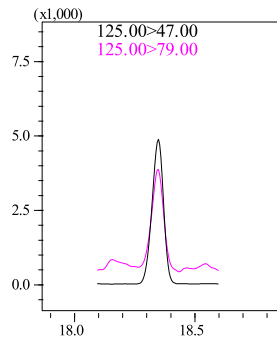
氯苯胺灵



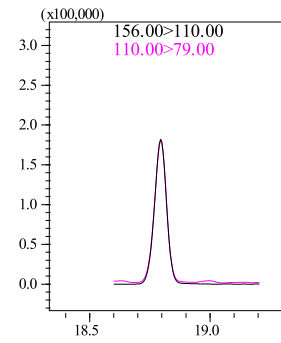
alpha-六六六



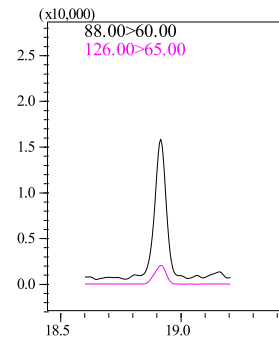
五氯硝基苯



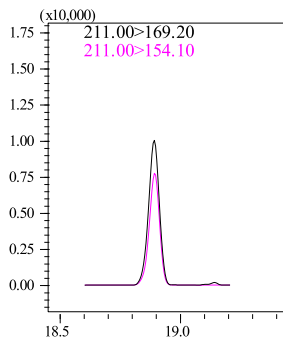
甲基乙拌磷



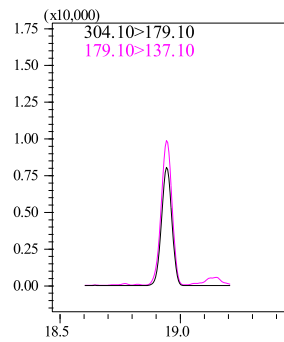
氧化乐果



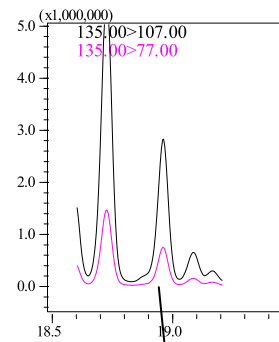
内吸磷



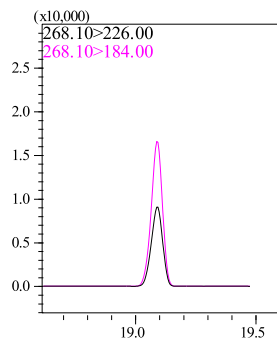
阿特拉通



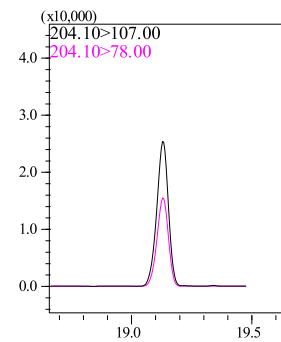
二嗪农(二嗪磷)



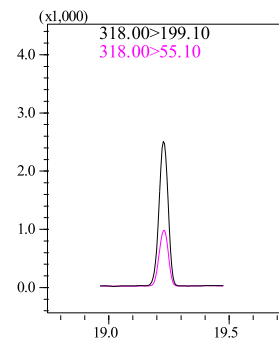
杀螨特



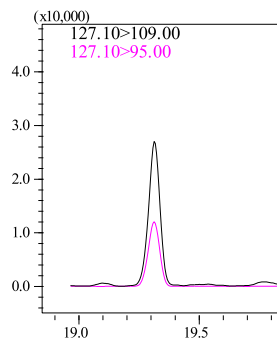
野麦畏



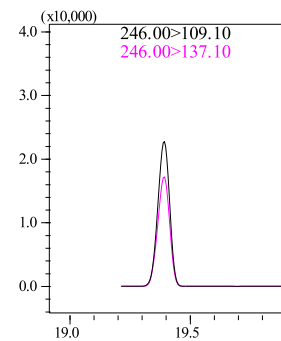
广灭灵(异噁草酮)



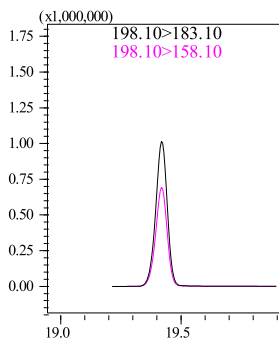
环丙氟灵



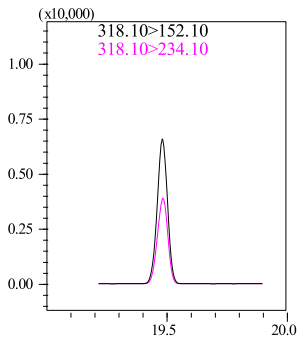
百治磷



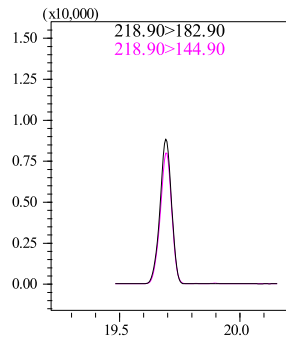
大福松(地虫磷)



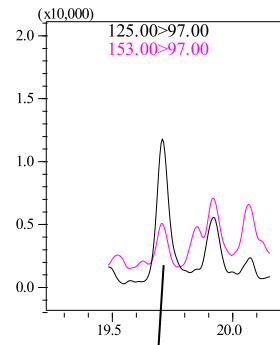
啞霉胺



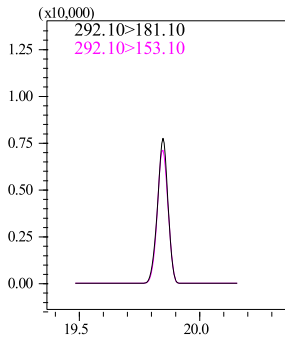
啉丙磷(丁基嘧啶磷)



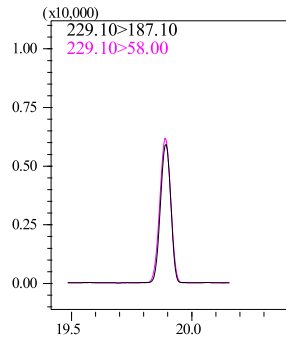
gamma-六六六(林丹)



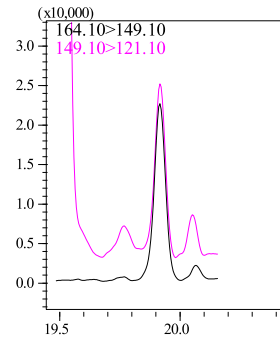
敌杀磷 (敌噠磷)



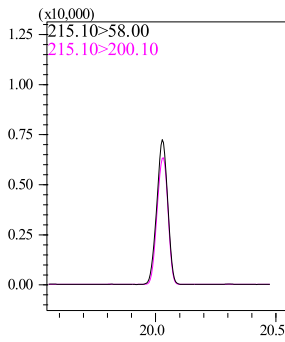
益多松(乙嘧硫磷)



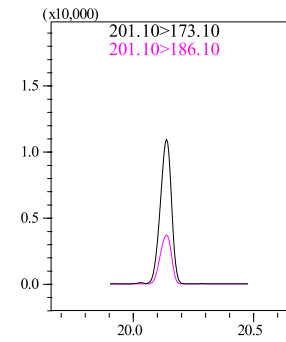
扑灭津



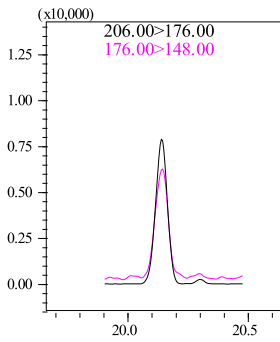
加保扶(克百威)



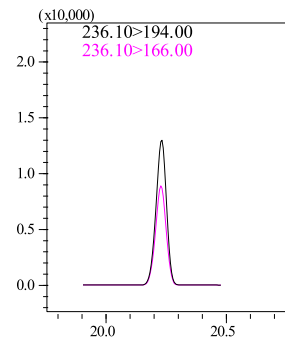
莠去津



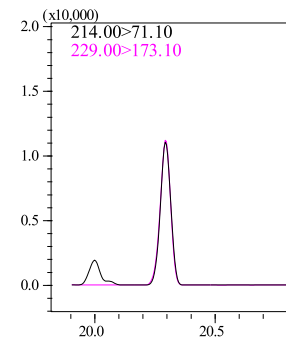
西玛津



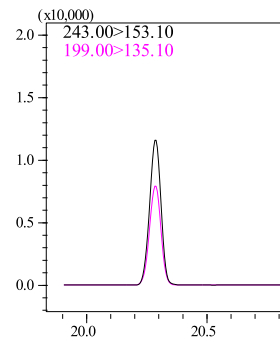
氯硝胺



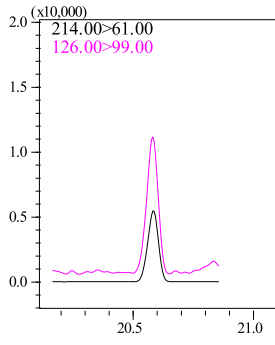
巴胺磷(胺丙畏)



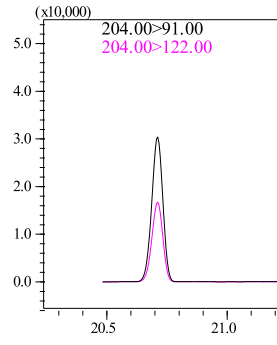
特丁津



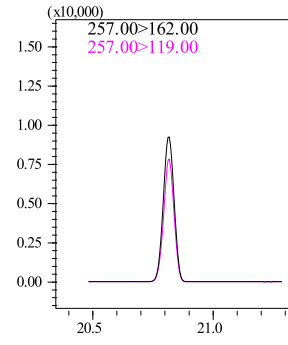
八甲磷



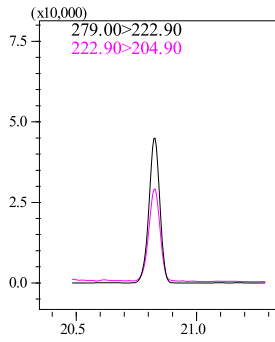
氯谷隆



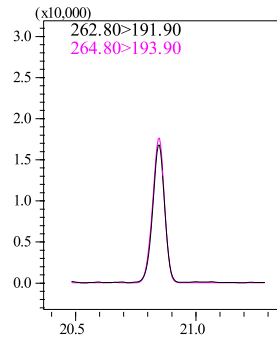
异稻瘟净(丙基喜乐松)



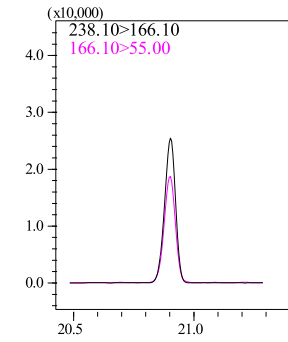
异丙三唑硫磷(氯唑磷)



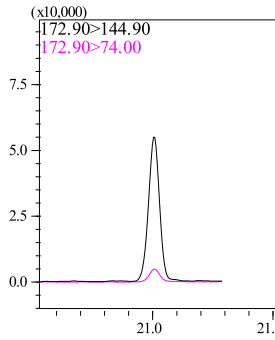
除线磷



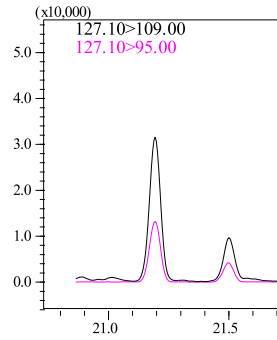
五氯苯胺



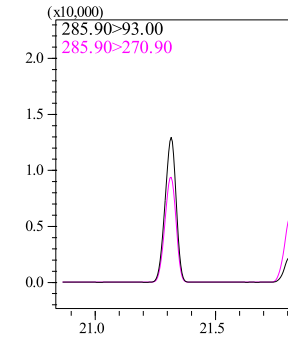
抗蚜威



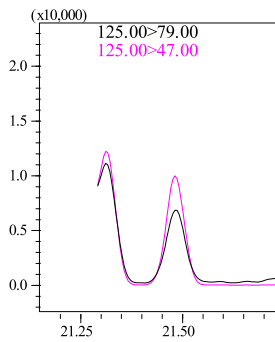
快敌稗(快苯酰草胺)



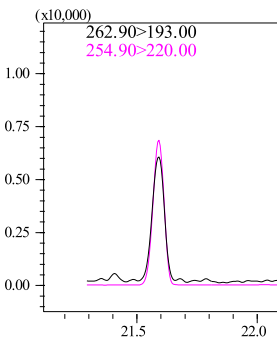
亚素灵(久效磷)



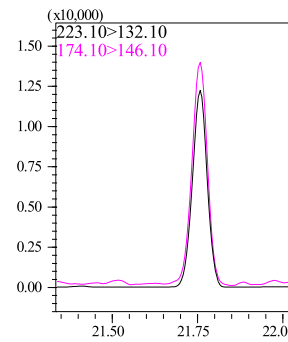
甲基毒死蜱



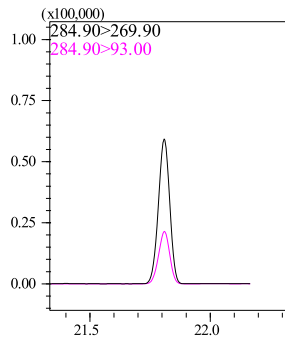
乐果



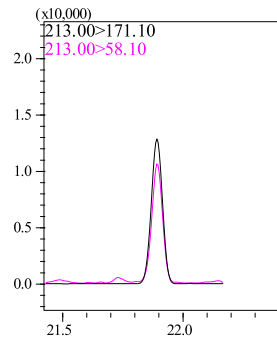
艾氏剂



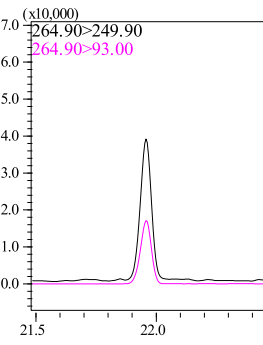
乙草胺



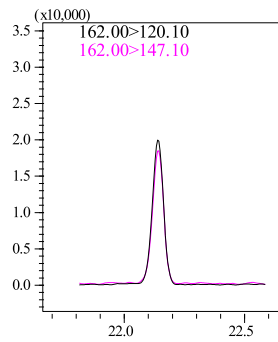
皮蝇磷



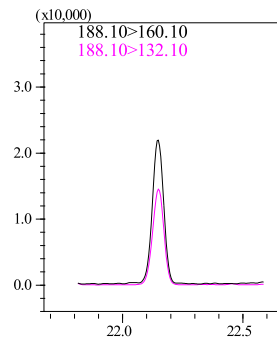
敌草净



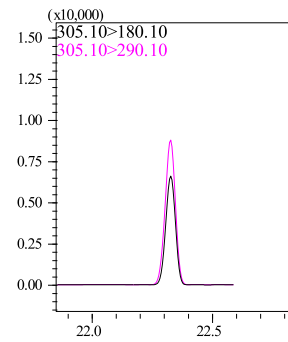
甲基立枯磷



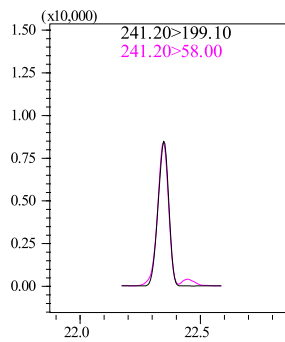
异丙草胺



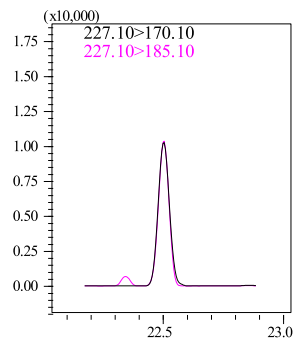
拉草(甲草胺)



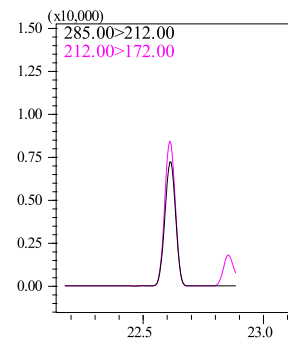
甲基嘧啶磷



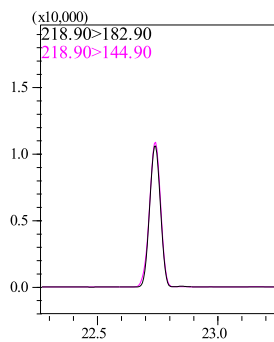
扑草净



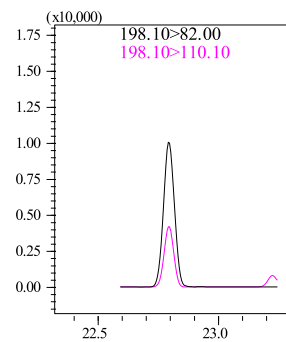
莠灭净



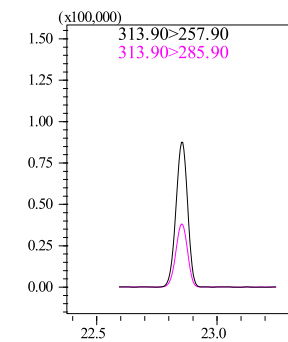
免克宁(乙烯菌核利)



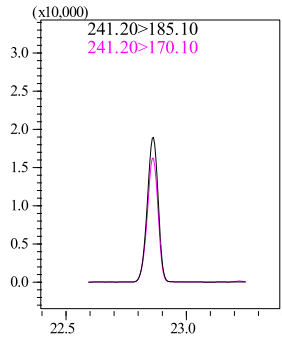
beta-六六六



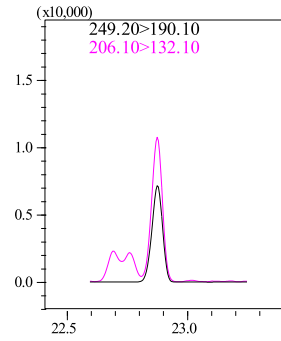
噻草酮



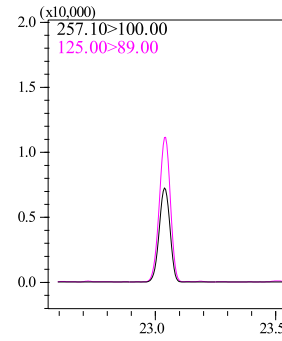
毒死蜱



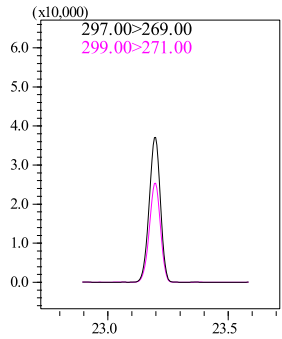
去草净(特丁净)



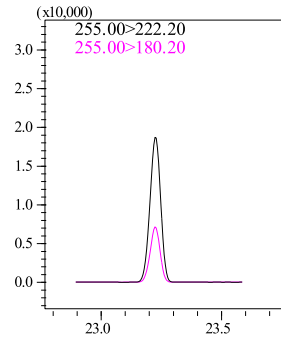
甲霜灵



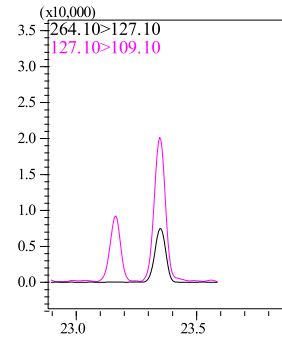
杀丹(禾草丹)



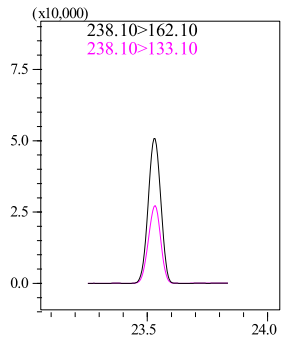
毒壤磷



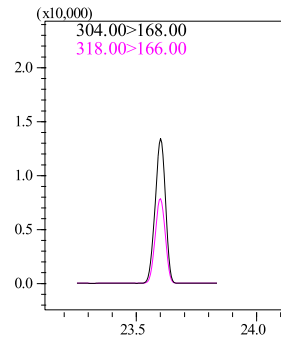
异丙净



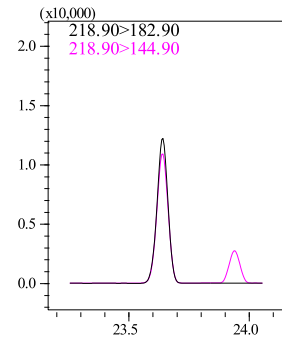
磷胺



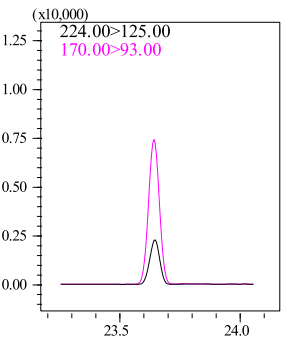
异丙甲草胺



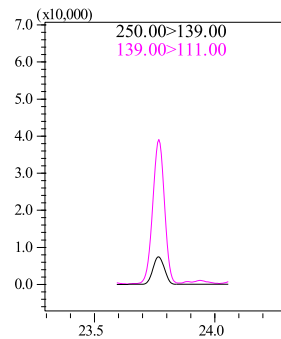
乙基虫磷/啉啉磷



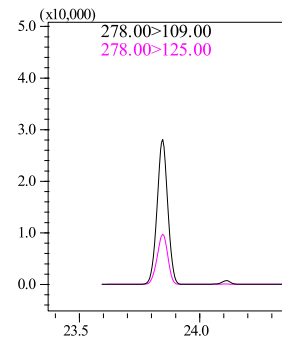
delta-六六六



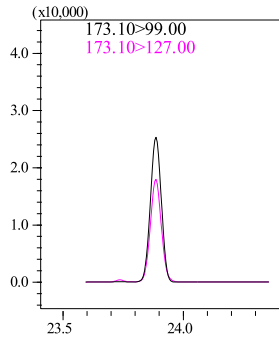
福木松(安果)(安硫磷)



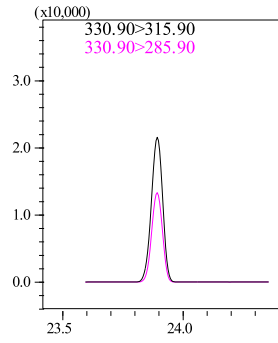
三氯杀螨醇分解物



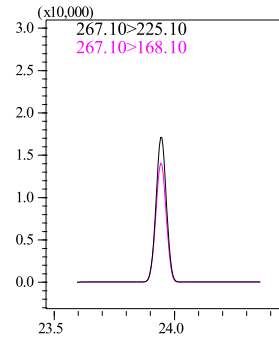
倍硫磷



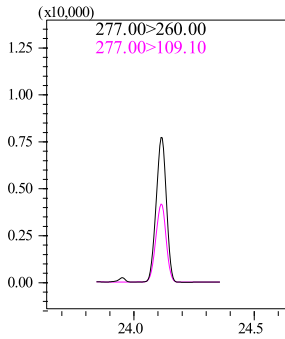
马拉硫磷



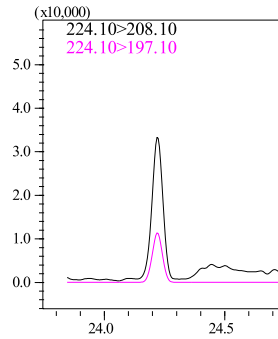
溴硫磷



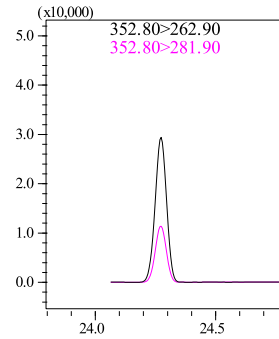
乙霉威



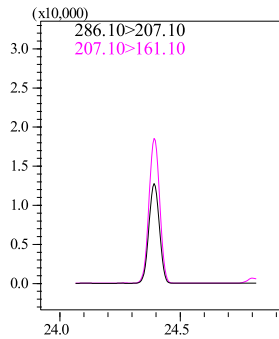
杀螟硫磷



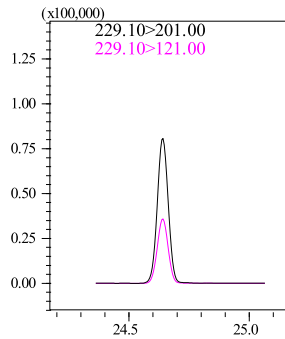
啉菌环胺



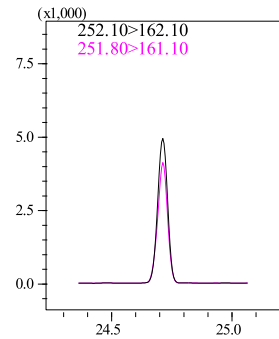
环氧七氯 (exo)



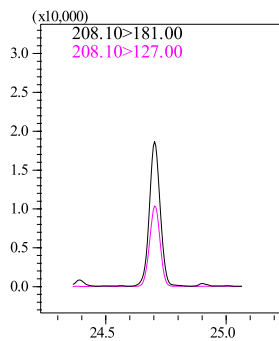
乙呋草黄(乙氧呋草黄)



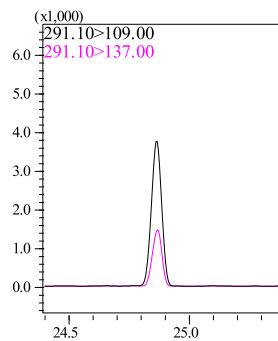
氧异柳磷



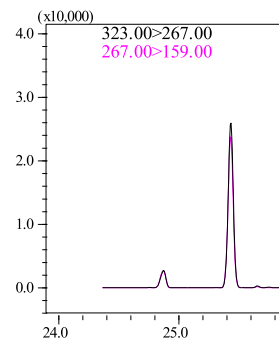
二甲戊乐灵(二甲戊灵)



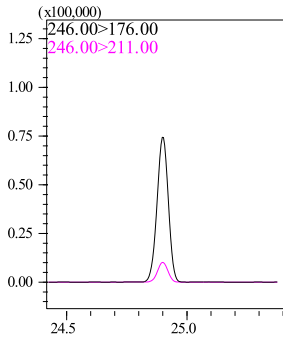
三泰芬(三唑酮)



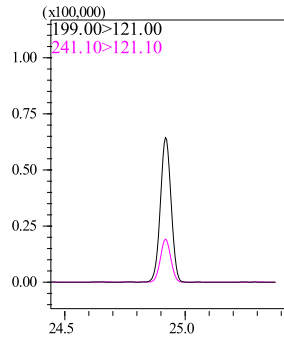
对硫磷



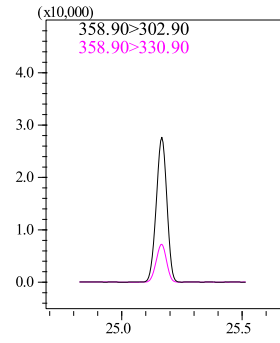
(E/Z)-毒虫畏



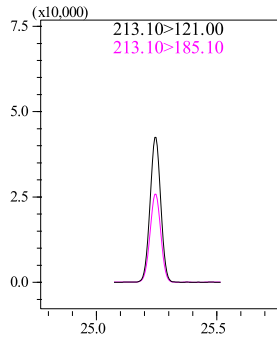
o,p'-DDE



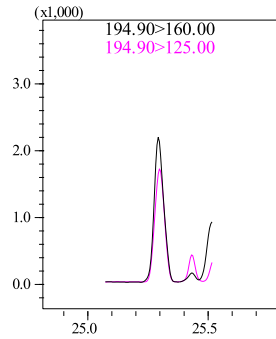
甲基异柳磷



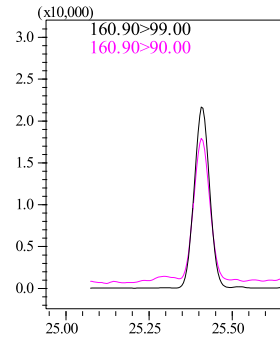
乙基溴硫磷



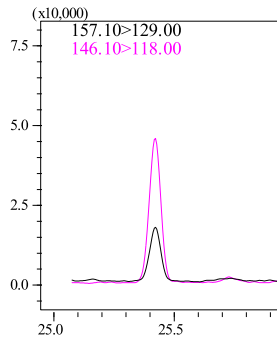
亚芬松(异柳磷)



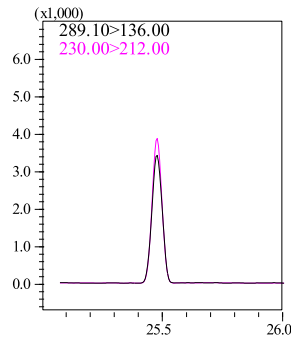
alpha-硫丹



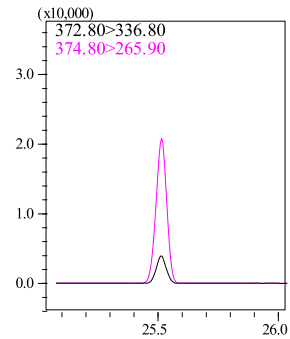
敌稗



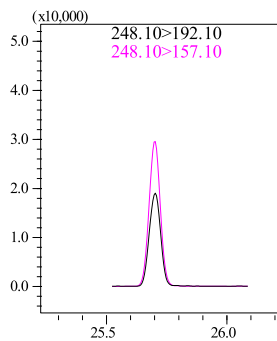
啶硫磷



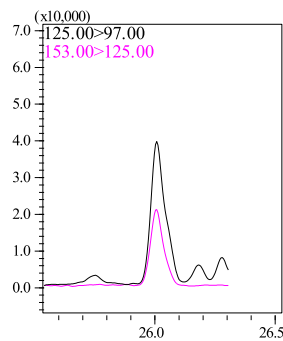
水胺硫磷



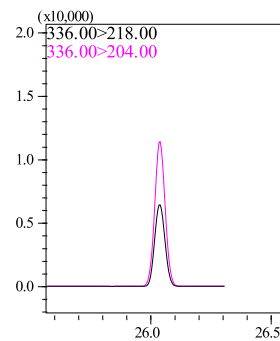
反-氯丹



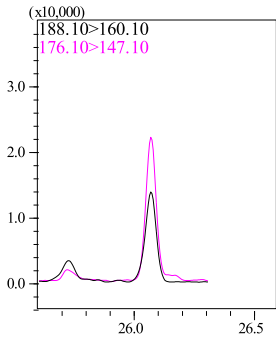
平克座(戊菌唑)



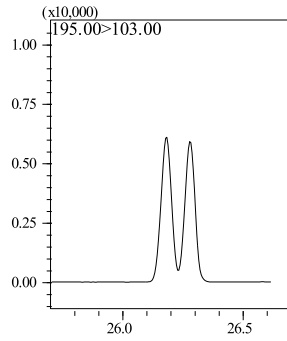
甲拌磷砷



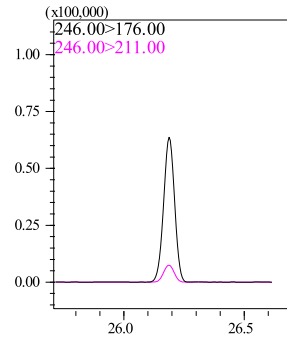
四克利(四氟醚唑)



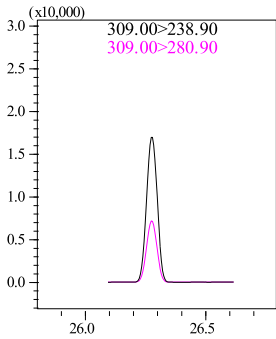
丁基拉草(丁草胺)



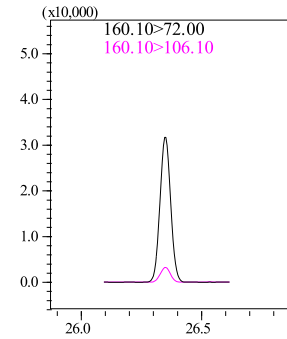
噻唑磷-1,2



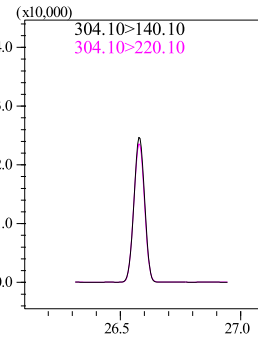
p,p'-DDE



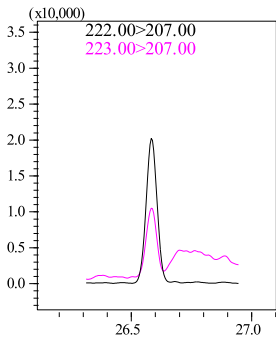
普硫松 (丙硫磷)



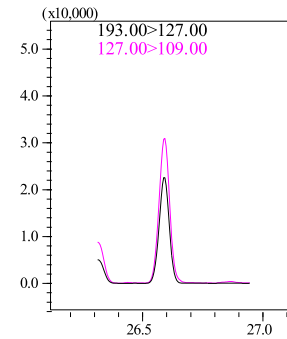
苯硫威



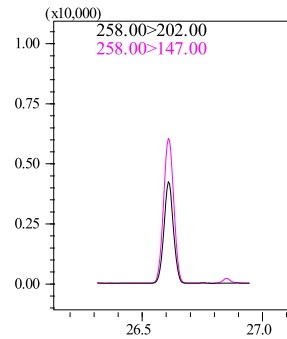
加护松(丙虫磷)



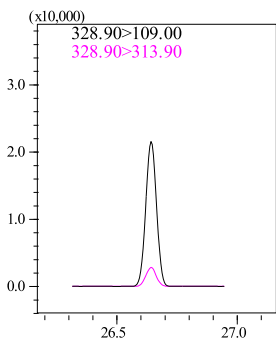
啞菌胺(灭派林)



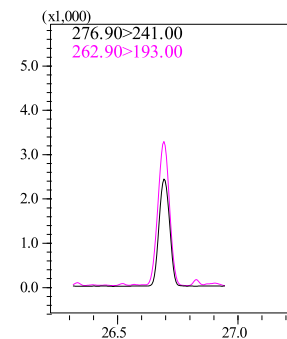
巴毒磷



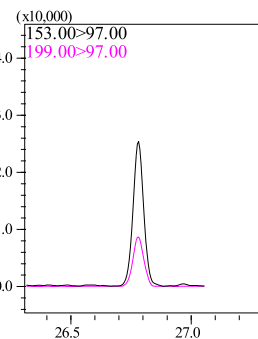
脱叶磷



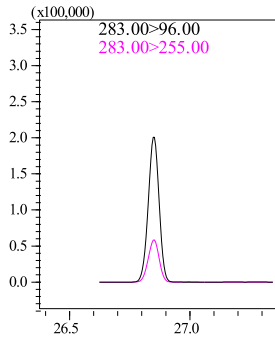
杀虫威



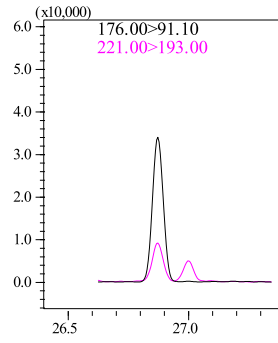
狄氏剂(地特灵)



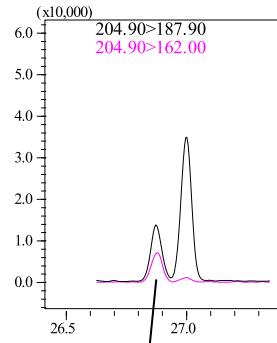
特丁硫磷



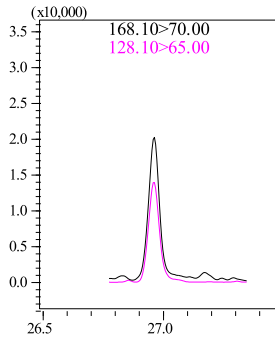
腐霉利



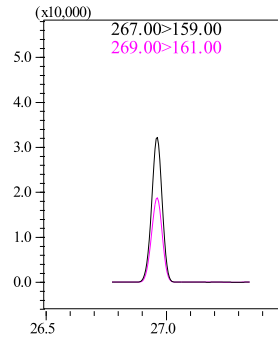
氟丁酰草胺



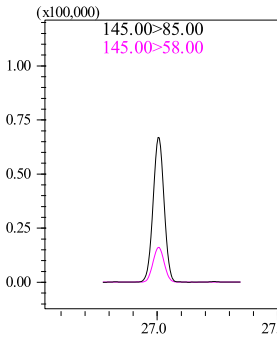
除草定



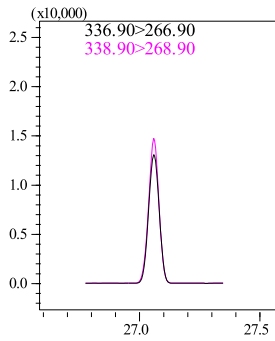
三唑乙醇-1(三唑醇)



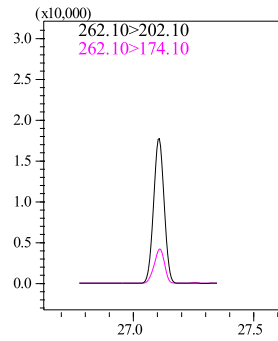
溴苯烯磷



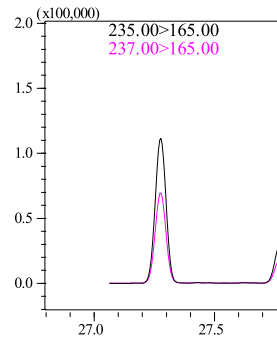
杀扑磷



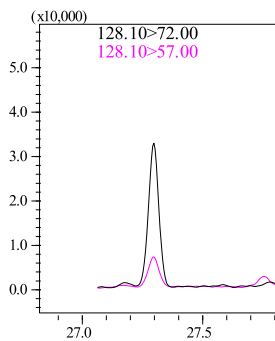
丙溴磷



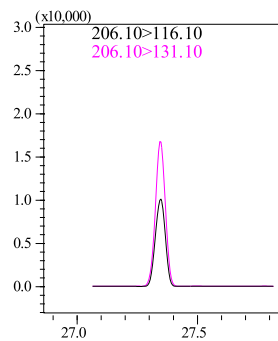
普拉草(丙草胺)



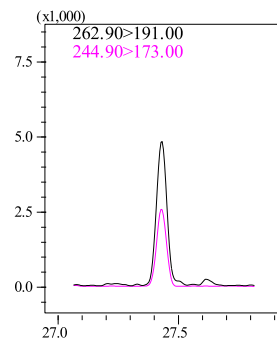
o,p'-DDD



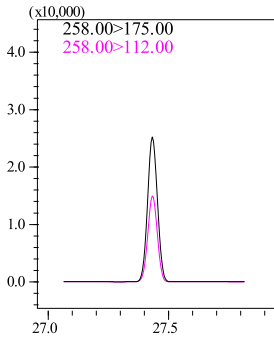
萘丙酰草胺(敌草胺)



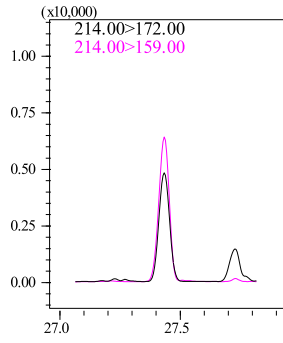
甲基克收欣(醚菌酯)



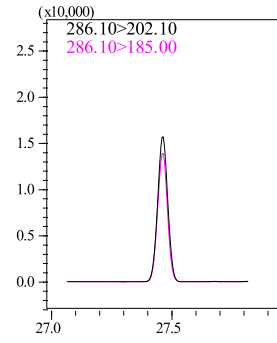
异狄氏剂



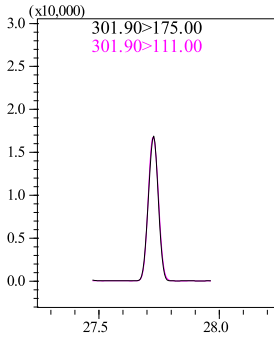
乐灭草(噁草酮)



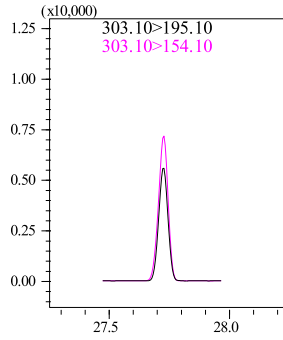
己唑醇



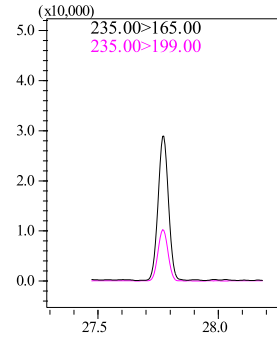
丁胺磷(抑草磷)



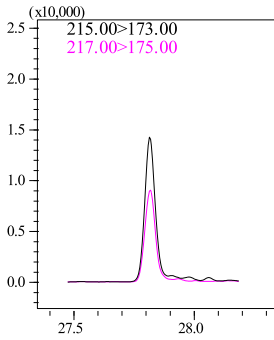
杀螨脂



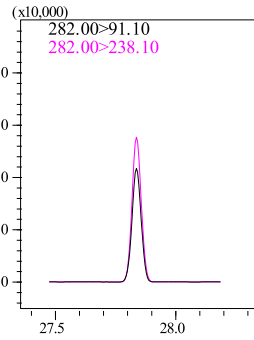
克线磷(苯线磷)



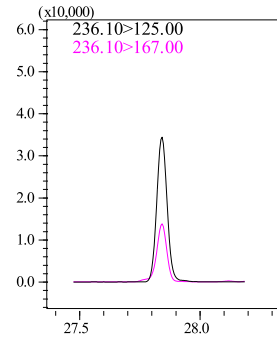
o,p'-DDT



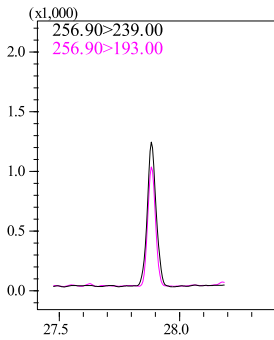
烯菌灵(抑霉唑)



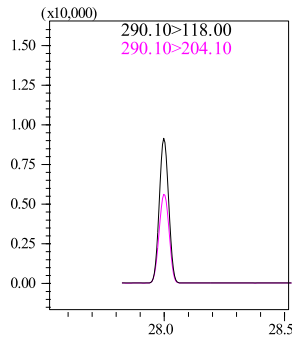
吡氟禾草灵



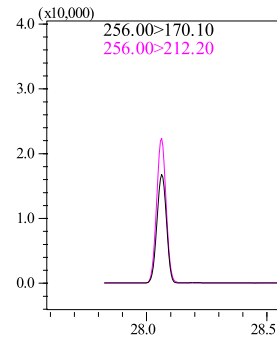
多效唑



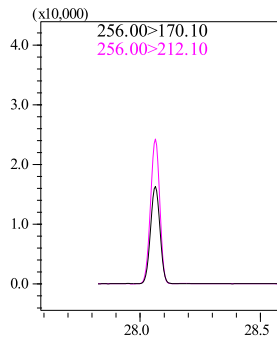
虫螨磷-1



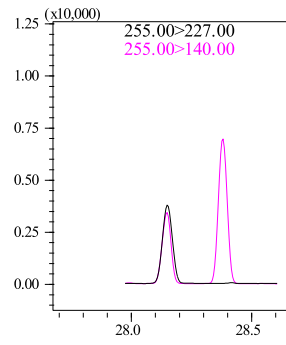
稻瘟灵



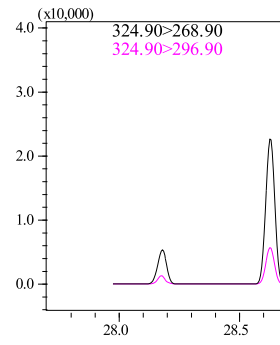
地胺磷



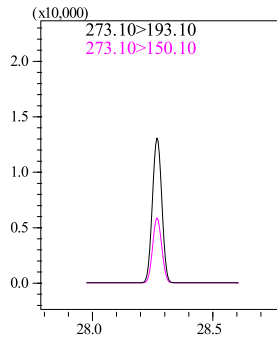
甲氧丙净



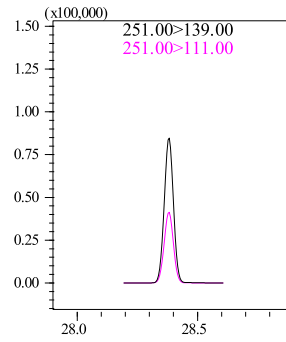
硫环磷



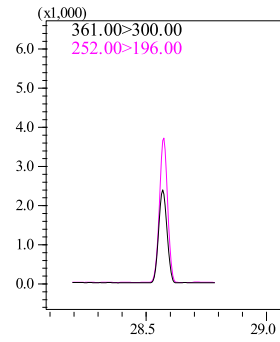
虫螨磷-2/3



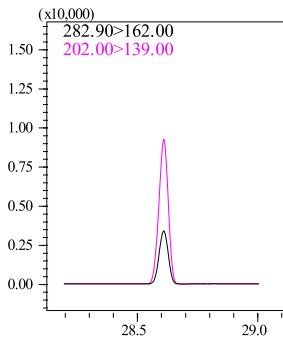
布瑞莫(乙啶酚磺酸酯)



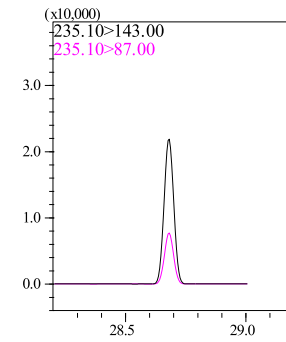
杀螨酯(乙酯杀螨醇)



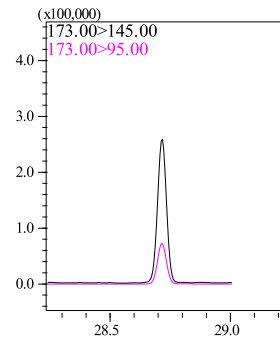
乙氧氟草醚



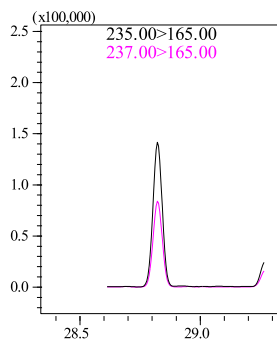
除草醚



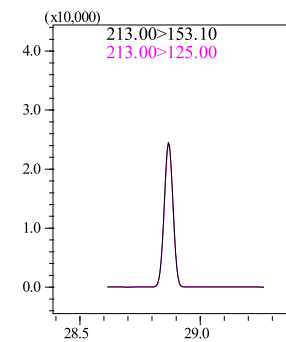
萎锈灵



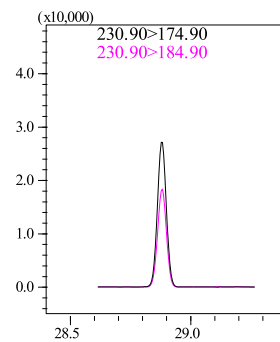
福多宁(氟酰胺)



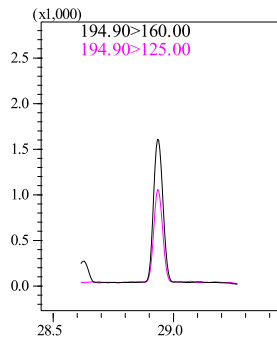
p,p'-DDD



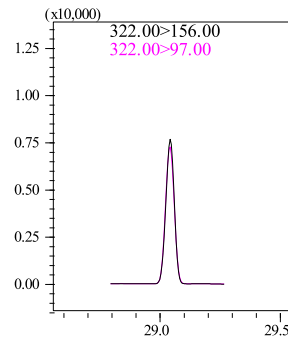
乙拌磷砒(乙拌砒)



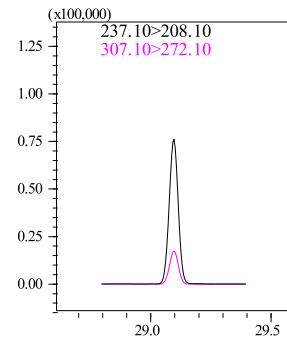
爱杀松(乙硫磷)



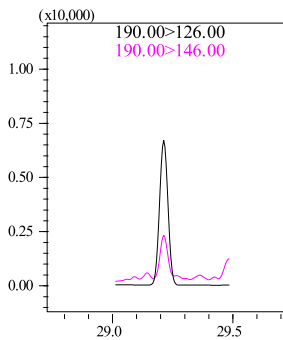
beta-硫丹



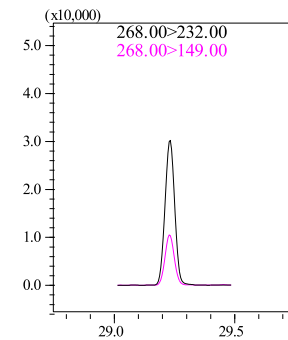
硫丙磷



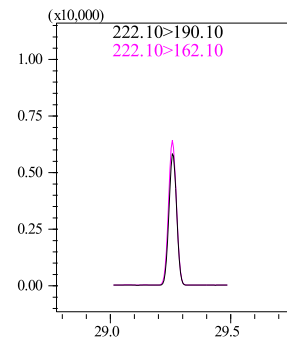
苯氧喹啉(啉氧灵)



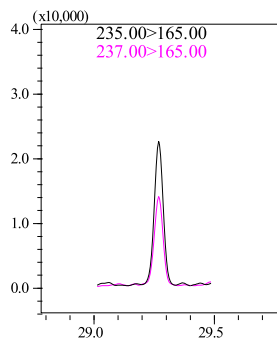
三氟硝草醚



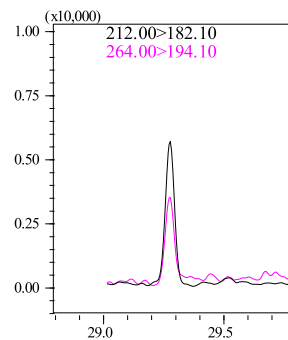
烯唑醇



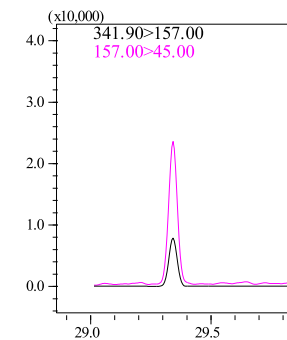
肟菌酯



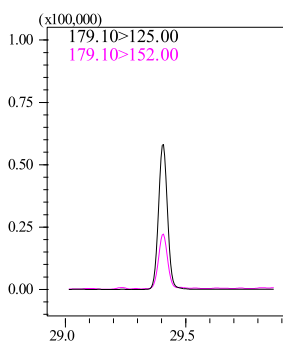
p,p'-DDT



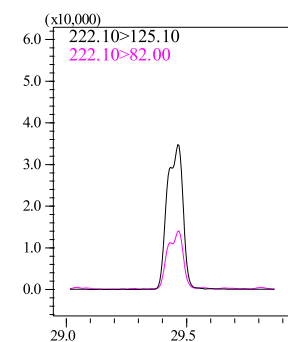
苯草醚



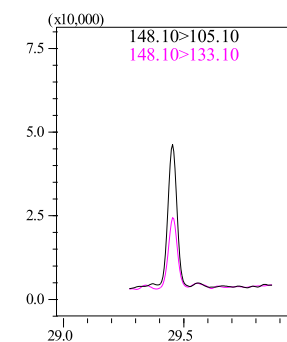
三硫磷



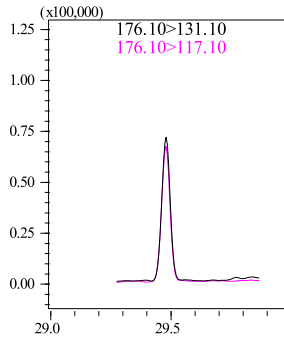
灭克落(腈菌唑)



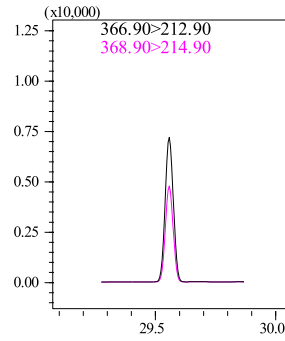
环唑醇-1,2(环丙唑醇)



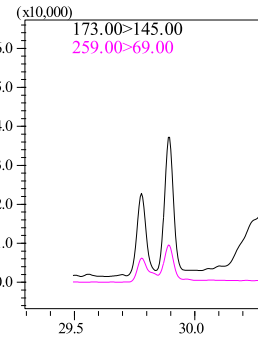
本达乐(苯霜灵)



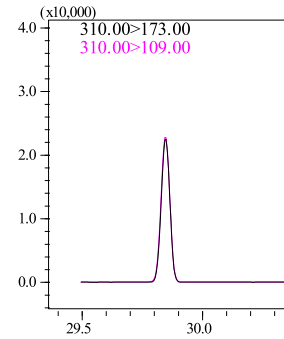
胡椒基丁醚(增效醚)



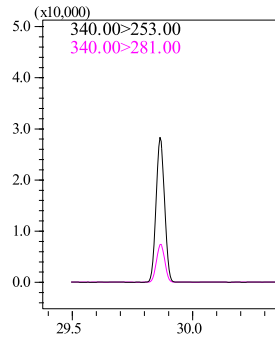
氟虫腈



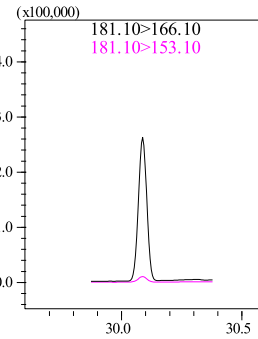
丙环唑-1,2



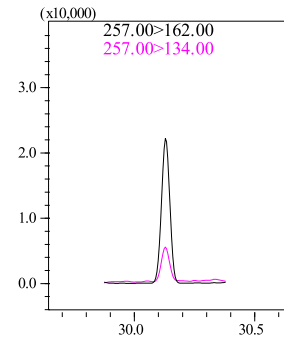
克温散(敌瘟磷)



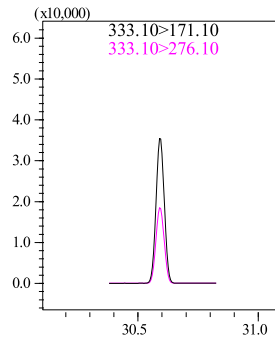
禾草灵



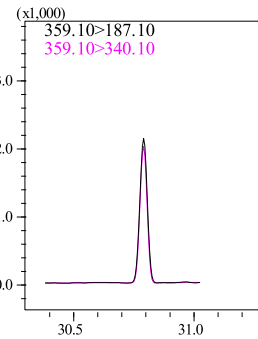
联苯菊酯(氟氯菊酯)



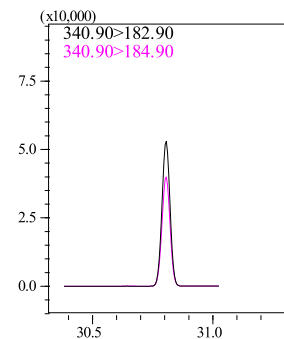
三唑磷



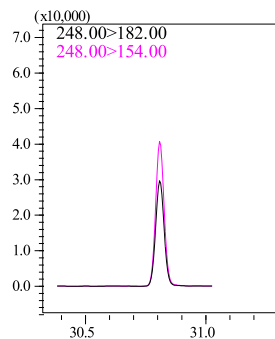
吡螨胺(吡螨胺)



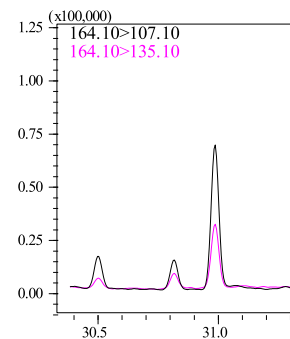
乙螨唑



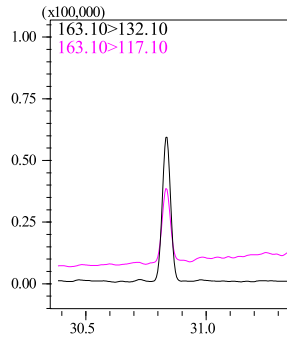
溴螨酯



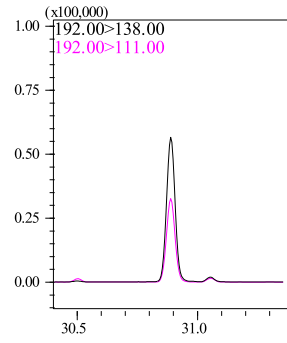
咯菌腈



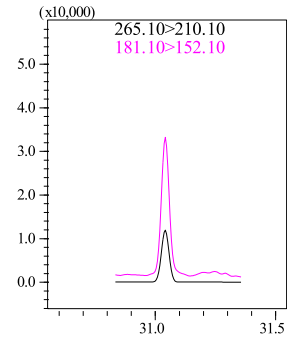
胺菊酯-1,2



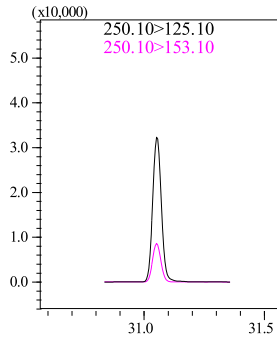
毆杀斯(噁霜灵)



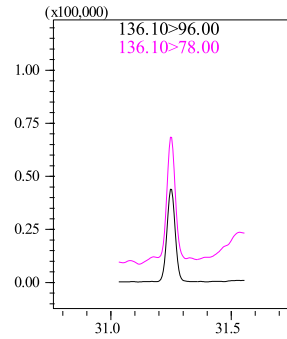
氟环唑



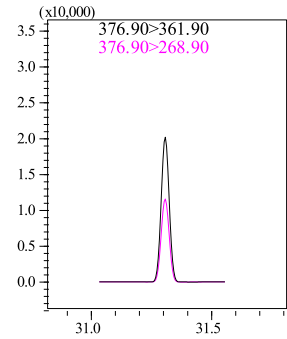
芬普宁(甲氰菊酯)



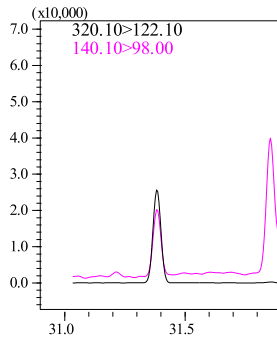
戊唑醇



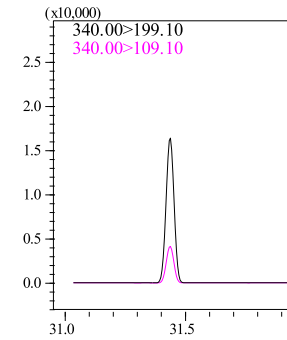
吡丙醚



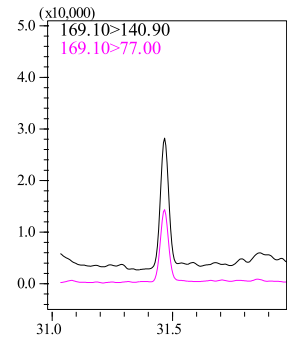
溴苯磷



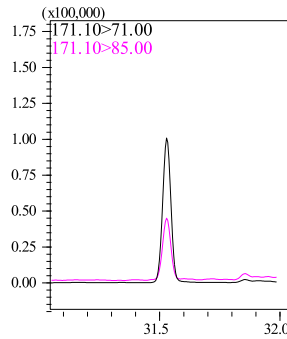
啉草磷



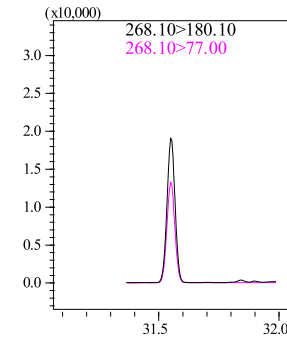
必芬松(哒嗪硫磷)



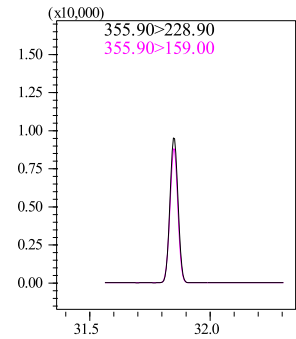
苯硫磷



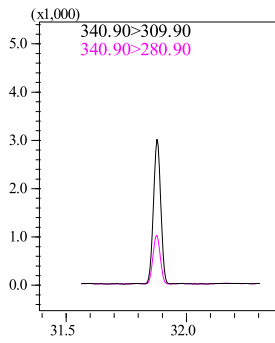
环嗪酮



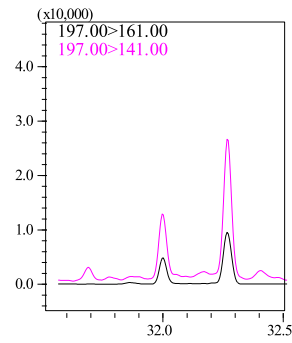
咪唑菌酮



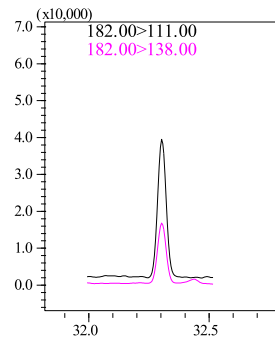
四氯杀螨砒(三氯杀螨砒)



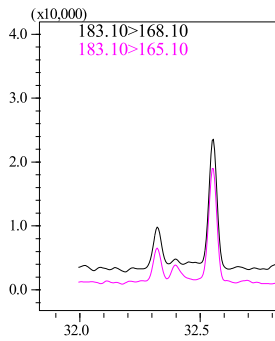
比芬诺(甲羧除草醚)



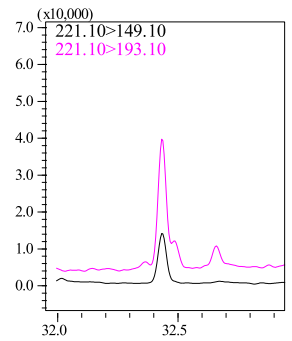
氯氟氰菊酯-1,2



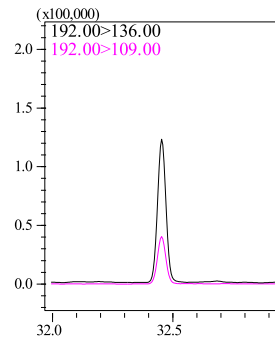
伏杀磷



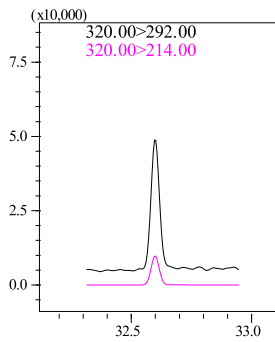
氯菊酯-1,2



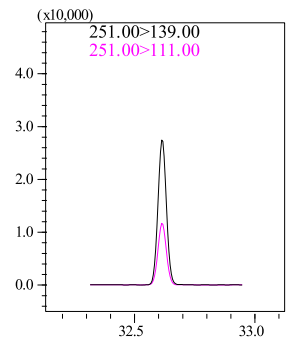
定菌磷(吡菌磷)



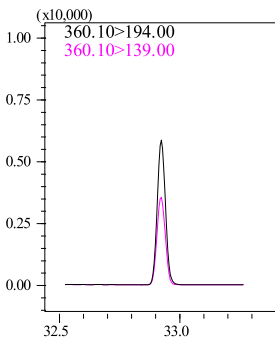
灭芬草(苯噻酰草胺)



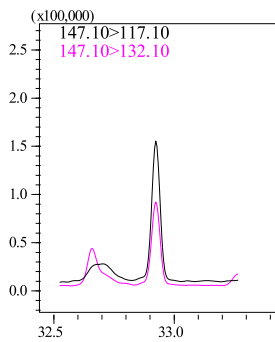
苯胺磷砷(苯线磷砷)



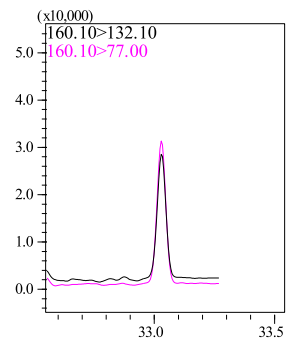
氯苯嘧啶醇



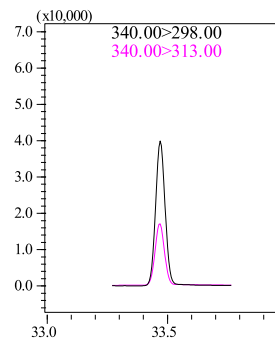
吡唑硫磷



哒螨灵



乙基谷硫磷(益棉磷)



氟啶唑

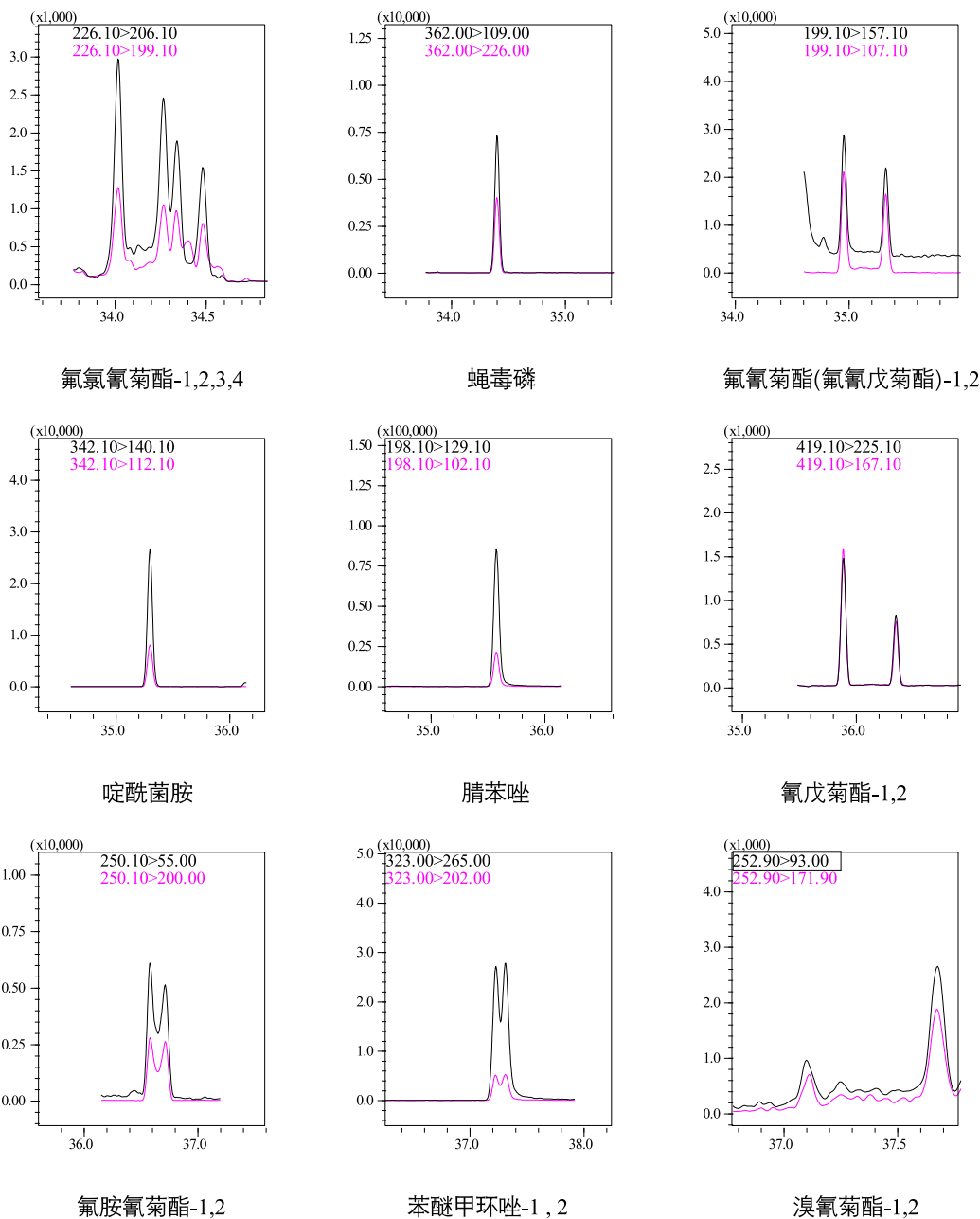


图2 葡萄中213种农药混标(加标10 μg/L)的质量色谱图

## 2.2 重复性测试

取葡萄空白基质配制的 10 μg/L 的混合标品，重复进样 6 次，重复性结果见表 2。

表2 葡萄中213种农药残留(加标10 μg/L)连续进样6针的峰面积

No.	中文名称	峰面积 1	峰面积 2	峰面积 3	峰面积 4	峰面积 5	峰面积 6	RSD%
1	苯胺	52219	50035	51132	50184	51223	51587	1.63
2	硫草敌	16252	15553	15593	15331	15383	14927	2.81
3	敌敌畏	48283	45092	46561	46553	46835	45806	2.31
4	乃力松(二溴磷)	85899	84904	83061	86646	86159	84113	1.60
5	联苯	58933	57960	57927	57924	58629	55994	1.77
6	甲胺磷	49389	50329	49190	48833	50346	48296	1.66

7	敌草腈	162338	157529	156744	157262	156003	151917	2.13
8	美文松-1(速灭磷)	24791	24572	23642	23045	24182	23841	2.67
9	虫螨畏	11543	11771	10826	11114	11072	11314	3.04
10	地茂散(氯苯甲醚)	100494	98549	96635	97950	98035	93931	2.24
11	四氯硝基苯	17024	15874	16228	16939	16525	15430	3.79
12	草灭特(环草敌)	73853	69596	70918	68377	70198	69909	2.63
13	乙酰甲胺磷	32426	31817	29960	30884	32763	32086	3.31
14	六氯苯	75092	73914	71522	72192	74230	72464	1.88
15	虫线磷	37854	37449	38472	38922	37419	35813	2.86
16	灭克磷(灭线磷)	39836	40097	40279	39960	41213	39236	1.62
17	梨内二苯胺(二苯胺)	69498	67295	67278	68029	66848	66012	1.75
18	丁氟消草(乙丁烯氟灵)	5663	4552	4646	5474	6047	5318	11.06
19	丁基灭必虱(仲丁威)	368987	362150	365925	381537	362888	354658	2.45
20	杀虫脒	43757	41292	40242	40381	42509	39659	3.77
21	氟草胺(乙丁氟灵)	25116	24754	25406	24624	25192	23369	2.96
22	残杀威	102734	102053	102231	102118	103390	102775	0.50
23	甲拌磷	9130	8813	8840	8774	9017	8983	1.56
24	硫特普(治螟磷)	32713	29926	31879	32467	32722	31016	3.52
25	氯苯胺灵	25405	25671	23940	25362	25862	25573	2.73
26	alpha-六六六	38445	38266	35849	37950	37766	38685	2.71
27	五氯硝基苯	15507	15260	14735	15943	15171	15570	2.67
28	甲基乙拌磷	12690	12255	12594	11891	12034	12161	2.56
29	氧化乐果	606960	585945	584583	585444	584011	578868	1.67
30	内吸磷	43529	45334	43401	44290	43151	42044	2.54
31	阿特拉通	27494	27204	26295	26391	26446	26444	1.89
32	二嗪农(二嗪磷)	18492	21233	20740	19397	20226	18641	5.69
33	杀螨特	7817316	7551924	7498552	7506169	7483624	7383354	1.95
34	野麦畏	24697	23831	24017	24007	24730	24065	1.60
35	广灭灵(异噁草酮)	73834	72098	73185	73499	71909	75709	1.88
36	环丙氟灵	6586	6451	6403	6081	6045	6384	3.40
37	百治磷	76904	72876	73689	76271	74749	72629	2.38
38	大福松(地虫磷)	69537	64331	67514	66597	66247	64996	2.79
39	噁霉胺	2850019	2799034	2831261	2833280	2828617	2784009	0.87
40	噁丙磷(丁基噁啶磷)	15950	16060	16450	16257	16802	16382	1.86
41	gamma-六六六(林丹)	29667	29327	27606	27397	28497	27335	3.60
42	敌杀磷(敌噁磷)	29050	31784	28922	31258	30903	30787	3.90
43	益多松(乙噁硫磷)	17494	17283	17467	16687	17028	16854	1.94
44	扑灭津	15117	15327	14362	14395	14253	13232	5.13
45	加保扶(克百威)	68867	66713	65123	66233	68186	64931	2.39
46	莠去津	17362	17467	16070	17965	16939	16987	3.73

47	西玛津	27879	28778	26494	26874	27599	26633	3.21
48	氯硝胺	22681	21729	20704	21467	21923	20307	4.00
49	巴胺磷(胺丙畏)	31293	29797	30737	30122	29811	30865	2.03
50	特丁津	29796	28882	27126	27156	27675	26295	4.63
51	八甲磷	29679	30109	30957	30305	30577	29786	1.60
52	氯谷隆	12434	11443	12382	12096	13446	12444	5.24
53	异稻瘟净(丙基喜乐松)	79677	76968	77504	80871	76380	76928	2.30
54	异丙三唑硫磷(氯唑磷)	21696	19585	19928	20102	20795	19514	4.12
55	除线磷	114882	114098	114685	114572	114122	110150	1.58
56	五氯苯胺	53480	51155	54690	51669	52164	53436	2.52
57	抗蚜威	74191	70656	72142	71411	71893	68236	2.74
58	炔敌稗(炔苯酰草胺)	161812	149671	156539	154967	157253	154800	2.54
59	亚素灵(久效磷)	93914	94098	92573	92865	91748	91739	1.10
60	甲基毒死蜱	36931	34362	35649	33436	34383	35362	3.50
61	乐果	18918	18395	19511	17898	19046	19480	3.34
62	艾氏剂	16904	18051	18340	16553	17933	15912	5.60
63	乙草胺	33820	29897	30564	30054	31077	31803	4.68
64	皮蝇磷	170751	166236	170240	169667	174312	164413	2.07
65	敌草净	36593	35869	35287	35142	36691	34300	2.58
66	甲基立枯磷	122862	114389	117098	117261	118455	118192	2.34
67	异丙草胺	58641	54202	55205	56238	55412	54139	3.00
68	拉草(甲草胺)	64500	60841	61109	63766	60260	61537	2.77
69	甲基嘧啶磷	14423	14880	14325	15004	14298	14949	2.26
70	扑草净	21339	20704	20934	21994	20775	20831	2.34
71	莠灭净	28692	28476	27552	28025	27181	27793	2.03
72	免克宁(乙烯菌核利)	18373	18274	17967	17050	17818	17770	2.64
73	beta-六六六	32659	29701	30306	30956	29549	30165	3.74
74	噻草酮	27111	25265	26703	27125	25963	26887	2.81
75	毒死蜱	273619	265803	264525	260719	262910	259663	1.89
76	去草净(特丁净)	46814	46253	48502	48530	48200	46030	2.44
77	甲霜灵	16817	16610	15429	15975	15940	17185	4.00
78	杀丹(禾草丹)	18343	19247	18334	19340	18366	18613	2.49
79	毒壤磷	99639	100299	99790	98697	101417	99539	0.91
80	异丙净	51056	48614	49075	48882	48516	49926	1.98
81	磷胺	19420	19138	18916	20061	18265	19597	3.20
82	异丙甲草胺	155810	150477	151227	152761	154009	149693	1.52
83	乙基虫螨磷/嘧啶磷	37962	35450	34405	35915	35399	35667	3.29
84	delta-六六六	33942	32552	33748	32971	33535	32428	1.92
85	福木松(安果)(安硫磷)	5328	5694	5381	5476	5198	5547	3.20
86	三氯杀螨醇分解物	15951	15404	14854	15586	15833	15278	2.58

87	倍硫磷	69737	68764	67519	69115	67544	68515	1.28
88	马拉硫磷	71088	68870	68440	68217	70722	68950	1.75
89	溴硫磷	59218	56878	56924	56228	53303	55655	3.42
90	乙霉威	43784	42929	43560	43442	44829	41615	2.44
91	杀螟硫磷	18114	17538	17424	18442	20445	17864	6.08
92	噁菌环胺	99069	94820	95105	95254	93878	95016	1.89
93	环氧七氯 (exo)	87749	86093	85318	88967	87655	85168	1.76
94	乙炔草黄(乙炔呋草黄)	30600	29984	32222	30888	31359	28806	3.83
95	氧异柳磷	210963	197620	203081	207943	207072	206009	2.25
96	二甲戊乐灵(二甲戊灵)	12000	11650	9913	9844	10801	12885	10.83
97	三泰芬(三唑酮)	44964	46152	44455	45838	47075	44942	2.12
98	对硫磷	9220	9288	9178	10154	8724	10168	6.15
99	o,p'-DDE	198181	197015	195364	199111	199708	196891	0.81
100	甲基异柳磷	171454	167888	165738	167900	170610	169111	1.23
101	乙基溴硫磷	70092	67481	67738	68256	69898	67710	1.70
102	亚芬松(异柳磷)	107770	111118	106369	109856	105384	108351	1.97
103	敌稗	62964	63791	59284	60782	59511	61091	2.97
104	啶硫磷	46940	46180	49832	48936	48883	48862	2.89
105	毒虫畏	63858	60947	61010	61618	61338	64081	2.31
106	水胺硫磷	9538	9047	9362	8803	8907	8399	4.52
107	反-氯丹	9466	9191	8241	9268	8926	8713	4.94
108	平克座(戊菌唑)	50998	49999	51820	47561	49022	49032	3.08
109	甲拌磷砒	128890	121842	127336	128575	130105	132432	2.78
110	四克利(四氟醚唑)	16199	16101	16229	15982	16851	15610	2.51
111	丁基拉草(丁草胺)	39016	39042	39545	39100	38432	39070	0.91
112	p,p'-DDE	165594	162311	163443	163767	162000	157895	1.59
113	噻唑磷	17419	16583	18022	17615	16893	18219	3.63
114	普硫松(丙硫磷)	45172	44637	42992	45085	44053	42725	2.38
115	苯硫威	82981	81500	81107	79854	82649	79287	1.81
116	加护松(丙虫磷)	62751	62280	61910	62828	60170	62505	1.60
117	噁菌胺/灭派林	53213	51156	53499	50598	50822	51270	2.44
118	巴毒磷	61143	61424	64020	60502	60690	60705	2.15
119	脱叶磷	10977	10352	11622	10592	10773	10738	4.01
120	杀虫威	62512	59834	61570	60712	58882	60488	2.10
121	狄氏剂(地特灵)	3725	3396	3905	3452	4110	3951	7.61
122	特丁硫磷砒	68678	64238	66673	65169	65056	69069	3.03
123	腐霉利	521202	507128	509010	504013	512863	512368	1.16
124	氟丁酰草胺	95856	92202	97450	91887	94956	90013	3.00
125	除草定	42759	40462	41240	39450	42195	39031	3.63
126	三唑乙醇(三唑醇)	52351	56682	55120	58320	51402	55533	4.75

127	溴苯烯磷	82378	83431	80949	80597	84255	77839	2.83
128	杀扑磷	187693	185744	183626	182923	182752	183252	1.07
129	丙溴磷	38362	37788	35542	35986	34463	35928	4.01
130	普拉草(丙草胺)	49194	50438	49398	45262	49383	47623	3.80
131	o,p'-DDD	300332	292736	300362	297605	295483	295902	1.00
132	萘丙酰草胺(敌草胺)	79307	77106	78361	76815	78113	76232	1.46
133	甲基克收欣(醚菌酯)	24953	25285	24497	22750	25065	23590	4.07
134	异狄氏剂	14073	14059	13116	13790	13241	12868	3.82
135	乐灭草(噁草酮)	60587	56913	56201	56793	57356	56177	2.88
136	己唑醇	13306	13101	11827	13747	13021	11860	6.17
137	丁胺磷(抑草磷)	35998	35722	37887	35449	36686	38148	3.11
138	杀螨脂	44647	43359	42791	42282	44276	42162	2.39
139	克线磷(苯线磷)	13887	13291	12243	13056	14900	14547	7.24
140	o,p'-DDT	100776	98116	98068	91503	91316	88660	5.13
141	烯菌灵(抑霉唑)	36947	35851	34802	34597	34919	35666	2.48
142	吡氟禾草灵	49821	47427	49034	47052	47231	47891	2.31
143	多效唑	81951	82440	80727	81070	83177	77779	2.33
144	稻瘟灵	19768	20088	18118	18235	19134	18376	4.43
145	地胺磷	38822	38025	38133	36728	36960	39169	2.57
146	甲氧丙净	40959	36541	36127	37900	36719	36668	4.81
147	硫环磷	9455	8890	9292	10603	9844	8490	7.85
148	布瑞莫(乙啶酚磺酸酯)	30537	28883	30027	27525	29760	28564	3.78
149	杀螨酯(乙酯杀螨醇)	185103	183976	183867	189530	185920	182623	1.30
150	乙氧氟草醚	3936	4453	4266	4765	5166	4116	10.16
151	除草醚	7578	7875	8033	7113	9898	8555	11.81
152	虫螨磷	56068	58201	56291	56312	55819	56970	1.53
153	萎锈灵	47170	45812	46206	48717	46588	46040	2.29
154	福多宁(氟酰胺)	602358	578129	585467	582616	580243	584208	1.48
155	p,p'-DDD	324886	330483	322893	323979	324338	325884	0.82
156	乙拌磷砷(乙拌砷)	57115	55335	58441	58609	57843	56402	2.21
157	爱杀松(乙硫磷)	62517	61683	59715	63784	62137	61255	2.19
158	硫丹	3059	2927	2901	3291	3138	3101	4.69
159	硫丙磷	17038	17964	16598	16495	18257	18197	4.65
160	苯氧喹啉(喹氧灵)	159735	154752	155074	157933	157658	158109	1.22
161	三氟硝草醚	13531	13203	12758	12994	13854	14351	4.37
162	烯唑醇	69599	68525	64525	65074	69502	66855	3.29
163	肟菌酯	9739	10554	11039	10755	9646	10304	5.39
164	p,p'-DDT	64847	62588	63091	57834	60495	59086	4.31
165	苯草醚	10698	12287	11377	10738	11499	10257	6.52
166	三硫磷	18318	18212	17910	17654	19946	16448	6.27

167	灭克落(腈菌唑)	123659	125774	122603	125314	120680	123414	1.50
168	本达乐(苯霜灵)	91712	96003	96556	101370	93769	89381	4.42
169	环唑醇(环丙唑醇)	63874	69420	67380	68791	72702	67235	4.27
170	胡椒基丁醚(增效醚)	154640	153933	155799	156919	151543	155079	1.19
171	氟虫腈	14777	14436	14556	15397	15602	15292	3.22
172	克温散(敌瘟磷)	50932	49923	52908	51175	52096	51923	2.02
173	禾草灵	56471	56014	54829	55726	54064	55062	1.58
174	丙环唑	67965	73674	72797	77570	73303	71804	4.26
175	联苯菊酯(氟氯菊酯)	529617	524631	524023	505943	520534	520217	1.55
176	三唑磷	41707	41884	41534	41751	41821	43715	1.94
177	吡螨胺(吡螨胺)	73717	73188	74112	71891	71908	71032	1.66
178	乙螨唑	4313	4228	4310	4221	3489	3849	8.16
179	溴螨酯	101334	99058	97825	97304	98010	99798	1.52
180	咯菌腈	62955	64658	63809	63699	61483	62887	1.71
181	殴杀斯(噁霜灵)	112568	111440	113888	110231	110894	113903	1.38
182	氟环唑	133749	129527	128360	130797	127550	125430	2.22
183	胺菊酯	125082	124144	122750	122569	121886	121237	1.16
184	芬普宁(甲氰菊酯)	21733	19482	22445	20500	22544	22290	5.78
185	戊唑醇	64014	64082	66520	64771	62940	64374	1.84
186	吡丙醚	86367	85108	88722	83717	86125	87536	2.04
187	溴苯磷	39619	40244	40021	38693	41749	42548	3.51
188	啶草磷	50479	51036	50466	52365	51200	52653	1.82
189	必芬松(哒嗪硫磷)	35057	35152	33762	33166	34097	33308	2.50
190	苯硫磷	50133	49933	54104	52331	50595	53792	3.59
191	环嗪酮	209677	207123	204095	200700	205733	204476	1.48
192	咪唑菌酮	32570	32939	32369	31998	31174	33373	2.36
193	四氯杀螨砜(三氯杀螨砜)	18202	17512	16106	17458	16054	18648	6.15
194	比芬诺(甲羧除草醚)	5741	6286	4547	5483	4826	5945	12.25
195	氯氟氰菊酯	21095	21605	20454	19768	20906	21053	3.03
196	伏杀磷	86645	87059	82111	87714	85934	81554	3.12
197	定菌磷(吡菌磷)	28781	31276	29415	28670	28951	31659	4.46
198	灭芬草(苯噻酰草胺)	260578	255133	256700	253531	254649	256704	0.96
199	氯菊酯	42622	41312	42847	43118	40570	47330	5.48
200	苯胺磷砜(苯线磷砜)	102414	103452	101555	104308	109246	104078	2.58
201	氯苯嘧啶醇	56096	53862	54935	57924	54243	55788	2.66
202	吡唑硫磷	12326	12515	12357	12452	11739	12006	2.44
203	哒螨灵	309148	314272	312970	300066	307156	307312	1.64
204	乙基谷硫磷(益棉磷)	60252	59764	59027	59510	56931	59169	1.95
205	氟啶唑	92642	90029	91686	90462	92723	90596	1.27
206	氟氯氰菊酯	7497	8395	7813	7593	8089	7402	4.90

207	蝇毒磷	17959	18049	18830	18431	18369	17514	2.49
208	氟氰菊酯(氟氰戊菊酯)	69718	72740	72304	73028	70028	70673	2.03
209	啶酰菌胺	73317	72976	71623	72279	74215	73176	1.23
210	腈苯唑	243506	243115	242309	236225	238495	238369	1.26
211	氰戊菊酯	4003	3976	4164	4613	4282	4135	5.56
212	氟胺氰菊酯	22091	19647	20012	19947	20875	22572	5.86
213	苯醚甲环唑	86961	89098	89592	90482	86345	88516	1.79
214	溴氰菊酯	8851	8649	9021	9095	9675	9416	4.10

## ■ 结论

采用岛津公司三重四极杆气质联用仪 GCMS-TQ8040 对葡萄基质中 213 种农药 (浓度为 10  $\mu\text{g/L}$ ) 的灵敏度和重复性进行考察。结果表明, 葡萄基质中 213 种农药色谱峰峰形好, 连续进 6 针进行重复性实验, 其峰面积的相对标准偏差 (RSD%) 均在 13% 以下, 岛津 GCMS-TQ8040 在分析葡萄中多农药残留时灵敏度高, 稳定性良好。