

# 赛默飞全面应对GB 23200.121-2021-植物源性食品中331种农药及其代谢物残留量的测定 液相色谱-质谱联用法的完整解决方案

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## 关键词

三重四极杆质谱法 GB 23200.121 QuEChERS 农药残留

## 摘要

本文基于赛默飞液相色谱-串联三重四极杆质谱平台，建立了针对常见植物源性食品中375种农药的超高效液相色谱串联三重四极杆质谱分析方法。方法选用Acclaim Vanquish C18色谱柱（150x2.1 mm, 2.2 $\mu$ m），以甲醇-水（均含0.1%甲酸，2.5 mM甲酸铵）为流动相进行梯度洗脱，流速0.3 mL/min，柱温40  $^{\circ}$ C。采用ESI源，正负模式同时采集，扫描方式为选择反应检测（SRM）。

结果表明：在基质标曲条件下，375种农药在2.5-100 ng/mL的范围内的线性相关系数均大于0.99；采用该方法对黄瓜、番茄、芸豆、玉米粉和红茶等基质样品进行分析，灵敏度和重现性结果良好，适用于果蔬，谷物以及茶叶等植物源性食品基质农药残留的检测。

## 1. 引言

2021年3月，国家卫生健康委员会、农业农村部、国家市场监督管理总局联合发布GB 23200.121-2021《植物源性食品中331种农药及其代谢物残留量的测定液相色谱-质谱联用法》，该标准采用QuEChERS前处理方法及LC/MS/MS检测方法。相较于之前的NY/T 761和GB/T 20769等检测方法，新标准的最大特色在于它充分引入了QuEChERS前处理方法，大大简化了实验前处理流程，提高了分析效率。新推出的GB23200.121-2021法和2018年推出的GB

23200.113-2018法双谱合璧，将成为今后质谱法多农残分析的金标准。

本文基于Thermo Scientific串联三重四极杆串联质谱平台，采用QuEChERS法对植物源性食品进行前处理。按照GB23200.121-2021规定的提取盐包对常见的食品进行盐析除水提取，提取后离心得到的上清液用标准对应的QuEChERS净化包进行净化。色谱条件以Acclaim Vanquish C18色谱柱进行分离，用甲醇-水体系（均含0.1%甲酸，2.5 mM甲酸铵）作为流动相进行梯度洗脱。质谱采用ESI源，正负切换模式同时采集，SRM分段扫描检测；采用基质匹配外标法定量。所有化合物在2.5~100 ng/mL范围内呈良好线性关系，五种样品基质中375种农药均能够满足定量限的需求。该方法前处理快速高效，可重复性强，可为果蔬、谷物以及茶叶等植物源性食品中多农残的检测提供借鉴。

## 2. 实验部分

### 2.1 仪器与试剂

2.1.1 Thermo Scientific™ Vanquish™ Flex超高效液相色谱仪；

2.1.2 Thermo Scientific™ TSQ Fortis™三重四极杆质谱仪；

2.1.3 国标GB23200.121-2021方法涉及的QuEChERS等耗材如下表：

表1 QuEChERS法耗材清单

类别	适用基质样品	描述	货号	
QuEChERS	蔬菜、水果、食用菌和糖料	提取盐包: 4 g硫酸镁、1 g氯化钠、1 g柠檬酸钠、0.5 g柠檬酸氢二钠	60105-333-B	
		净化管: 150mg MgSO <sub>4</sub> , 25mg PSA, 2mL	60105-219-B	
	谷物、油料、坚果	净化管(色深样品): 150mg MgSO <sub>4</sub> , 25mg PSA, 2.5mg GCB, 2mL	60105-221-B	
		提取盐包: 6 g无水硫酸镁、1.5 g醋酸钠	60105-335-B	
	茶叶和香辛料	净化管: 150mg MgSO <sub>4</sub> , 50mg PSA, 50mg C18, 2mL	60105-204-B	
		提取盐包: 6 g无水硫酸镁、1.5 g醋酸钠	60105-335-B	
	植物油	净化管: 150mg MgSO <sub>4</sub> , 50mg PSA, 50mg C18, 25mg GCB, 2 mL	60105-380-B	
		提取盐包: 4 g硫酸镁、1 g氯化钠、1 g柠檬酸钠、0.5 g柠檬酸氢二钠	60105-333-B	
			净化管: 150mg MgSO <sub>4</sub> , 50mg PSA, 50mg C18, 2mL	60105-204-B

2.1.4 甲醇(质谱纯,美国Thermo Fisher公司);水(质谱纯,美国Thermo Fisher公司);甲酸(HPLC纯,美国Thermo Fisher公司);甲酸铵(HPLC纯,美国Thermo Fisher公司)。

2.1.5 陶瓷均质子(P/N 60105-370-B)

2.1.6 微孔滤膜: Titan3, 17mmPTFE过滤器, 0.2um (P/N 42213-NP)

2.1.7 色谱柱: Acclaim Vanquish C18 2.2um 2.1 x 150 mm (P/N 071399-V)

## 2.2 化合物信息及溶液配制

### 2.2.1 375种农药化合物信息

表2 375种农药化合物信息列表(部分)

中文名称	英文名称	CAS	分子式	精确质量数
3-羟基克百威	3-Hydroxycarbofuran	16655-82-6	C <sub>12</sub> H <sub>15</sub> NO <sub>4</sub>	237.1001
乙酰甲胺磷	Acephate	30560-19-1	C <sub>4</sub> H <sub>10</sub> NO <sub>3</sub> PS	183.0119
啶虫脒	Acetamidiprid	135410-20-7	C <sub>10</sub> H <sub>11</sub> ClN <sub>4</sub>	222.0672
甲草胺	Alachlor	15972-60-8	C <sub>14</sub> H <sub>20</sub> ClNO <sub>2</sub>	269.1183
涕灭威	Aldicarb	116-06-3	C <sub>7</sub> H <sub>14</sub> N <sub>2</sub> O <sub>2</sub> S	190.0776
涕灭威砜	Aldicarb-Sulfone	1646-88-4	C <sub>7</sub> H <sub>14</sub> N <sub>2</sub> O <sub>4</sub> S	222.0674
涕灭威亚砜	Aldicarb-Sulfoxide	1646-87-3	C <sub>7</sub> H <sub>14</sub> N <sub>2</sub> O <sub>3</sub> S	206.0725
啞啞菌胺	Ametoctradin	865318-97-4	C <sub>15</sub> H <sub>25</sub> N <sub>5</sub>	275.2110
乙草胺	Acetochlor	34256-82-1	C <sub>14</sub> H <sub>20</sub> ClNO <sub>2</sub>	269.1183
丙硫多菌灵	Albendazole	54965-21-8	C <sub>12</sub> H <sub>15</sub> N <sub>3</sub> O <sub>2</sub> S	265.0885
磺草灵	Asulam	3337-71-1	C <sub>8</sub> H <sub>10</sub> N <sub>2</sub> O <sub>4</sub> S	230.0361
莠去津	Atrazine	1912-24-9	C <sub>8</sub> H <sub>14</sub> ClN <sub>5</sub>	215.0938
阿维菌素B1a	Avermectin B1a	65195-55-3	C <sub>48</sub> H <sub>72</sub> O <sub>14</sub>	872.4922
莠灭净	Ametryn	834-12-8	C <sub>9</sub> H <sub>17</sub> N <sub>5</sub> S	227.1205
啞啞磺隆	Amidosulfuron	120923-37-7	C <sub>9</sub> H <sub>15</sub> N <sub>5</sub> O <sub>7</sub> S <sub>2</sub>	369.0413
啞啞磺菌胺	Amisulbrom	348635-87-0	C <sub>13</sub> H <sub>13</sub> BrFN <sub>5</sub> O <sub>4</sub> S <sub>2</sub>	464.9576
莎稗磷	Anilofos	64249-01-0	C <sub>13</sub> H <sub>19</sub> ClNO <sub>3</sub> PS <sub>2</sub>	367.0233
保棉磷	Azinphos-Methyl	86-50-0	C <sub>10</sub> H <sub>12</sub> N <sub>3</sub> O <sub>3</sub> PS <sub>2</sub>	317.0058
啞菌酯	Azoxystrobin	131860-33-8	C <sub>22</sub> H <sub>17</sub> N <sub>3</sub> O <sub>5</sub>	403.1168
苯霜灵	Benalaxyl	71626-11-4	C <sub>20</sub> H <sub>23</sub> NO <sub>3</sub>	325.1678
恶虫威	Bendiocarb	22781-23-3	C <sub>11</sub> H <sub>13</sub> NO <sub>4</sub>	223.0845
草除灵	Benazolin-Ethyl	25059-80-7	C <sub>11</sub> H <sub>10</sub> ClNO <sub>3</sub> S	271.0070
苯并烯氟菌唑	Benzovindiflupyr	1072957-71-1	C <sub>18</sub> H <sub>15</sub> Cl <sub>2</sub> F <sub>2</sub> N <sub>3</sub> O	397.0560
苄啞磺隆	Bensulfuron Methyl	83055-99-6	C <sub>16</sub> H <sub>18</sub> N <sub>4</sub> O <sub>7</sub> S	410.0896
甲羧除草醚	Bifenox	42576-02-3	C <sub>14</sub> H <sub>9</sub> Cl <sub>2</sub> NO <sub>5</sub>	340.9858
苯螨特	Benzoximate	29104-30-1	C <sub>18</sub> H <sub>18</sub> ClNO <sub>5</sub>	363.0874

联苯菊酯	Bifenthrin	82657-04-3	$C_{23}H_{22}ClF_3O_2$	422.8678
生物苾呋菊酯	Bioresmethrin	28434-01-7	$C_{22}H_{26}O_3$	338.1882
联苯三唑醇	Bitertanol	55179-31-2	$C_{20}H_{23}N_3O_2$	337.1790
啉酰菌胺	Boscalid	188425-85-6	$C_{18}H_{12}Cl_2N_2O$	342.0327
糠菌唑	Bromuconazole cis	116255-48-2	$C_{13}H_{12}BrCl_2N_3O$	374.9541
糠菌唑	Bromuconazole trans	116255-48-3	$C_{13}H_{12}BrCl_2N_3O$	375.9541
乙嘧酚磺酸酯	Bupirimate	41483-43-6	$C_{13}H_{24}N_4O_3S$	316.1569
噻嗪酮	Buprofezin	69327-76-0	$C_{16}H_{23}N_3OS$	305.1562
丁草胺	Butachlor	23184-66-9	$C_{17}H_{26}ClNO_2$	311.1652
仲丁灵	Butralin	33629-47-9	$C_{14}H_{21}N_3O_4$	295.1532
硫线磷	Cadusafos	95465-99-9	$C_{10}H_{23}O_2PS_2$	270.0877
甲萘威	Carbaryl	63-25-2	$C_{12}H_{11}NO_2$	201.0790
多菌灵	Carbendazim	10605-21-7	$C_9H_9N_3O_2$	191.0695
克百威	Carbofuran	1563-66-2	$C_{12}H_{15}NO_3$	221.1052
萎锈灵	Carboxin	5234-68-4	$C_{12}H_{13}NO_2S$	235.0667
唑草酮	Carfentrazone-Ethyl	128639-02-1	$C_{15}H_{14}Cl_2F_3N_3O_3$	411.0364
氯虫苯甲酰胺	Chlorantraniliprole	500008-45-7	$C_{18}H_{14}BrCl_2N_5O_2$	480.9708
灭幼脲	Chlorbenzuron	57160-47-1	$C_{14}H_{10}Cl_2N_2O_2$	308.0119
杀虫脒	Chlordimeform	6164-98-3	$C_{10}H_{13}ClN_2$	196.0767
毒虫畏	Chlorfenvinphos	470-90-6	$C_{12}H_{14}Cl_3O_4P$	357.9695
氟啶脲	Chlorfluazuron	71422-67-8	$C_{20}H_9Cl_3F_5N_3O_3$	538.9630
杀草敏	Chloridazon	1698-60-8	$C_{10}H_8ClN_3O$	221.0356
氯嘧磺隆	Chlorimuron-Ethyl	90982-32-4	$C_{15}H_{15}ClN_4O_6S$	414.0401
氯苯胺灵	Chlorpropham	101-21-3	$C_{10}H_{12}ClNO_2$	213.0556
毒死蜱	Chlorpyrifos	2921-88-2	$C_9H_{11}Cl_3NO_3PS$	348.9263
甲基毒死蜱	Chlorpyrifos-Methyl	5598-13-0	$C_7H_7Cl_3NO_3PS$	320.8950
氯磺隆	Chlorsulfuron	64902-72-3	$C_{12}H_{12}ClN_5O_4S$	357.0298
绿麦隆	Chlortoluron	15545-48-9	$C_{10}H_{13}ClN_2O$	212.0716
环虫酰肼	Chromafenozide	143807-66-3	$C_{24}H_{30}N_2O_3$	394.2256
醚磺隆	Cinosulfuron	94593-91-6	$C_{15}H_{19}N_5O_7S$	413.1005
烯草酮	Clethodim	99129-21-2	$C_{17}H_{26}ClNO_3S$	359.1322
烯草酮砒	Clethodim Sulfone	111031-17-5	$C_{18}H_{29}NO_5S$	371.1766
烯草酮亚砒	Clethodim Sulfoxide	111031-14-2	$C_{17}H_{26}ClNO_4S$	375.9106
四螨嗪	Clofentezine	74115-24-5	$C_{14}H_8Cl_2N_4$	302.0126
异噁草酮	Clomazone	81777-89-1	$C_{12}H_{14}ClNO_2$	239.0713
噻虫胺	Clothianidin	210880-92-5	$C_6H_8ClN_5O_2S$	249.0087
蝇毒磷	Coumaphos	56-72-4	$C_{14}H_{16}ClO_5PS$	362.0145
丁香菌酯	Coumoxystrobin	850881-70-8	$C_{26}H_{28}O_6$	436.1886

## 2.2.2 标准品信息

2.2.2.1 375种农药标准溶液单标，浓度100 µg/mL(购于阿尔塔科技)；

2.2.2.2 储备液：精确吸取相应标准品溶液，用甲醇稀释配置成100 ng/mL的混合储备液；

2.2.2.3 标准曲线溶液：以QuEChERS净化后的对应的植物源性食品空白基质作为溶剂，稀释成系列工作标准溶液，2.5、5.0、10、20、50和100 ng/mL，考察仪器灵敏度、重现性和线性范围。

### 2.3 色谱条件：

色谱柱：Acclaim Vanquish™ C18, 2.1x150mm, 2.2 µm (P/N 071399-V)；

柱温：40 °C；

进样量：2 µL；

流动相：A为0.1%甲酸水溶液（含2.5mM甲酸铵）；

B为0.1%甲酸甲醇（含2.5mM甲酸铵）；

梯度洗脱程序见表3

表3 梯度洗脱程序

时间	A%	B%	流速mL/min
0.0	98	2	0.3
0.5	98	2	0.3
1.0	50	50	0.3
19.0	0	100	0.3
19.1	0	100	0.4
22.4	0	100	0.4
22.5	98	2	0.4
24.9	98	2	0.3
25.0	98	2	0.3

### 2.4 质谱条件：

可加热电喷雾电离源（HESI），正负离子切换扫描模式；

扫描方式：Timed-SRM；喷雾电压（+/-模式）：3500V；

离子传输管温度：325 °C；鞘气压力40 arb；辅助气压力10 arb；

反吹气：1 arb；离子源温度：350 °C；碰撞气压力：2 mTorr；

选择反应监测离子对信息见表4。

表4 375种农药质谱采集参数

序号	化合物	RT (min)	Polarity	Precursor (m/z)	Product (m/z)	CE (V)	Tube Lens (V)	Source Fragmentation
1	Abamectin B1a	18.96	Positive	895.5	449.1 751.3	44.68 40.68	160	47.3
2	Acephate	3.44	Positive	184	124.9 142.9	18.61 10.23	60	5.0
3	Acetamiprid	4.99	Positive	223	99.0 126.0	25.99 21.03	76	5.0
4	Acetochlor	12.08	Positive	270.1	148.1 224.1	20.39 10.23	98	0.0
5	Alachlor	12.22	Positive	270.1	162.1 238.1	20.73 10.23	76	5.0
6	Albendazole	8.86	Positive	266.1	190.8 233.9	32.86 19.67	104	19.6
7	Aldicarb	5.99	Positive	208	89.1 116.0	15.91 10.23	56	1.6
8	Aldicarb-sulfone	3.96	Positive	223	86.1 148.1	14.28 10.23	87	11.4
9	Aldicarb-sulfoxide	3.80	Positive	207	89.1 132.0	14.13 10.23	78	5.0
10	Ametoctradin	14.50	Positive	276.1	149.1 176.1	37.56 35.51	79	5.0
11	Ametryn	8.33	Positive	228.1	95.9 185.9	26.07 19.02	92	16.3
12	Amidosulfuron	7.65	Positive	370	218.0 261.0	23.28 13.3	81	0.0
13	Amisulbrom	18.50	Positive	466	148.0 226.9	47.27 20.16	120	0.0
14	Anilofos	13.35	Positive	368	124.8 198.8	31.27 14.21	91	3.3
15	Atrazine	9.91	Positive	216.1	103.9 174.0	28.35 17.35	86	11.4
16	Azinphos-methyl	9.53	Positive	317.9	125.0 132.0	17.43 14.74	79	0.0
17	Azoxystrobin	9.83	Positive	404.1	343.9 371.9	25.35 14.74	85	0.0

序号	化合物	RT (min)	Polarity	Precursor (m/z)	Product (m/z)	CE (V)	Tube Lens (V)	Source Fragmentation
18	Benalaxyl	13.44	Positive	326.2	91.0 148.1	41.22 21.22	76	5.0
19	Benazolin-ethyl	10.05	Positive	272	169.8 197.8	24.9 15	96	66.9
20	Bendiocarb	6.84	Positive	224.1	109.1 167.1	16.96 8.83	81	4.9
21	Bensulfuron-methyl	9.43	Positive	411	149.1 182.0	20.01 19.1	79	5.0
22	Benzovindiflupyr	13.52	Positive	398.1	342.0 378.0	17.22 13.55	105	11.4
23	Benzovindiflupyr-H	12.63	Negative	396	91.0 368.0	50.37 20.37	94	24.5
24	Benzoximate	14.17	Positive	364	105.0 199.0	30.6 10.23	66	5.0
25	Bifenox	17.59	Positive	359	310.0 342.0	12.16 25.68	90	0.0
26	Bifenthrin	19.72	Positive	440.1	166.1 181.1	40.18 12.69	109	0.0
27	Bioresmethrin	18.88	Positive	339.2	127.9 171.1	43.78 13.93	96	9.8
28	Bitertanol	14.15	Positive	338.2	251.0 269.1	12.23 10.23	79	5.0
29	Boscalid	10.64	Positive	342.9	140.0 307.0	21.87 19.36	71	5.0
30	Bromuconazole cis	11.45	Positive	378	159.0 161.2	27.7 27.58	90	6.5
31	Bromuconazole trans	13.06	Positive	378	159.0 161.2	27.7 27.58	90	6.5
32	Bupirimate	11.44	Positive	317.1	166.0 210.0	23.95 23.98	68	5.0
33	Buprofezin	15.70	Positive	306.2	115.8 200.9	16.56 12.54	64	0.0
34	Butachlor	16.29	Positive	312.2	162.0 237.9	23.42 10.23	88	6.5
35	Butralin	17.57	Positive	296.2	221.9 239.9	21.49 10.23	82	1.6
36	Cadusafos	14.59	Positive	271.1	131.0 158.8	31 14.59	87	6.5
37	Carbaryl	7.61	Positive	201.9	127.0 145.1	29.07 10.23	76	5.0
38	Carbendazim	4.10	Positive	191.9	131.9 160.0	30.21 18.3	69	5.0
39	Carbofuran	7.04	Positive	222	123.0 165.1	21.41 11.52	87	0.0
40	Carbofuran-3-Hydroxy	4.75	Positive	238	163.1 181.1	15.84 10.23	87	9.8
41	Carboxin	7.42	Positive	236.1	87.0 142.8	37 14.85	85	8.2
42	Carfentrazone-ethyl	13.01	Positive	411.9	346.1 366.0	22.85 17.24	82	5.0
43	Chlorantranilprole	9.34	Positive	484	286.0 453.0	11.44 17.24	89	5.0
44	Chlorbenzuron	12.01	Positive	309.1	139.0 156.0	27.54 13.93	84	4.9
45	Chlordimeform	4.13	Positive	197.2	89.3 117.0	47.29 27.03	73	11.4
46	Chlorfenvinphos	13.59	Positive	359	127.0 155.1	16 12.25	99	0.0
47	Chlorfluazuron	17.99	Positive	539.9	383.0 385.0	20.58 20.58	72	5.0
48	Chloridazon	5.04	Positive	222.1	92.1 104.1	25.98 22.31	83	21.2
49	Chlorimuron-ethyl	10.78	Positive	415	121.0 185.9	37 18.11	88	0.0
50	Chlorpropham	8.75	Positive	214.1	154.0 172.1	20.42 17.62	69	5.0

序号	化合物	RT (min)	Polarity	Precursor (m/z)	Product (m/z)	CE (V)	Tube Lens (V)	Source Fragmentation
51	Chlorpyrifos	16.92	Positive	349.9	97.0 197.9	34 18.68	100	9.8
52	Chlorpyrifos-methyl	14.83	Positive	321.9	125.0 125.0	19.55 19.55	85	5.0
53	Chlorsulfuron	7.35	Positive	358	140.9 166.9	21 20	95	0.0
54	Chlortoluron	8.36	Positive	213.2	45.9 72.1	15.95 18.23	77	8.2
55	Chromafenozide	11.60	Positive	395.3	175.1 339.1	16.04 7.32	76	0.0
56	Cinosulfuron	6.00	Positive	414.1	156.9 183.0	20.54 16.07	91	0.0
57	Clethodim	15.38	Positive	360.1	164.1 268.1	19.57 12.03	92	4.9
58	Clethodim sulfone	8.21	Positive	392.1	164.0 300.1	25 13.8	100	6.5
59	Clethodim Sulfoxide	9.29	Positive	376.1	164.1 206.1	22.86 15.28	97	6.5
60	Clofentezine	14.40	Positive	303	102.0 138.0	33.77 13.75	88	5.0
61	Clomazone	9.66	Positive	240	89.0 125.0	46.55 20.65	83	5.0
62	Clothianidin	4.60	Positive	250	132.0 169.0	16.44 12	62	5.0
63	Coumaphos	13.58	Positive	363	227.0 306.8	24.55 15.78	92	13.1
64	Coumoxystrobin	16.24	Positive	437.2	145.0 205.1	23.49 9.8	102	3.3
65	Cyanazine	6.27	Positive	241.1	104.0 214.1	29.79 17.28	70	5.0
66	Cyantranilprole	7.51	Positive	475	286.0 444.0	14.06 17.55	103	0.0
67	Cyazofamid	12.25	Positive	325	108.0 261.0	12.73 8.94	84	5.0
68	Cyazofamid metabolite CCIM	11.41	Negative	216.1	216.0 218.0	28 28	82	16.3
69	Cyclosulfamuron	11.60	Positive	422.1	218.0 260.9	30 16.86	86	0.0
70	Cycloxydim	15.33	Positive	326.1	180.1 280.1	22.02 14.09	89	5.0
71	Cyflufenamid	13.98	Positive	413.1	241.0 295.0	22.27 14.69	84	0.0
72	Cyflumetofen+NH4	15.37	Positive	465.2	173.0 249.0	23.58 13.72	104	0.0
73	Cyflumetofen+H	18.74	Positive	448.2	145.0 173.0	52.14 22.1	106	18.0
74	Cymoxanil	5.25	Positive	198.9	111.0 128.0	19.4 10.23	69	5.0
75	Cyproconazole	11.69	Positive	292.1	70.1 125.0	20.05 31.61	79	5.0
76	Cyprodinil	12.31	Positive	226.1	92.9 107.9	34.98 26.68	93	18.0
77	Deltamethrin	18.12	Positive	523	280.9 506.0	15.19 9.42	86	1.6
78	Demeton(O+S)	9.81	Positive	259	61.1 89.0	31.99 10.23	60	5.0
79	Demeton-S-methyl	7.05	Positive	231	61.0 89.1	29.49 10.23	78	5.0
80	Demeton-S-methyl-sulfone	3.99	Positive	263	124.8 168.8	23.5 16.37	90	13.1
81	Demeton-S-Sulfone	5.05	Positive	291.1	235.0 263.0	15.53 12.25	107	21.2
82	Demeton-S-Sulfoxide	4.89	Positive	275	141.0 197.0	21.34 12.41	91	11.4
83	Desmethyl-formamido-pirimicarb	6.62	Positive	253.1	72.1 225.2	17.01 10.98	78	0.0

序号	化合物	RT (min)	Polarity	Precursor (m/z)	Product (m/z)	CE (V)	Tube Lens (V)	Source Fragmentation
84	Desmethyl-pirimicarb	4.20	Positive	225.1	168.1 180.0	14.31 13.68	71	3.3
85	Diazinon	13.61	Positive	305.1	153.1 169.1	20.58 20.69	78	5.0
86	Dichlorvos	6.83	Positive	220.9	108.8 145.0	17.85 14.02	94	21.2
87	Diclobutrazol	13.10	Positive	328	70.0 70.0	35 35	78	0.0
88	Diclofop-methyl	18.98	Positive	358.1	280.8 340.8	14.59 10.23	87	0.0
89	Dicrotophos	4.23	Positive	237.9	112.0 193.1	11.95 9.42	71	0.0
90	Diethofencarb	9.96	Positive	268.2	179.9 225.9	18.26 10.23	96	6.5
91	Diethyl aminoethyl hexanoate	4.53	Positive	216.2	100.0 143.0	15.91 16.92	71	6.5
92	Difenoconazole	14.63	Positive	406	251.0 337.0	25.73 17.01	73	5.0
93	Diflubenzuron	12.71	Positive	311	141.0 158.0	31.84 13.72	84	5.0
94	Diflufenican	15.03	Positive	395.1	246.0 266.0	34.91 23.38	77	5.0
95	Dimepiperate	14.98	Positive	264	119.0 146.1	16.94 10.23	62	5.0
96	Dimethenamid-P	10.39	Positive	276.2	167.8 244.1	23.49 13.76	78	3.3
97	Dimethoate	4.94	Positive	229.9	124.9 198.9	21.37 10.23	60	5.0
98	Dimethomorph	10.22	Positive	388.1	165.1 301.0	31.23 20.39	75	5.0
99	Dimoxystrobin	12.96	Positive	327.2	205.0 238.1	10.14 10.6	71	0.0
100	Diniconazole	14.58	Positive	326.1	70.1 159.0	25.66 32.25	69	5.0
101	Dinocap	18.65	Negative	295	133.9 209.0	54.28 30.59	93	5.0
102	Dinotefuran	3.87	Positive	203	129.1 157.0	10.99 8.7	60	5.0
103	Disulfoton	14.53	Positive	275	61.0 89.1	33.32 10.23	68	5.0
104	Disulfoton sulfoxide	8.00	Positive	291	185.0 213.0	13.17 9.34	68	1.6
105	Disulfoton-sulfone	8.22	Positive	307.1	125.0 153.1	16.5 12.29	93	6.5
106	Diuron	9.07	Positive	233	46.0 72.1	16.63 18.64	76	5.0
107	Edifenphos	13.23	Positive	311	108.8 282.8	32.18 13.79	100	14.7
108	Emamectin-B1a-benzoate	15.30	Positive	886.5	82.0 158.2	52 39	152	0.0
109	Enestroburin	15.88	Positive	400.1	137.0 178.1	27.16 14.1	72	0.0
110	EPN	18.20	Positive	324.1	157.0 296.0	15.71 7.53	78	0.0
111	Epoxiconazole	12.18	Positive	330	101.1 121.1	43.63 20.84	88	5.0
112	Ethion	16.45	Positive	385	171.0 198.8	14 10.23	113	0.0
113	Ethiprole	10.45	Positive	396.9	255.0 350.9	35.17 20.43	76	5.0
114	Ethirimol	5.38	Positive	210.1	98.1 140.1	26.95 22.13	64	5.0
115	Ethofumesate	10.11	Positive	287	121.0 259.1	15.91 10.23	69	5.0
116	Ethoprophos	12.00	Positive	243	97.0 131.0	29.64 20	80	3.2

序号	化合物	RT (min)	Polarity	Precursor (m/z)	Product (m/z)	CE (V)	Tube Lens (V)	Source Fragmentation
117	Ethoxysulfuron	11.07	Positive	399	218.0 261.0	23.88 14.81	88	5.0
118	Etofenprox	19.66	Positive	394.1	107.0 177.2	48 13.68	102	11.4
119	Etoazole	17.21	Positive	360.1	141.0 304.1	30.28 17.62	76	5.0
120	Etrimfos	13.38	Positive	293.1	125.0 265.0	25.64 14.52	5	8.2
121	Famoxadone	13.72	Positive	392.2	237.9 330.9	17.28 10.23	97	0.0
122	Fenamidone	10.37	Positive	312	65.0 92.1	49 24.86	86	4.9
123	Fenaminstrobin	15.21	Positive	434.1	171.0 212.0	25.68 14.94	77	0.0
124	Fenamiphos	12.58	Positive	304.1	201.9 217.0	35.48 23.04	102	1.0
125	Fenamiphos-Sulfone	6.99	Positive	336.1	266.0 308.0	18.9 13.55	95	11.4
126	Fenamiphos-Sulfoxide	6.70	Positive	320.1	171.0 233.0	21.13 23.41	97	11.4
127	Fenarimol	12.00	Positive	331	258.8 267.9	24.94 22.93	82	0.0
128	Fenazaquin	18.87	Positive	307.2	130.9 161.1	45.79 16.98	89	9.8
129	Fenbuconazole	12.47	Positive	337	70.1 125.0	20.31 30.21	65	5.0
130	Fenhexamid	11.84	Positive	302	55.0 97.1	34.38 22.43	67	5.0
131	Fenobucarb	9.97	Positive	208.1	95.0 152.1	15.12 10.23	64	5.0
132	Fenothiocarb	12.96	Positive	254.1	72.0 160.1	17.3 9.76	75	0.0
133	Fenoxanil	12.54	Positive	329.1	86.0 301.9	30 10.23	100	16.3
134	Fenoxaprop-P-ethyl	15.68	Positive	362.1	244.0 288.0	22.94 17.68	98	9.8
135	Fenoxycarb	12.80	Positive	302.1	116.1 256.3	11.07 12.37	78	4.9
136	Fenpropathrin	17.49	Positive	350.2	97.1 125.1	28.67 12.33	69	18.0
137	Fenpropidin	8.04	Positive	274.2	117.0 147.1	51.78 28.61	70	5.0
138	Fenpropimorph	8.45	Positive	304.2	117.0 147.1	53.75 28.92	70	5.0
139	Fenpyrazamine	11.22	Positive	332.2	272.1 304.0	13.51 13.72	73	3.3
140	Fenpyroximate	17.82	Positive	422.2	138.0 366.0	33 16.03	96	1.6
141	Fensulfothion	8.60	Positive	309	252.9 281.0	15.78 12.58	93	8.2
142	Fensulfothion oxon	5.35	Positive	293.1	237.1 265.0	18.65 15.49	81	8.2
143	Fensulfothion oxon sulfone	5.54	Positive	309.1	175.0 253.0	24.8 15.7	87	11.4
144	Fensulfothion sulfone	8.92	Positive	325	269.0 296.9	15.28 10.9	97	9.8
145	Fenthion	10.42	Positive	279	169.0 247.0	18.06 12.62	79	5.0
146	Fenthion-sulfone	7.48	Positive	311	124.9 278.9	20.05 17.92	100	14.7
147	Fenthion-sulfoxide	7.08	Positive	295	109.0 280.0	31.72 18.53	79	5.0
148	Fenvalerate	17.70	Positive	437.2	125.0 167.1	40 16.37	95	0.0
149	Fipronil	12.73	Negative	434.9	249.9 329.9	26.34 15.12	68	5.0



序号	化合物	RT (min)	Polarity	Precursor (m/z)	Product (m/z)	CE (V)	Tube Lens (V)	Source Fragmentation
150	Fipronil desulfinyl	14.46	Negative	386.9	282.0 351.0	31 13	86	9.8
151	Fipronil sulfone	13.55	Negative	450.8	281.9 414.8	26 15.08	75	5.0
152	Fipronil sulfoxide	13.07	Negative	418.9	261.9 382.9	27.06 11.55	92	5.0
153	Flonicamid	4.11	Positive	230.1	148.0 202.8	25 17.35	83	9.8
154	Florasulam	5.43	Positive	360	108.9 129.0	53.48 24.63	107	13.1
155	Fluazifop	10.70	Positive	328	254.1 282.1	26.65 18.57	70	5.0
156	Fluazinam	16.35	Negative	462.8	397.9 415.9	15.35 18.8	85	5.0
157	Flubendiamide+H	12.89	Positive	683	273.8 407.9	31.38 10.23	118	0.0
158	Flubendiamide	12.89	Positive	705.1	531.1 571.1	32 29	118	0.0
159	Flucetosulfuron	9.99	Positive	488.1	156.1 273.0	20.12 25.26	97	0.0
160	Flucythrinate	17.03	Positive	469.2	181.0 412.2	45 12.58	103	0.0
161	Fludioxonil	10.64	Positive	266	158.0 229.1	35.36 10.23	66	5.0
162	Flufenacet	11.92	Positive	364	152.1 194.1	18.8 10.23	80	5.0
163	Flufenoxuron	17.36	Positive	489	141.0 158.1	32.75 18.95	123	5.0
164	Flumetralin	17.86	Positive	422.1	107.0 143.0	55 18.14	79	0.0
165	Flumetsulam	4.50	Positive	326.1	109.0 128.9	39 25.81	103	14.7
166	Flumorph	9.11	Positive	372.2	165.1 285.0	31.92 19.83	102	11.4
167	Fluopicolide	10.89	Positive	382.9	172.9 364.9	23.23 15	63	5.0
168	Fluopyram	11.61	Positive	397.1	172.8 207.8	28.69 21.9	97	6.5
169	Fluoroglycofen-ethyl	15.08	Positive	465	222.8 344.0	32.25 13.45	98	0.0
170	Flurtamone	10.10	Positive	334.1	246.9 303.0	26.72 18	99	11.4
171	Flusilazole	12.66	Positive	316.1	165.1 247.1	26.91 17.66	68	5.0
172	Fluthiacet-methyl	13.16	Positive	404	274.0 344.0	27.93 21.87	75	5.0
173	Flutolanil	10.84	Positive	324.1	262.1 282.1	17.89 11.2	79	5.0
174	Flutriafol	8.40	Positive	302	109.0 123.0	30 27.59	79	5.0
175	Fluxapyroxad	10.97	Positive	382	342.0 362.1	20.54 13.83	61	5.0
176	Fonofos	13.64	Positive	247	109.0 137.0	17.3 9.63	54	4.9
177	Forchlorfenuron	8.95	Positive	248	93.1 129.0	32.56 17.58	88	5.0
178	Formothion	9.42	Positive	258.1	124.7 199.0	23.74 12.16	49	0.0
179	Fosthiazate	7.83	Positive	284	104.0 228.0	21.3 10.23	70	5.0
180	Furathiocarb	15.77	Positive	383.2	195.2 252.2	19.07 11.32	75	0.0
181	Halosulfuron-methyl	12.01	Positive	435	139.0 182.1	42.45 19.55	64	5.0
182	Heptenophos	8.97	Positive	251	125.0 127.1	13.42 13.59	84	6.5

序号	化合物	RT (min)	Polarity	Precursor (m/z)	Product (m/z)	CE (V)	Tube Lens (V)	Source Fragmentation
183	Hexaconazole	13.99	Positive	314.1	70.1 158.9	20.8 32.14	60	5.0
184	Hexaflumuron	15.11	Positive	461	141.1 158.0	20 17.7	111	5.0
185	Hexazinone	6.97	Positive	253.1	71.1 171.1	30.24 15.91	75	5.0
186	Hexythiazox	16.84	Positive	353	168.0 228.0	24.41 14.85	85	5.0
187	Imazalil	6.90	Positive	297.1	159.0 200.9	23.04 17.77	91	9.8
188	Imibenconazole	16.35	Positive	411	125.0 171.0	28.92 16	103	8.2
189	Imidacloprid	4.47	Positive	256	175.1 209.1	18.8 16.37	76	5.0
190	Imidaclothiz	4.87	Positive	262	122.0 181.0	28.2 14.81	76	5.0
191	Indoxacarb	14.79	Positive	528.1	249.0 293.0	16.71 12	113	6.5
192	Iodosulfuron methyl	9.39	Positive	508	83.0 167.1	44.6 18.94	96	0.0
193	Ipconazole	15.21	Positive	334.1	69.9 125.0	22.89 40.9	89	5.0
194	Iprobenfos	12.89	Positive	289.1	91.0 204.9	21.68 10.23	92	0.0
195	Iprodione	14.00	Positive	330	245.0 288.0	15.19 12.58	87	5.0
196	Iprovalicarb	11.47	Positive	321	119.3 203.1	17.26 8.66	64	0.0
197	Isazafos	11.41	Positive	316	122.0 164.0	25.81 15.61	71	9.7
198	Isocarbophos	9.87	Positive	307.1	272.9 231.8	5 14	77.5	1.3
199	Isofenphos-Methyl	13.03	Positive	332.1	120.9 230.9	33.96 14.44	70	0.0
200	Isoprocarb	8.58	Positive	194	95.1 137.1	14.93 10.78	60	5.0
201	Isoprothiolane	10.90	Positive	291.1	188.9 231.0	20.99 10.23	50	0.0
202	Isoproturon	8.86	Positive	207.1	72.0 165.1	18.42 14.09	86	11.4
203	Isopyrazam	14.72	Positive	360.2	244.0 340.1	23.16 16.14	100	9.8
204	Isoxaflutole	8.99	Positive	360	144.0 251.0	46 16.79	89	5.0
205	Isoxaflutole-diketonitrile	6.69	Negative	358	64.0 79.1	35.2 14.98	76	0.0
206	Ivermectin	20.22	Positive	897.5	329.2 753.2	36 27	134	0.0
207	ivermectin1 B1a	20.19	Positive	892.5	551.3 569.3	21.51 14.14	157	0.0
208	ivermectin2 B1b	19.85	Positive	878.5	293.1 555.2	24.01 14.6	134	0.0
209	Kresoxim-Methyl	13.08	Positive	314.1	222.1 267.1	10.23 10.23	91	0.0
210	Kresoxim-Methyl+NH4	13.08	Positive	331.2	267.2 314.2	9.09 5.25	91	6.5
211	Lactofen	15.96	Positive	462	222.8 343.8	30.21 10.23	117	9.8
212	Linuron	10.31	Positive	248.9	159.9 182.0	20.58 10.23	89	5.0
213	Lufenuron	16.42	Positive	511	141.0 158.0	42.41 18.64	118	5.0
214	Malaoxon	6.80	Positive	315.1	99.0 127.0	22.52 12.03	81	0.0
215	Malathion	12.00	Positive	331	99.0 127.0	21.9 10.91	79	5.0

序号	化合物	RT (min)	Polarity	Precursor (m/z)	Product (m/z)	CE (V)	Tube Lens (V)	Source Fragmentation
216	Mandipropamid	10.59	Positive	412.1	328.0 356.0	14.28 10.23	100	8.2
217	Mefenacet	11.36	Positive	299	120.1 148.1	24.37 13.94	80	5.0
218	Mepronil	11.00	Positive	270.1	119.0 228.1	23.76 15.12	94	11.4
219	Mesosulfuron-methyl	8.19	Positive	504.1	139.0 182.0	48.14 22.85	102	0.0
220	Metaflumizone	16.07	Positive	507	178.1 287.1	24.63 24.1	84	5.0
221	Metalaxyl	8.60	Positive	280.2	192.3 220.1	18 14.4	85	6.5
222	Metamifop	15.69	Positive	441.1	180.0 288.0	19 18.73	121	0.0
223	Metamitron	5.15	Positive	203	104.0 175.1	23.12 16.79	81	5.0
224	Metazachlor	8.45	Positive	278.1	134.0 210.0	22.74 10.23	75	0.0
225	Metazosulfuron	10.45	Positive	476.1	182.0 295.0	18.56 15.49	91	0.0
226	Metazosulfuron-H	9.15	Negative	474.1	251.9 293.0	26.9 17.97	115	0.0
227	Metconazole	14.07	Positive	320.2	70.1 125.0	22.86 37.9	86	6.5
228	Methacrifos	9.39	Positive	241.1	125.0 209.0	12.58 5.25	75	0.0
229	Methamidophos	3.40	Positive	142	94.0 125.0	12.71 12.58	61	9.8
230	Methidathion	9.29	Positive	302.9	85.1 145.0	19.63 10.23	76	5.0
231	Methiocarb	10.44	Positive	226	121.0 169.1	18.64 10.23	65	5.0
232	Methiocarb sulfone	4.86	Positive	258	122.0 201.0	18.19 10.23	75	5.0
233	Methiocarb sulfoxide	4.50	Positive	242.1	122.0 185.0	28.65 13.26	70	5.0
234	Methomyl	4.21	Positive	163	88.0 106.0	10.23 10.23	67	5.0
235	Methoprene+H	16.75	Positive	311.3	191.1 279.2	13.09 6.9	47	0.0
236	Methoprene+NH4	16.75	Positive	328.3	279.2 311.2	9.34 5.25	91	6.5
237	Methoxyfenozide	10.94	Positive	369.2	149.1 313.2	16.98 10.23	76	5.0
238	Metolachlor	16.00	Positive	284.1	176.0 252.1	25.47 15.04	86	5.0
239	Metolcarb	6.53	Positive	166.2	94.0 109.1	30.19 10.64	82	0.0
240	Metrafenone	14.40	Positive	409.1	208.9 226.8	13.98 20.46	86	0.0
241	Metribuzin	7.01	Positive	215.1	84.0 187.0	21.6 18.42	87	11.4
242	Metsulfuron-Methyl	6.66	Positive	382.1	167.1 199.0	16 20	86	0.0
243	Mevinphos	5.00	Positive	225.1	127.0 193.0	20.67 6.64	60	0.0
244	Molinate	11.73	Positive	188.1	55.0 126.1	37.92 13.45	87	11.4
245	Monocrotophos	4.29	Positive	224.1	98.1 127.0	10.25 14.52	84	1.0
246	Myclobutanil	11.24	Positive	289.1	70.1 125.1	19.21 33.05	79	5.0
247	Napropamide	12.05	Positive	272.1	129.1 171.1	16.41 19.33	76	5.0
248	Nitenpyram	3.73	Positive	271	99.0 225.1	15 10.23	70	5.0

序号	化合物	RT (min)	Polarity	Precursor (m/z)	Product (m/z)	CE (V)	Tube Lens (V)	Source Fragmentation
249	Novaluron	15.30	Positive	493	141.0 158.1	42.07 18	87	5.0
250	Omethoate	3.57	Positive	213.9	109.0 182.9	22.43 10.23	74	5.0
251	Orthosulfamuron	8.58	Positive	425.1	199.0 227.0	12.16 15.19	83	0.0
252	Oxadiargyl	13.95	Positive	341	222.9 230.0	16.07 14.81	104	19.6
253	Oxadiazon	16.31	Positive	345.1	219.9 302.9	20.39 13.83	104	18.0
254	Oxadixyl	5.92	Positive	279	132.1 219.1	30.74 10.23	68	5.0
255	Oxamyl	3.81	Positive	237	72.0 90.1	10.23 10.23	60	5.0
256	Oxamyl-oxime	3.82	Positive	163	72.1 90.0	10.23 18.87	87	5.0
257	Oxaziclofone	15.58	Positive	376.1	133.0 190.0	27.29 13.45	89	5.0
258	Oxydemeton-methyl	3.87	Positive	247	127.0 169.0	25.06 13.83	67	5.0
259	Oxyfluorfen	13.38	Positive	362	237.0 316.0	24.71 14.18	99	0.0
260	Paclobutrazol	10.83	Positive	294.1	70.0 124.9	20.92 37.37	89	8.2
261	Parathion	11.76	Positive	292	235.9 264.0	15.35 10.23	92	0.0
262	Penconazole	13.31	Positive	284	70.1 159.0	17.85 30.21	78	5.0
263	Pencycuron	14.43	Positive	329.2	125.1 218.1	26.15 15.32	85	8.2
264	Pendimethalin	17.08	Positive	282.1	194.0 212.0	18.23 10.23	80	5.0
265	Penflufen	13.04	Positive	318.2	141.0 234.1	29.43 15.87	81	8.2
266	Penoxsulam	7.34	Positive	484.1	194.9 443.9	27.63 24.18	111	11.4
267	Penthiopyrad	13.23	Positive	360.1	256.0 276.0	20.54 14.52	100	9.8
268	Permethrin	19.04	Positive	408.1	183.0 355.2	16.37 7.86	70	3.3
269	Phenamacril	6.40	Positive	217.1	104.0 189.0	26 12.29	90	13.1
270	Phenmedipham+NH4	9.40	Positive	318.1	136.1 168.1	23.99 13.26	68	5.0
271	Phenmedipham	9.40	Positive	301	136.1 168.1	23.99 13.26	68	5.0
272	Phenthoate	12.93	Positive	321	79.0 163.0	45 14.82	93	6.5
273	Phorate	14.23	Positive	261	47.0 75.1	31.41 10.18	55	0.0
274	Phorate-Sulfone	8.33	Positive	293	96.9 115.0	31.92 19.25	70	9.8
275	Phorate-Sulfoxide	8.03	Positive	277.1	153.0 199.0	12.36 9	80	0.0
276	Phosalone	14.16	Positive	368	182.0 322.0	15.38 9.81	89	5.0
277	Phosfolan	5.60	Positive	256.1	140.0 228.0	27 11.49	80	5.0
278	Phosfolan methyl	4.21	Positive	227.9	108.9 167.9	26.04 15.04	72	5.0
279	Phosmet	9.63	Positive	317.9	133.0 160.1	35.44 10.23	68	5.0
280	Phosmet-oxon	5.81	Positive	302.2	133.0 160.0	43 17.62	103	14.7
281	Phosphamidon	5.89	Positive	300	127.0 174.1	21.01 12.5	80	6.5

序号	化合物	RT (min)	Polarity	Precursor (m/z)	Product (m/z)	CE (V)	Tube Lens (V)	Source Fragmentation
282	Phoxim	13.94	Positive	299.2	129.2 153.0	15 13	76	5.0
283	Picolinafen	16.19	Positive	377.1	238.0 358.9	25.89 19.36	113	8.2
284	Picoxystrobin	12.70	Positive	368.1	145.1 205.1	21.3 10.23	55	0.0
285	Piperonyl butoxide	16.31	Positive	356.2	119.1 177.1	33.62 10.23	77	5.0
286	Pirimicarb	5.87	Positive	239.1	72.1 182.1	21.68 15.84	75	5.0
287	Pirimiphos-methyl	13.91	Positive	306	108.0 164.1	30.17 22.28	72	5.0
288	Pretilachlor	15.17	Positive	312.2	176.1 252.1	27.48 15.72	88	6.5
289	Probenazole	6.25	Positive	224	39.0 41.0	49 44	88	9.8
290	Prochloraz	13.56	Positive	376	266.0 308.0	16.46 11.44	87	5.0
291	Prochloraz Metabolite Bts44596	13.74	Positive	353	308.0 310.0	13.68 13.72	79	3.3
292	Prochloraz Metabolite Bts44595	13.97	Positive	325	282.0 284.0	15.11 15.15	92	0.0
293	Procymidone	15.00	Positive	284	256.0 258.0	17 17	109	26.1
294	Profenofos	15.64	Positive	372.9	302.8 344.8	18.52 12.79	105	11.4
295	Promecarb	10.81	Positive	208.1	109.1 151.2	15.45 8.83	78	6.5
296	Prometryn	9.98	Positive	242.1	158.0 199.9	23.65 18.76	89	11.4
297	Propachlor	8.75	Positive	212	94.0 170.1	26.72 15.27	63	5.0
298	Propamocarb	3.61	Positive	189.1	74.0 102.1	25.13 17.62	80	5.0
299	Propanil	8.32	Positive	218	127.0 162.0	26.83 16.33	89	0.0
300	Propaquizafop	16.12	Positive	444	100.1 371.0	18.02 15.91	88	3.3
301	Propargite	17.28	Positive	368.1	175.1 231.1	15.46 10.23	79	5.0
302	Propiconazole	13.61	Positive	342	159.0 161.0	30.02 30.02	68	5.0
303	Propisochlor	12.29	Positive	284.1	212.0 224.0	15.08 10.23	106	0.0
304	Propoxur	6.96	Positive	210	111.1 168.1	13.8 7.86	64	3.3
305	Propyrisulfuron	11.00	Positive	456.1	196.0 218.0	14.9 12	90	0.0
306	Propyrisulfuron-H	11.00	Negative	454.1	154.1 273.1	22.35 14.6	104	0.0
307	Propyzamide	11.11	Positive	256	173.0 189.9	22.27 14.31	90	0.0
308	Proquinazid	18.24	Positive	373.1	288.9 330.9	22.48 14.86	54	24.5
309	Prosulfocarb	15.41	Positive	252.1	90.9 128.1	22.14 12.29	74	16.3
310	Pyraclostrobin	13.93	Positive	388.1	163.1 194.0	23.61 11.86	48	5.0
311	Pyraflufen-ethyl	13.47	Positive	413	253.0 339.0	34.23 19.7	109	16.3
312	Pyrametostrobin	12.75	Positive	382.2	163.1 194.0	23.49 10.6	71	0.0
313	Pyraoxystrobin	14.01	Positive	413.1	145.0 205.0	23.62 10.14	83	0.0
314	Pyrazosulfuron-ethyl	11.76	Positive	415.1	139.0 182.0	40.97 18.53	88	0.0

序号	化合物	RT (min)	Polarity	Precursor (m/z)	Product (m/z)	CE (V)	Tube Lens (V)	Source Fragmentation
315	Pyrethrin I	17.56	Positive	329.1	133.1 161.1	17.55 9.8	82	3.3
316	Pyrethrin I+NH4	17.56	Positive	346.2	161.1 329.2	12.03 5.25	82	3.3
317	Pyrethrin II	14.94	Positive	373.2	133.1 161.1	17.01 9.38	74	13.1
318	Pyribenzoxim	15.84	Positive	610.2	180.1 413.1	40.79 22.79	117	0.0
319	Pyribenzoxim+Na	15.84	Positive	632.2	180.0 488.1	39.79 19.87	117	0.0
320	Pyridaben	18.45	Positive	365.1	147.0 309.0	24.9 12.92	86	5.0
321	Pyridalyl	20.33	Positive	490	108.9 111.0	27.21 27.21	105	0.0
322	Pyridaphenthion	11.23	Positive	341.1	189.0 204.9	21.41 21.03	101	11.4
323	Pyrifthalid	9.64	Positive	319.1	139.0 219.9	28.42 23.27	97	13.1
324	Pyrimethanil	9.70	Positive	200.1	168.0 183.0	24.03 24.03	89	16.3
325	Pyrimorph	13.65	Positive	385.2	242.0 272.0	27.45 30.45	109	14.7
326	Pyriproxyfen	16.67	Positive	322.1	96.0 185.0	15.61 24.51	79	3.3
327	Pyrisoxazole	8.12	Positive	289.1	120.0 151.1	20.29 14.98	96	6.5
328	Quinalphos	13.08	Positive	299.1	147.0 163.0	21.71 21.11	86	8.2
329	Quizalofop-ethyl	15.75	Positive	373.1	271.0 298.9	25.62 19.02	99	9.8
330	Rotenone	12.58	Positive	395.1	192.1 213.1	23.19 21.98	74	5.0
331	Saflufenacil	9.52	Positive	501.1	348.8 459.0	26.72 13.32	119	18.0
332	Sedaxane	11.43	Positive	332.2	159.0 292.1	19.87 14.98	86	0.0
333	Sethoxydim	15.33	Positive	328.1	178.1 282.1	18.68 11.14	79	5.0
334	Silthiofam	12.88	Positive	268.1	139.0 252.0	19.83 8.83	79	0.0
335	Simazine	7.14	Positive	202	104.0 123.9	24.86 18.07	66	5.0
336	Simetryn	6.76	Positive	214.1	95.9 124.0	24.22 19.55	88	13.1
337	Spinetoram J	13.82	Positive	748.5	142.0 203.0	26 30	120	0.0
338	Spinetoram L	15.51	Positive	760.4	97.9 142.0	42.38 28.8	140	0.0
339	Spinosad A	12.81	Positive	732.5	98.1 142.1	43.78 28.05	125	5.0
340	Spinosad D	13.69	Positive	746.5	98.1 142.1	44.01 28.05	130	5.0
341	Spirodiclofen	17.71	Positive	411	71.1 312.9	15.53 10.23	94	5.0
342	Spiromesifen	17.03	Positive	388.2	255.1 273.3	26.9 8.62	68	0.0
343	Spirotetramat	11.63	Positive	374.2	302.0 330.1	18 15.5	94	4.9
344	Spirotetramat Metabolite-enlo	7.83	Positive	302.3	216.1 270.1	27.49 20.04	99	14.7
345	Spirotetramat Metabolite-enol-glucoside	4.24	Positive	464.2	216.1 302.1	43.8 14.44	84	0.0
346	Spirotetramat Metabolite-keto-hydroxy	8.97	Positive	318.2	214.0 300.1	27 12.33	82	8.2
347	Sulfentrazone	7.15	Positive	387	146.0 306.9	54 20.73	125	5.0

序号	化合物	RT (min)	Polarity	Precursor (m/z)	Product (m/z)	CE (V)	Tube Lens (V)	Source Fragmentation
348	Sulfotep	13.15	Positive	323	115.0 171.0	28.38 13.13	83	0.0
349	Sulfoxaflor	5.01	Positive	278.1	154.0 174.0	28.39 10.23	102	0.0
350	tau-Fluvalinate	18.75	Positive	503.1	181.0 208.0	25.13 11.36	85	6.5
351	tau-Fluvalinate+NH4	18.75	Positive	520.2	208.1 503.1	15.24 7.4	85	6.5
352	Tebuconazole	13.38	Positive	308.1	70.1 125.0	22.17 37.3	77	5.0
353	Tebufenozide	12.63	Positive	353.2	133.1 297.1	19.4 10.23	77	5.0
354	Tebuthiuron	7.15	Positive	229.1	115.9 172.1	26.64 17.77	76	5.0
355	Teflubenzuron	16.54	Positive	381	141.0 158.0	34.3 15.84	89	5.0
356	Terbufos	16.06	Positive	289.1	103.0 232.9	10.23 10.23	92	0.0
357	Terbufos Sulfone	9.92	Positive	321.1	97.0 115.1	45 26.64	97	1.0
358	Terbufos Sulfoxide	9.89	Positive	305.1	131.0 187.0	27.82 10.23	97	0.0
359	Terbutylazine	10.51	Positive	230.1	104.0 174.0	33.43 17.17	83	9.8
360	Tetraconazole	12.05	Positive	372	70.1 159.0	22.02 31.34	72	5.0
361	Thiabendazole	4.39	Positive	202.1	131.0 175.0	33.05 25.3	70	5.0
362	Thiacloprid	5.19	Positive	253	99.0 126.0	42.35 21.18	79	5.0
363	Thiamethoxam	4.10	Positive	292	181.1 211.0	21.76 11.95	75	5.0
364	Thidiazuron	6.94	Positive	221	101.9 127.9	15.95 16.82	86	8.2
365	Thifensulfuron methyl	6.38	Positive	388	167.0 204.8	15.23 26.04	85	0.0
366	Thifluzamide	12.40	Positive	528.8	148.0 488.9	37.35 27.2	117	18.0
367	Thiophanate-methyl	6.66	Positive	343	151.0 311.0	20.12 10.23	69	5.0
368	Tolclofos-methyl	14.32	Positive	300.9	175.0 268.9	24.43 16.56	63	5.0
369	Tolfenpyrad	16.30	Positive	384.1	171.0 197.0	23.16 24.79	82	5.0
370	Tralkoxydim	17.00	Positive	330.1	96.0 284.1	32.59 12.54	76	5.0
371	Triadimefon	11.16	Positive	294.1	196.9 224.9	15.35 13.07	88	8.2
372	Triadimenol	11.55	Positive	296	70.0 227.0	10.23 10.23	83	3.3
373	Triallate	17.06	Positive	304	83.0 142.8	52 27.02	100	8.2
374	Triasulfuron	6.30	Positive	402	141.1 167.1	19.63 16.56	71	5.0
375	Triazophos	11.45	Positive	314.1	118.9 162.0	34 18.45	91	6.5
376	Tribenuron-methyl	8.22	Positive	396	155.1 181.0	10.72 19.4	89	5.0
377	Trichlorfon	4.95	Positive	256.9	109.0 220.9	17.17 10.23	79	5.0
378	Tricyclazole	5.75	Positive	190	136.0 163.0	28.2 22.51	75	5.0
379	Trifloxystrobin	14.89	Positive	409.1	145.0 186.0	43.1 17.2	95	5.0
380	Triflumizole	14.95	Positive	346.1	73.0 278.0	16.37 10.23	77	0.0

序号	化合物	RT (min)	Polarity	Precursor (m/z)	Product (m/z)	CE (V)	Tube Lens (V)	Source Fragmentation
381	Triflumizole metabolite	5.44	Positive	295.1	195.0 215.0	25.65 22.65	96	11.4
382	Triflumuron	14.08	Positive	359	111.0 138.9	52.74 30.74	76	5.0
383	Triflusulfuron-methyl	10.52	Positive	493.1	264.0 460.6	20.16 12.33	85	0.0
384	Triticonazole	13.00	Positive	318.1	70.1 125.1	18.4 33.9	84	3.3
385	Tritosulfuron	10.00	Positive	446.1	195.1 221.0	18.27 17.85	100	6.5
386	Uniconazole	15.00	Positive	292.1	70.0 124.9	24.18 29.33	97	13.1
387	Vamidothion	4.68	Positive	288	117.9 146.1	22.36 11.74	70	5.0
388	Vamidothion-sulfone	3.96	Positive	319.9	58.0 178.0	31.27 14.81	76	5.0
389	Vamidothion-sulfoxide	3.79	Positive	304	108.9 200.9	29.07 12.69	83	5.0
390*	Zoxamide	13.74	Positive	336	186.9 204.0	21.75 12.34	57	5.0

\*采集方法涵盖不同化合物多种加合模式以及个别化合物的代谢物

## 2.5 样品前处理

### 2.5.1 蔬菜、水果、食用菌和糖料

称取10 g试样(精确至0.01 g)于50 mL塑料离心管中,加入10 mL乙腈及1颗陶瓷均质子,剧烈震荡1 min,加入4 g无水硫酸镁、1g氯化钠、1 g柠檬酸钠、0.5 g柠檬酸氢二钠(P/N 60105-333-B),剧烈震荡1 min后4200 r/min离心5 min。吸取1mL上清液至内含150 mg无水硫酸镁、25 mg PSA的2mL塑料离心管中(P/N 60105-219-B);对于颜色较深的试样,离心管中另加入2.5 mg GCB(P/N 60105-221-B),涡旋混匀1 min。4200 r/min离心5 min,吸取上清液过微孔滤膜,待测定。

注:对于干制蔬菜、水果和食用菌,称取1 g试样(精确至0.01g)于50mL塑料离心管中,加9 mL水涡旋混匀,静置30 min后按上述方式处理。

### 2.5.2 谷物、油料和坚果

称取5 g试样(精确至0.01 g)于50 mL塑料离心管中,加10 mL水涡旋混匀,静置30 min。加入15 mL 乙腈-醋酸溶液及1颗陶瓷均质子,剧烈震荡1 min,加入6 g无水硫酸镁、1.5 g醋酸钠(P/N 60105-335-B),剧烈震荡1 min后4200 r/min离心5 min。吸取1mL上清液至内含150 mg无水硫酸镁、50 mg C18和50 mg PSA的2mL塑料离心管中(P/N 60105-204-B),涡旋混匀1 min。4200 r/min离心5 min,吸取上清液过微孔滤膜,待测定。

### 2.5.3 茶叶和香辛料

称取2 g试样(精确至0.01 g)于50 mL塑料离心管中,加10 mL水涡旋混匀,静置30 min。加入15 mL 乙腈-醋酸溶液及1颗陶瓷均质子,剧烈震荡1 min,加入6 g无水硫酸镁、1.5 g醋酸钠(P/N 60105-335-B),剧烈震荡1 min后4200 r/min离心5 min。吸取1mL上清液至内含150 mg无水硫酸镁、50 mg C18、50 mg PSA 和25 mg GCB的2mL塑料离心管中(P/N 60105-380-B),涡旋混匀1 min。4200 r/min离心5 min,吸取上清液过微孔滤膜,待测定。

### 2.5.4 植物油

称取2 g试样(精确至0.01 g)于50 mL塑料离心管中,加入5 mL水。加入10 mL乙腈及1颗陶瓷均质子,剧烈震荡1 min,加入4 g无水硫酸镁、1 g氯化钠、1 g柠檬酸钠、0.5 g柠檬酸氢二钠(P/N 60105-333-B),剧烈震荡1 min后4200 r/min离心5 min。吸取1mL上清液至内含150 mg无水硫酸镁、50 mg C18和50 mg PSA的2mL塑料离心管中(P/N 60105-204-B),涡旋混匀1 min。4200 r/min离心5 min,吸取上清液过微孔滤膜,待测定。

注:测定蔬菜、水果、食用菌、糖料、植物油中磺酰胺类除草剂、环己烯酮类除草剂(烯草酮、烯草酮砒、烯草酮亚砒、噻草酮、三甲苯草酮、烯禾啶)、三唑并嘧啶磺酰胺类除草剂(双氟磺草胺、唑啶磺草胺、五氟磺草胺)、氟啶胺、螺虫乙酯及其代谢物、甲磺草胺、苯嘧磺草胺、苯噻隆、氟霜唑代谢物CCIM和异噁唑草酮-二酮腈时,PSA的用量降低至每毫升提取液5 mg(P/N 60105-381-B/60105-382-B),谷物、油料、坚果降低至每毫升提取液10 mg(P/N 60105-383-B)。

## 3. 实验结果与讨论

### 3.1 快速定量筛查方法的建立

基于Trace Finder 软件强大的农药残留数据库功能,可以通过GB23200.121方法包中提供的仪器采集方法,或者XML格式的方法文件,在质谱模块TSQ下拉菜单导入Mass list XML格式的农残化合物信息列表,可快速建立植物源性基质多农残的定量筛查采集方法。包含全部375种农药化合物保留时间、离子对(母离子和子离子)、Lens电压和碰撞能量等一系列质谱参数(如图2所示),无需手动输入化合物的信息,使用方便,既节约大量的工作时间,也避免手动输入引起的错误。利用赛默飞三重四极杆快速高效扫描功能(600 SRM /s),采用Timed-SRM模式,可实现对植物源性食品中多农残进行高通量的采集。



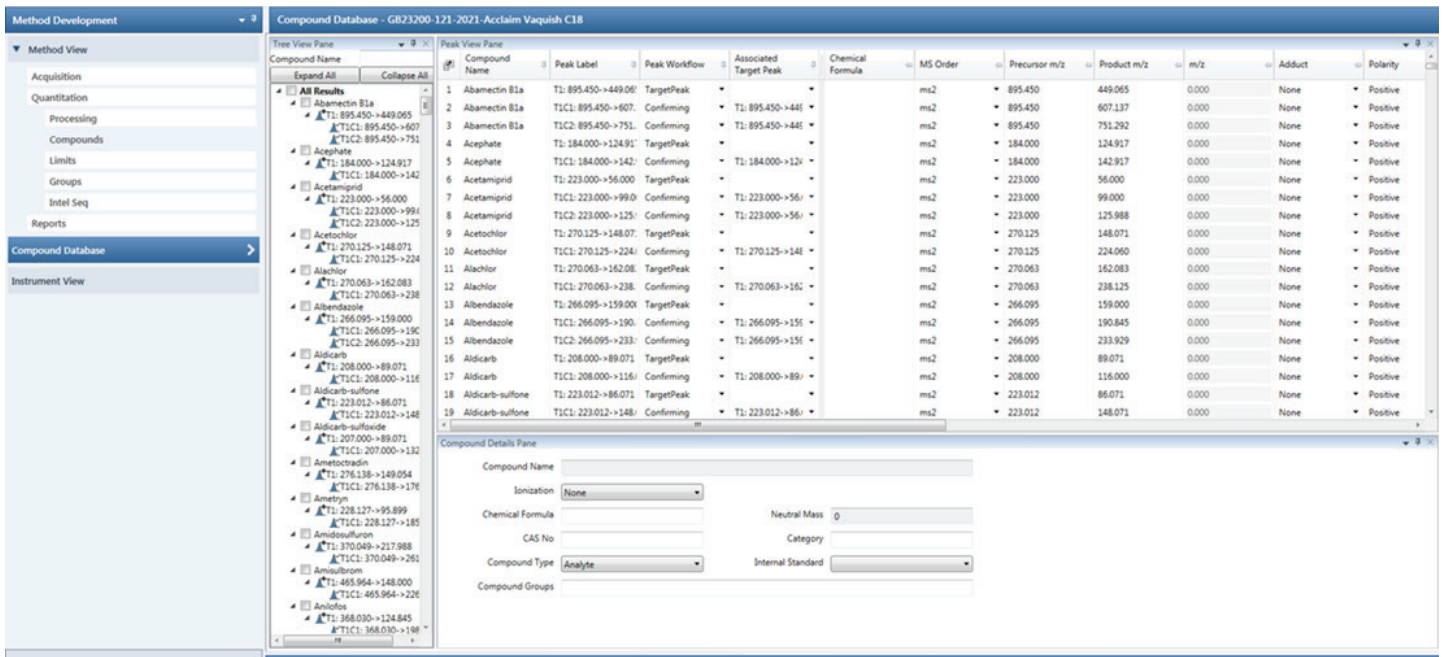


图1. 375 种农药化合物数据库信息

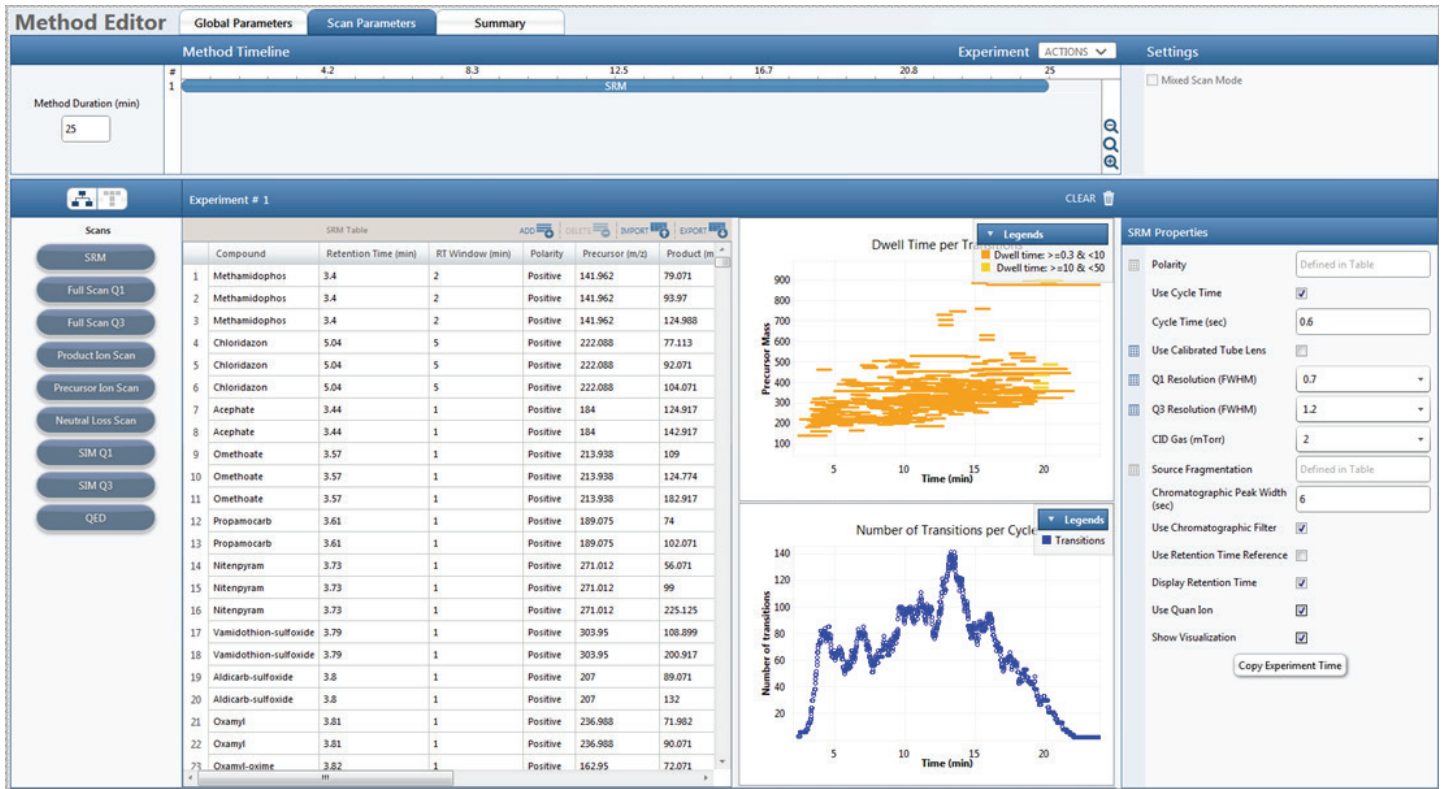


图2. 375 种农药化合物仪器采集方法

### 3.2 色谱图

本方法基于赛默飞QuEChERS提取盐包以及净化盐包对五种植物源性样品进行前处理，在TSQ Fortis上一针进样，正负模式同时

采集，可在20 min内轻松实现对植物源性食品中375种农药的筛查和确证可大大节省人力和物力成本。对称且尖锐的色谱峰表明待测农药组分在保留时间窗口内均可以实现高效的色谱分离效果（如图3）。

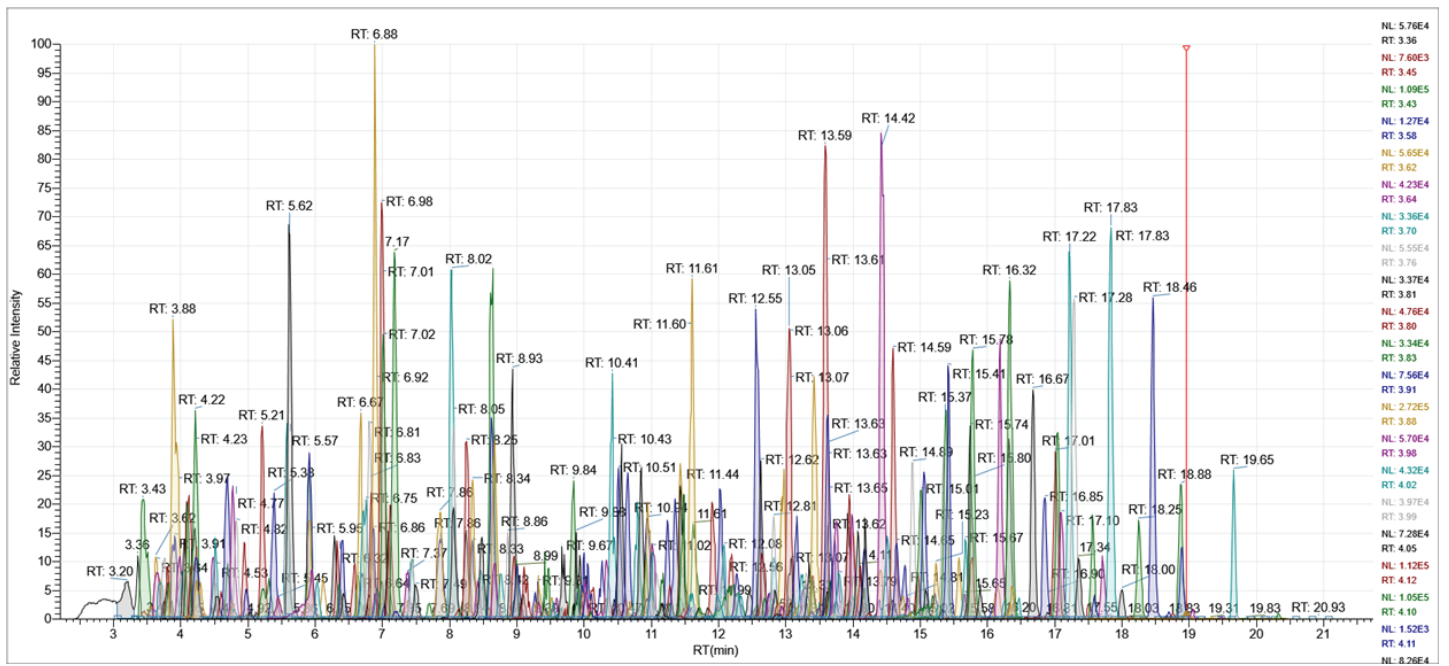


图3 黄瓜基质中375种农药的TIC图 (5.0 ng/mL)

### 3.3 方法灵敏度，线性及范围

采用2.3及2.4的仪器采集方法，可以在确定农药种类的同时对样品中含有的农药残留进行定量分析。色谱-质谱联用技术对于复杂基质中待测组分的检测过程中，由于样品基质引起的基质效应非常普遍，通常气质表现为基质效应增强，液质则表现为基质效应抑制。本文通过五种植物源性样品空白基质，进样浓度在2.5-200 ng/mL的

范围内的7个校准级别的标准品得到校正曲线，分别对五种植物源性样品中的农药残留进行定量分析。结果表明在基质标准条件下，待测所有的农残组分的线性相关系数 $R^2$ 均大于0.99，线性关系良好（表4）。方法中375种农残的定量限均可以达到GB23200.121中规定的五种基质对应的定量限要求，能够满足常规多农残留检测的需求。在定量限条件下，所有测定农残化合物均能获得良好的谱图效果（图4），可实现准确定量定性分析。

表4 黄瓜基质中375种农药的标曲范围、相关系数等参数(部分)

序号	化合物	线性范围	线性方程	$R^2$
1	Cyanazine	2.5-100 ng/mL	$Y=1.18e4*X-6.035e3$	0.9988
2	Propyzamide	2.5-100 ng/mL	$Y=2.612e4*X+6.269e3$	0.9995
3	Formothion	2.5-100 ng/mL	$Y=4.539e3*X+8.441e2$	0.9992
4	Clomazone	2.5-100 ng/mL	$Y=3.781e4*X-5.045e4$	0.9978
5	Fenobucarb	2.5-100 ng/mL	$Y=9.677e3*X+4.798e3$	0.9990
6	Linuron	2.5-100 ng/mL	$Y=1.052e4*X-1.618e4$	0.9981
7	Azoxystrobin	2.5-100 ng/mL	$Y=3.893e4*X-1.42e4$	0.9988
8	Fluazifop	2.5-100 ng/mL	$Y=4.214e3*X-2.744e3$	0.9997
9	Boscalid	2.5-100 ng/mL	$Y=8.379e3*X-2.792e3$	0.9999
10	Mevinphos	2.5-100 ng/mL	$Y=4.627e4*X-6.049e4$	0.9989
11	Promecarb	2.5-100 ng/mL	$Y=3.936e4*X-3.26e4$	0.9997
12	Triflurosulfuron-methyl	2.5-100 ng/mL	$Y=3.709e4*X+6.286e4$	0.9980
13	Dimethomorph	2.5-100 ng/mL	$Y=1.692e4*X+1.833e4$	0.9990
14	Fluopicolide	2.5-100 ng/mL	$Y=1.449e4*X+5.308e3$	0.9992
15	Fluxapyroxad	2.5-100 ng/mL	$Y=1.941e4*X+1.095e4$	0.9998
16	Bromuconazole trans	2.5-100 ng/mL	$Y=2.152e3*X+2.088e3$	0.9997
17	Fenarimol	2.5-100 ng/mL	$Y=2.768e3*X+7.862e3$	0.9973
18	Triticonazole	2.5-100 ng/mL	$Y=4.46e3*X-8.06e2$	0.9991
19	Epoxiconazole	2.5-100 ng/mL	$Y=1.177e4*X+1.63e4$	0.9997
20	Tetraconazole	2.5-100 ng/mL	$Y=8.829e3*X-5.514e3$	0.9995
21	Penflufen	2.5-100 ng/mL	$Y=4.559e4*X-5.81e2$	1.0000
22	Diclobutrazol	2.5-100 ng/mL	$Y=7.84e3*X+4.998e3$	0.9999
23	Chlorobenzuron	2.5-100 ng/mL	$Y=1.154e4*X+3.982e3$	0.9999
24	Haloxypol	2.5-100 ng/mL	$Y=2.664e3*X+1.128e3$	0.9985
25	Fipronil sulfoxide	2.5-100 ng/mL	$Y=9.539e2*X+9.117e2$	0.9967
26	Tebuconazole	2.5-100 ng/mL	$Y=7.067e3*X+9.656e3$	0.9978
27	Benalaxyl	2.5-100 ng/mL	$Y=4.311e4*X-4.847e4$	0.9975

28	Coumaphos	2.5-100 ng/mL	$Y=1.539e4*X-9.378e3$	0.9986
29	Prochloraz	2.5-100 ng/mL	$Y=1.178e4*X-1.153e4$	0.9996
30	Pyraclostrobin	2.5-100 ng/mL	$Y=1.417e4*X-1.186e4$	0.9973
31	Metconazole	2.5-100 ng/mL	$Y=1.4e4*X+4.497e3$	0.9997
32	Phosalone	2.5-100 ng/mL	$Y=9.452e3*X+1.295e4$	0.9998
33	Benzoximate	2.5-100 ng/mL	$Y=1.41e4*X-1.531e4$	0.9995
34	Spinosyn A	2.5-100 ng/mL	$Y=1.22e4*X+2.934e4$	0.9980
35	Bitertanol	2.5-100 ng/mL	$Y=4.415e3*X+4.141e3$	0.9989
36	Pencycuron	2.5-100 ng/mL	$Y=7.776e4*X-6.889e4$	0.9992
37	Ametoctradin	2.5-100 ng/mL	$Y=1.576e4*X-2.053e4$	0.9989
38	Difenoconazole	2.5-100 ng/mL	$Y=1.74e4*X-2.544e3$	0.9996
39	Dimepiperate	2.5-100 ng/mL	$Y=1.967e4*X+1.55e4$	0.9996
40	Cycloxydim	2.5-100 ng/mL	$Y=2.15e4*X-1.985e4$	0.9993
41	Diflufenican	2.5-100 ng/mL	$Y=1.79e4*X-2.45e4$	0.9989
42	Pyrethrin II	2.5-100 ng/mL	$Y=2.913e3*X-4.421e2$	0.9998
43	Spinosyn D	2.5-100 ng/mL	$Y=1.544e4*X+1.051e3$	0.9995
44	Clethodim	2.5-100 ng/mL	$Y=3.635e4*X+5.629e4$	0.9994
45	Buprofezin	2.5-100 ng/mL	$Y=7.287e3*X-5.96e3$	0.9980
46	Furathiocarb	2.5-100 ng/mL	$Y=3.749e4*X-9.399e3$	0.9998
47	Propaquizafop	2.5-100 ng/mL	$Y=4.844e4*X-3.235e3$	0.9998
48	Tralkoxydim	2.5-100 ng/mL	$Y=1.796e4*X-3.077e3$	0.9999
49	Spiromesifen	2.5-100 ng/mL	$Y=2.14e4*X-6.525e3$	0.9997
50	Etoazole	2.5-100 ng/mL	$Y=5.829e4*X-3.527e4$	0.9999
51	Pyrethrin I	2.5-100 ng/mL	$Y=4.397e3*X-2.231e3$	0.9999
52	Flufenoxuron	2.5-100 ng/mL	$Y=3.856e4*X+2.803e3$	0.9999
53	Fenpyroximate	2.5-100 ng/mL	$Y=3.879e4*X+8.839e3$	0.9999
54	Proquinazid	2.5-100 ng/mL	$Y=1.43e4*X+1.888e3$	0.9999
55	Spirodiclofen	2.5-100 ng/mL	$Y=5.666e3*X+1.224e3$	0.9996
56	Dinocap	2.5-100 ng/mL	$Y=1.01e2*X+1.892e2$	0.9970
57	Fenazaquin	2.5-100 ng/mL	$Y=2.416e4*X-2.105e4$	0.9996
58	Chlorfluazuron	2.5-100 ng/mL	$Y=1.94e3*X-1.142e2$	0.9995
59	Molinate	2.5-100 ng/mL	$Y=7.652e2*X+6.6e2$	0.9994
60	Pyridaben	2.5-100 ng/mL	$Y=4.625e4*X-6.151e3$	0.9994

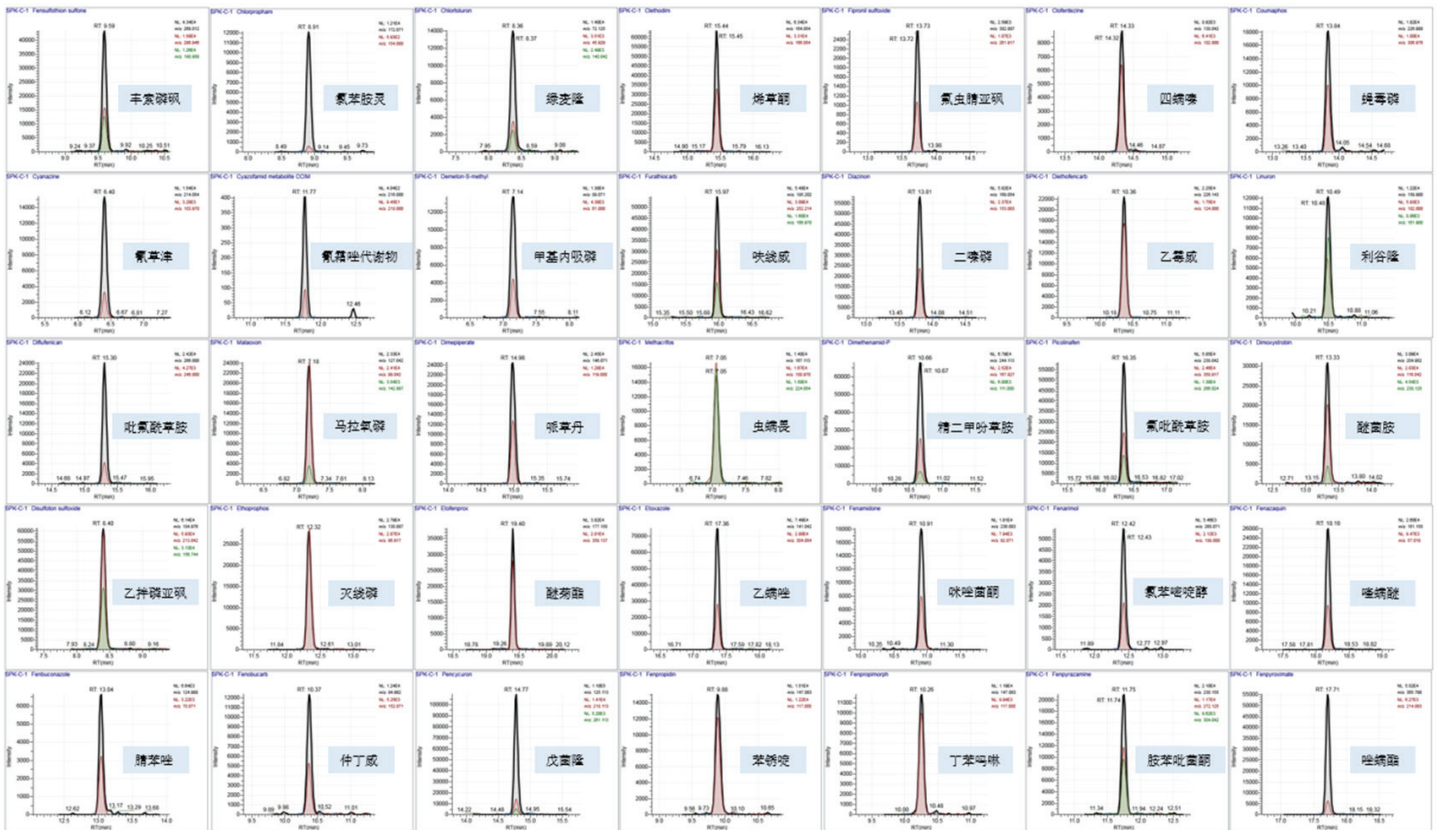


图4 基质曲线5.0 ng/mL浓度下部分化合物的定量定性离子叠图

### 3.4 方法精密度和回收率

分别在五种样品基质的定量限添加水平下进行了加标回收率的测试，考查了赛默飞三重四级杆平台对375种农药的稳定性。结果表明，除了茶叶以外（86.4%），其他四种样品基质90%以上的农残均可以实现回收率在70-120%之间，表5汇总了部分化合物的加标

回收率和精密度结果。采用标准中规定的QuEChERS前处理方法可能会导致部分农药出现回收率偏低的情况，可通过如下的一些方法来解决：一是按标准的要求对净化管中相关填料的比例进行调整来进行前处理；而对于一些基质比较干净的样品，也可以不用净化，待QuEChERS提取过程完成后，直接取适量的有机相上机检测，这样可以避免净化过程中由于填料的吸附引起的回收率低的情况。

表5 五种植物源性基质在定量限水平下部分化合物的回收率及精密度（n=6）

化合物名称	茶叶		玉米粉		黄瓜		豆角		番茄	
	回收率 (%)	RSD (%)	回收率 (%)	RSD (%)	回收率 (%)	RSD (%)	回收率 (%)	RSD (%)	回收率 (%)	RSD (%)
阿维菌素	115.9	6.48	82.2	2.91	82.5	8.49	101.6	7.12	95.9	9.22
啶虫脒	94.5	2.67	108.7	2.32	87.6	6.58	77.8	4.18	94.3	3.76
甲草胺	100.9	1.99	90.0	7.46	107.2	6.21	100.6	4.17	90.1	2.43
涕灭威砒	83.5	5.48	107.2	1.73	99.0	2.14	99.4	3.56	93.2	7.14
吡唑醚菌酯	95.1	5.66	87.0	2.57	91.3	4.69	96.6	3.89	98.3	4.78
苯霜灵	87.3	3.34	101.6	3.00	95.9	3.62	96.3	5.77	101.1	3.55
恶虫威	84.5	3.69	88.7	3.96	102.4	2.69	108.2	7.31	96.1	2.35
苯螨特	82.0	5.08	98.8	5.15	107.6	2.44	87.0	5.36	82.0	4.46
生物苜蓿菊酯	90.9	1.77	84.9	2.03	81.0	4.17	109.1	1.75	85.7	2.03
联苯三唑醇	84.1	6.19	76.2	1.80	68.1	8.89	122.8	5.65	108.8	9.25
啶酰菌胺	87.6	2.70	75.8	3.37	82.2	5.69	93.5	8.76	88.0	8.96
甲萘威	92.3	5.35	97.2	6.50	89.5	6.48	108.8	9.17	102.8	2.98
克百威	88.8	6.73	116.8	1.69	105.8	4.07	103.3	7.05	109.3	4.29
氟啶脲	89.0	5.03	93.8	2.54	113.6	8.44	77.3	8.27	105.9	7.69
毒死蜱	88.8	4.70	88.9	3.69	113.2	6.17	98.7	5.34	103.5	1.99
绿麦隆	82.3	3.32	96.9	2.13	94.3	8.07	101.6	0.92	97.9	1.34
蝇毒磷	86.9	4.94	95.8	0.97	84.4	5.48	99.5	5.86	104.4	2.92
氟草津	87.2	1.88	96.4	2.01	96.1	3.61	106.7	4.00	94.0	5.59
氟霜唑	101.3	5.51	83.1	2.71	74.0	5.18	109.1	1.77	102.6	5.48
噻草酮	96.1	6.72	100.1	0.65	79.5	2.61	90.2	9.52	113.5	3.77
甲基内吸磷	98.3	5.23	73.5	3.50	113.5	6.90	92.7	1.63	85.4	7.14
二嗪磷	89.6	2.82	106.2	0.39	92.7	9.03	93.2	7.48	104.0	3.91
百治磷	81.1	3.05	101.5	1.58	90.6	1.47	101.1	4.84	96.0	4.81
啶草丹	102.9	3.58	82.0	2.11	106.9	6.92	78.2	5.85	94.3	7.47
醚菌胺	96.7	1.86	87.8	2.57	83.2	10.63	91.3	7.61	87.0	1.99
乙拌磷亚砒	83.8	4.41	89.3	0.88	92.9	8.42	102.1	2.49	97.5	3.11
乙拌磷砒	83.5	6.11	97.1	1.69	88.3	7.24	103.6	4.19	88.5	9.54
敌草隆	97.2	0.23	96.4	1.52	95.2	5.30	100.1	0.95	98.0	5.71
乙虫腈	96.5	3.18	76.7	2.48	90.0	9.58	110.0	5.70	107.8	10.02
灭线磷	92.7	5.40	79.5	2.79	96.4	7.76	91.8	6.63	106.8	0.91
醚菊酯	88.4	1.79	92.3	0.62	90.3	1.71	96.3	1.00	95.6	2.20
乙螨唑	89.3	1.33	87.1	1.06	92.3	4.83	93.5	1.21	98.3	1.65
啉霉胺	88.4	6.65	92.3	3.95	90.3	6.16	96.3	5.21	95.6	3.48
吡丙醚	89.3	3.24	87.1	2.07	92.3	3.72	93.5	4.15	98.3	2.36
氟苯啉啶醇	90.5	0.75	80.1	5.87	86.4	8.65	109.5	6.72	82.2	2.47
胺苯吡菌酮	109.1	0.83	86.8	2.31	91.1	3.70	96.4	3.46	104.5	4.92
唑啉酯	101.0	2.40	82.2	0.82	85.6	8.26	90.3	3.78	98.0	2.65
丰索磷	95.5	4.14	98.0	2.65	82.5	1.48	100.4	5.89	83.8	4.89
氧丰索磷	94.6	2.08	94.1	1.58	92.8	3.28	101.1	1.91	96.0	2.04
氧丰索磷砒	99.4	2.62	90.3	2.04	93.1	2.18	96.8	5.64	101.3	0.71
丰索磷砒	86.2	6.16	91.8	1.60	85.4	3.20	92.4	2.37	98.9	5.60
倍硫磷砒	103.3	3.19	99.2	0.87	92.3	1.90	95.4	6.38	99.2	2.86
倍硫磷亚砒	100.3	3.11	83.8	3.91	104.0	5.08	89.6	3.91	93.9	4.34
氟虫腈亚砒	111.8	4.17	84.7	1.19	96.3	2.45	104.3	3.07	112.6	3.22
氟啶胺	84.1	6.31	95.4	4.96	85.1	4.95	81.0	5.36	102.0	2.15
氟虫脲	91.9	4.24	91.3	2.50	113.9	1.71	85.8	3.39	84.8	5.32
氟硅唑	98.1	4.17	99.1	0.79	85.1	4.14	102.0	2.20	95.6	8.15
氟酰胺	97.4	5.08	101.1	1.62	119.4	1.89	91.5	4.02	109.4	4.24
粉唑醇	99.3	6.02	78.1	6.25	90.1	4.66	100.6	4.48	80.6	3.94
噻唑膦	100.7	4.14	94.1	1.31	101.1	5.48	97.6	3.41	101.2	3.48
呋线威	89.4	0.86	90.9	0.65	99.6	1.20	93.7	3.63	92.3	1.24
噻唑酮	95.8	1.37	112.4	1.80	110.0	4.50	85.8	1.99	97.7	2.27
茚虫威	99.0	3.39	96.8	6.74	106.8	5.43	95.4	6.73	95.3	1.66
种菌唑	84.3	6.70	86.9	1.67	91.4	6.20	84.4	3.88	99.8	1.58
醚霉威	86.0	5.65	92.6	1.56	104.9	7.15	105.3	8.54	100.5	3.34

异丙威	105.7	3.18	86.4	2.42	95.1	6.18	103.8	1.59	103.7	2.17
利谷隆	85.9	3.65	99.7	2.71	91.1	8.44	99.6	6.14	101.6	6.92
甲霜灵	102.0	1.60	100.6	3.74	85.9	5.02	91.8	8.03	89.3	4.78
异丙甲草胺	112.2	2.64	85.8	1.59	95.9	3.63	88.4	1.62	100.5	1.48
速灭威	112.8	5.53	95.5	4.72	96.3	6.73	100.4	5.60	95.4	4.63
速灭磷	104.0	3.70	92.5	3.07	84.3	2.97	85.3	5.32	96.3	5.48
久效磷	101.7	4.08	93.9	2.10	92.6	1.27	86.4	4.30	105.2	3.69
亚砷磷	86.9	4.21	83.2	1.41	111.6	3.49	85.3	2.11	92.0	0.76
戊菌唑	95.3	1.01	86.9	2.53	95.0	7.58	104.9	4.76	85.6	8.73

## 4. 总结

本文根据最新的农残检测标准GB23200.121法，介绍了一个高灵敏且可重现的检测流程，对黄瓜、番茄、芸豆、玉米粉和红茶等五种植物源性基质中的 375种农药残留进行快速、可靠的定量分析。按照国标的规定，使用赛默飞 QuEChERS 提取盐包和净化包，对上述五种样品基质进行快速、高效、重现性好的前处理制备。结合使用赛默飞 Thermo Scientific Vanquish Flex 超高效液相色谱仪与 Thermo Scientific三重四极杆液质联用系统，通过 Acclaim Vanquish™ C18色谱柱在 25 min内液相色谱梯度法为所有目标分析物提供了良好的色谱分离。采用基质曲线进行数据分析，本方法不仅具有优异的灵敏度和线性范围，可满足各类植物源性食品农药残留的检测。Thermo Scientific 三重四极杆提供快速极性切换功能，且易于维护，可实现长时间，高效的运行。



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