

Supplementary Material

Multivariate optimization and validation of 200 pesticide residues in banana matrix by GC-MS/MS

Tushar Rajaram Ahire,^{ab1} Rupal Rajesh Thasale,^{a2} Ankita Das,^{ac} Nikhil Pradip Kulkarni,^a Dhyan Mineshkumar Vyas^{ab} and Sivaperumal Perumal^{*a3}

^aChemical Sciences Division, ICMR- National Institute of Occupational Health, Meghani Nagar, Ahmedabad.

^bDepartment of Biochemistry and Forensic Science, Gujarat University, Ahmedabad.

^cNational Forensic Sciences University, Tripura Campus.

* Corresponding Author- sivaperumal.p@gov.in, sivaperum2003@yahoo.co.in

Table S1: Summarization of P-B design table

Run order	Pt Type	Blocks	(A)	(B)	(C)	(D)	(E)
1	1	1	-1	-1	+1	+1	+1
2	0	1	0	0	0	0	0
3	1	1	-1	-1	-1	-1	-1
4	1	1	+1	-1	+1	+1	-1
5	1	1	-1	-1	-1	+1	+1
6	0	1	0	0	0	0	0
7	1	1	+1	+1	-1	+1	-1
8	1	1	-1	+1	+1	-1	+1
9	1	1	+1	-1	-1	-1	+1
10	0	1	0	0	0	0	0
11	1	1	-1	+1	+1	+1	-1
12	1	1	+1	+1	+1	-1	+1
13	1	1	-1	+1	-1	-1	-1
14	1	1	+1	-1	+1	-1	-1
15	1	1	+1	+1	-1	+1	+1

Table S2: Experimental factors and level of Plackett-Burman (P-B) design

FACTORS	UNIT	LEVELS		
		-1	0	+1
1. Sample Weight	g	5	10	15
2. MWCNT	mg	5	10	15
3. MgSO ₄	mg	30	45	60
4. PSA	mg	20	30	40
5. Activated Charcoal	mg	0	2.5	5

Table S3: Central composite design matrix with factors and levels

Factor	Levels			Star point α - 1.41421	
	Low (-1)	Central (0)	High (+1)	- α	+ α
Sample weight (g)	5	10	15	-1.41421	+1.41421
MWCNT weight (mg)	5	10	15	-1.41421	+1.41421

Run order	Pt Type	Blocks	(A) Sample weight	(B) MWCNT weight	Average Recovery
1	0	1	0	0	100.7
2	0	1	0	0	96.2
3	-1	1	-1.41421	0	99.8
4	0	1	0	0	101.1
5	-1	1	0	+1.41421	87.3
6	1	1	+1	-1	97.4
7	1	1	-1	+1	94.3
8	-1	1	+1.41421	0	107.2
9	0	1	0	0	119.5
10	1	1	+1	+1	99.6
11	-1	1	0	-1.41421	116.3
12	0	1	0	0	108.9
13	1	1	-1	-1	80.0

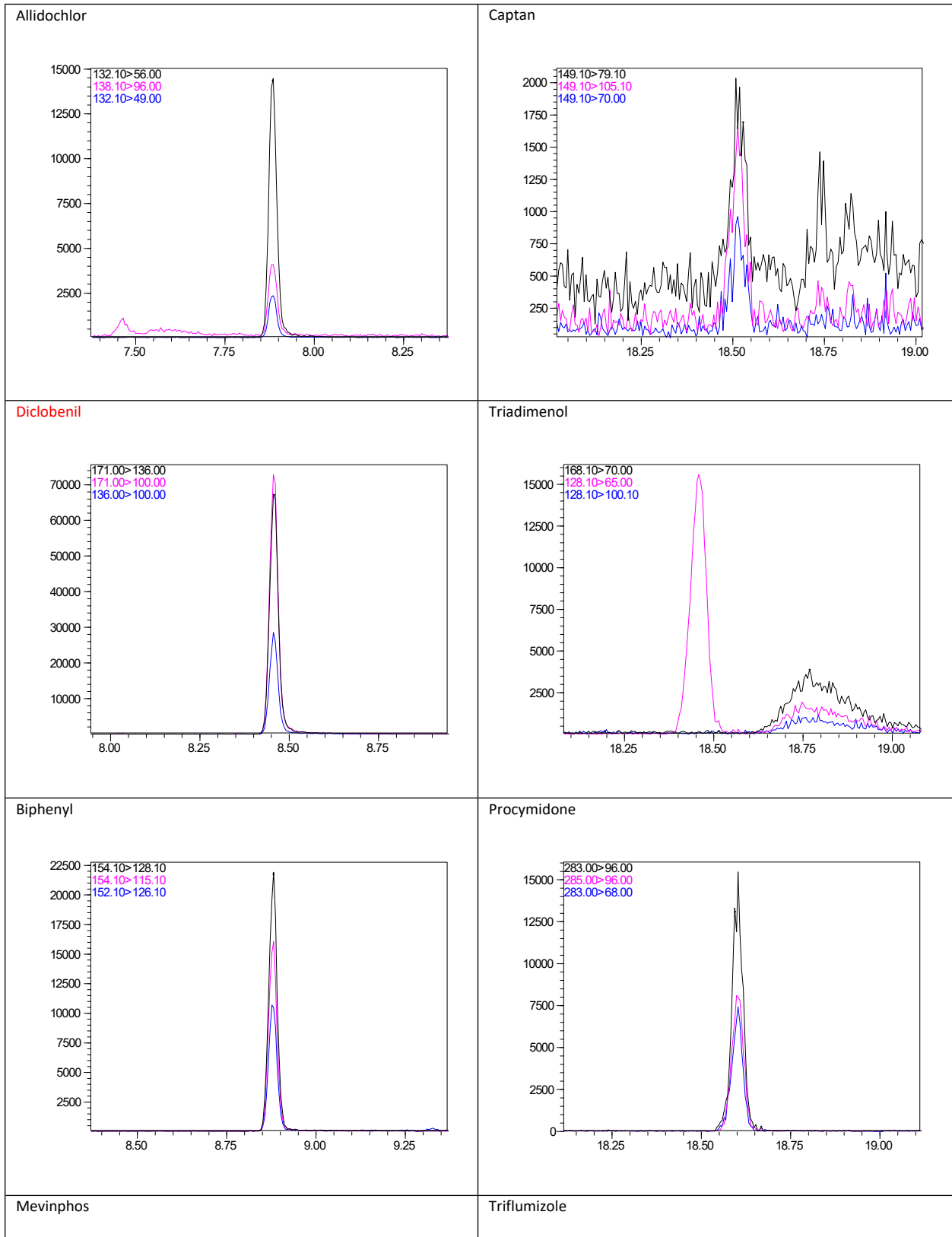
Table S4: Comparative study for the proposed method.

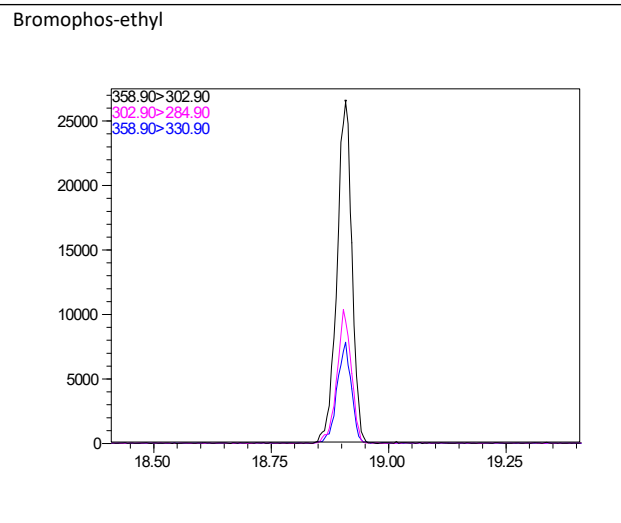
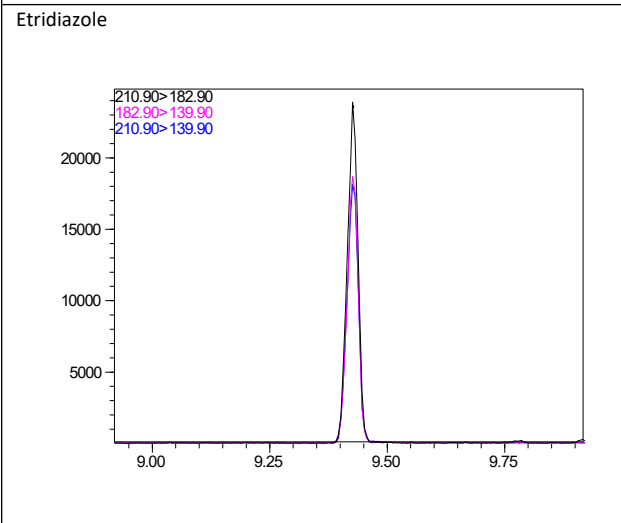
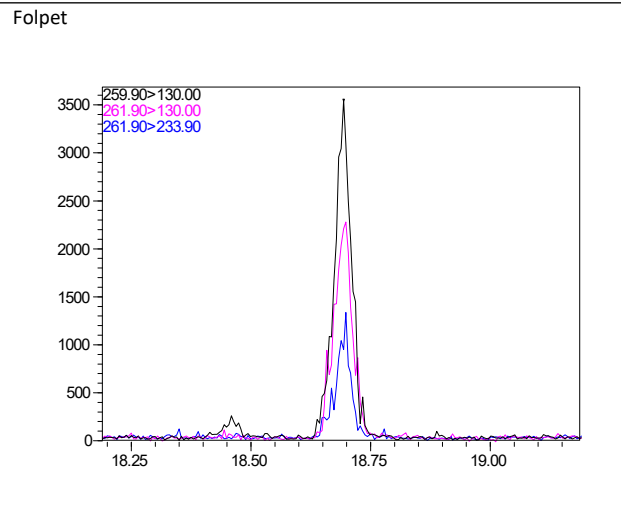
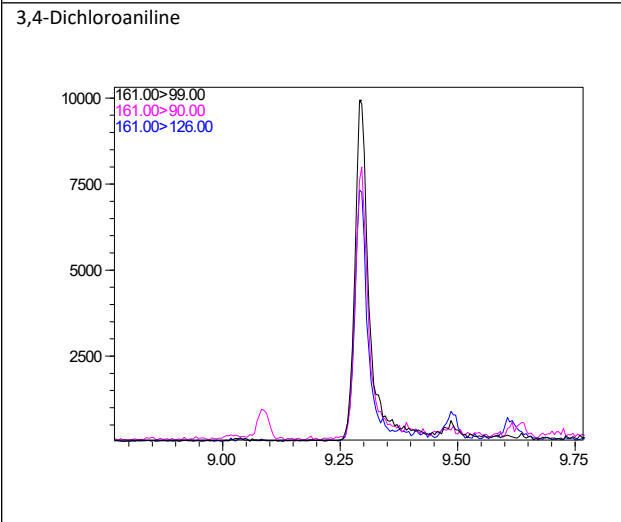
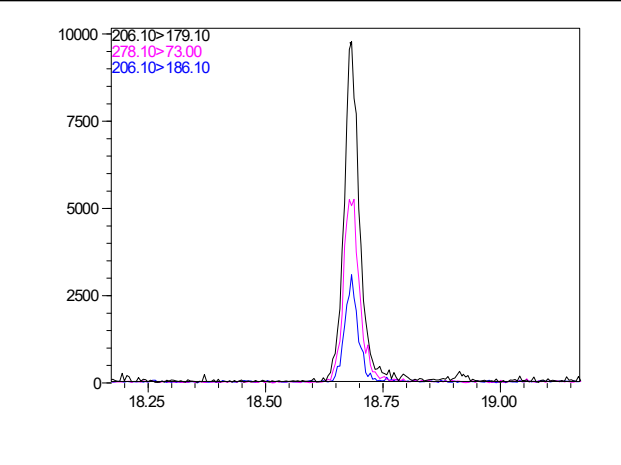
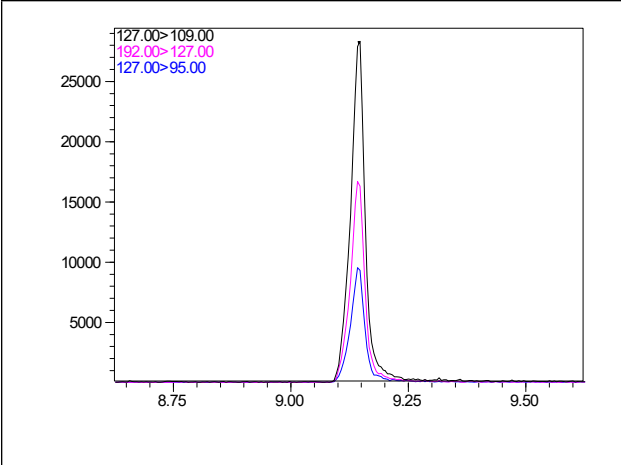
Matrix	Analytes	Extraction Techniques/ Method	Clean-up Technique	Analytical Separation Technique			Analytical Method Performance					
				Stationary Phase	Mobile Phase/ Carrier Gas	Analytical Instrument	LOD	LOQ	ER (%) & EF	(%) RSD	R ²	ME %
Banana ²⁴	294 Pesticides	QuEChERS	dSPE	Zorbax XDB C18 column (2.1 × 150 mm, 3.5 μm) (Agilent, USA)	A (5 mM NH ₄ HCO ₂ in HPLC grade H ₂ O with 0.1% HCO ₂ H) and B (5 mM NH ₄ HCO ₂ in CH ₃ OH)	LC-MS/MS		0.01 mg kg ⁻¹	73-93%			
				DB-5 MS column (5% phenyl 95% dimethylarylene siloxane, Agilent, USA)	Helium (99.999% purity)	GC-MS/MS						
Banana ²⁵	azoxystrobin, difenoconazole, and propiconazole	QuEChERS	dSPE	An RTX-5 MS capillary column (30 m × 0.25 mm; 0.5 μm film thickness)	helium gas (99.999%)	GC-QMS	0.01–0.05 mg kg ⁻¹	0.03–0.10 mg kg ⁻¹	74.78 and 99.98%	< 20%		
tomato, cucumber, cowpea, pepper, eggplant, potato, banana, grape, and citrus) ²⁶	fluopyram	QuEChERS	PSA, C18 and MWCNTs-NH2	TG-5SiIMS weakly polarised capillary column (30 m × .25 mm × .25 μm)	Not mentioned	GC-MS/MS			87.02% to 101.42%	9.25%		-1.41% to 17.67%
tomato, cucumber, zucchini, eggplant, okra, green pepper, grape, coriander, parsley, bean, rocca, leek, peppermint, dates, and lettuce ²⁷	49 pesticide	QuEChERS	dSPE+GCB	(TG-5MS; Thermo Scientific), 30 m long, internal diameter of 0.25 mm, and the film thickness was 0.25 μm	helium (99.999)	GC-MS/MS	0.0005 to 0.0024 mg/kg,	0.0011 to 0.0047 mg/kg	78 % to 107 %,	less than 20 %	0.99	

Hawk Tea ²⁸	186 Pesticides	EMR-Lipid materials. Then, 10 mL distilled H ₂ O, shaken for 30 s, stand for 30 min, the extraction done with 10 mL C ₂ H ₃ N, shaken 30 s, put in 4 g NaCl and shaken. centrifuged at 5000 rpm for 10 min	QuEChERS purification falcon tube (contained with 1200 mgMgSO ₄ , 400 mgPSA, 200 mg MWCNTs).	MgSO ₄ PSA MWCNT	SH-Rxi-5SiI MS column (30 m 0.25 mm i.d., 0.25 μm)	He	GCMS-TQ8050 triple-quadrupole (QqQ) MRM	0.001–0.02 mg/kg	0.005 mg/kg~0.05 mg/kg	70–120%	0.3–14.4%	0.99	
Banana ²⁹	azoxystrobin, difenoconazole, and propiconazole	Modified QuEChERS		dSPE	RTX-5 ms capillary column (30 m × 0.25 mm DI × 0.50 μm film thickness)	helium gas (99.999%)	(GC-MS), model DSQII, Thermo (USA)	0.018 0.066 0.007	0.054 0.199 0.022			0.9985, 0.9966 and 0.9997	difenoc onazole - 6.8%
banana- and citrus fruit ³⁰	Thiabendazole	5 gm sample + 20 g Na ₂ SO ₄ + Na ₂ HPO ₄ + 30 mL C ₄ H ₈ O ₂ , Centrifugation at 3100 rpm for 8 min- supernatant to 100-ml Erlenmeyer flask, residual plug was reextracted with another 20 ml of C ₄ H ₈ O ₂ . For banana 10-g sample + 40 g Na ₂ SO ₄ + 50 ml C ₄ H ₈ O ₂ , reextracted with another 30 ml of C ₄ H ₈ O ₂ .	Sep-Pak Vac Silica /Bond Elut PRS		C18 columns, (4.6 mm 250 mm, 5.0 m, Shiseido, Tokyo, Japan)	phosphoric acid buffer (pH = 7), acetonitrile, and methanol (7:2:1, v/v/v)	HPLC PDA system (Waters Co., Milford, MA, USA)	0.009 and 0.017 μg/mL	0.028 and 0.052 μg/mL	93.61 to 98.08%	1.33%	0.999	
					C18 columns, (4.6 mm 250 mm, 5.0 m, Shiseido, Tokyo, Japan)	phosphoric acid buffer (pH = 7), acetonitrile, and methanol (7:2:1, v/v/v)	4500 QTRAP LC-MS/MS system (AB Sciex, Framingham, USA)						
Banana (Proposed Method)	200 Pesticide	Modified QuEChERS		60 mg MgSO ₄ , 20 mg PSA & 15 mg MWCNT	SH-I-5SiI MS, L 30 m X ID 0.25 μm X dF 0.25 μm	Helium (99.9999%)	Nexis, GC 2030 and GC-MS-TQ8050NX, Shimadzu	0.45-6.33 μg kg ⁻¹	1.44-9.59 μg kg ⁻¹	71%-116% (10 μg kg ⁻¹) and 72%-119% (25 μg kg ⁻¹)	< 20%	>0.99	-20+20

³⁰AS PER, [https://doi.org/10.1016/S0021-9673\(98\)00185-X](https://doi.org/10.1016/S0021-9673(98)00185-X) AND <https://doi.org/10.1016/j.jmicroc.2017.05.017>

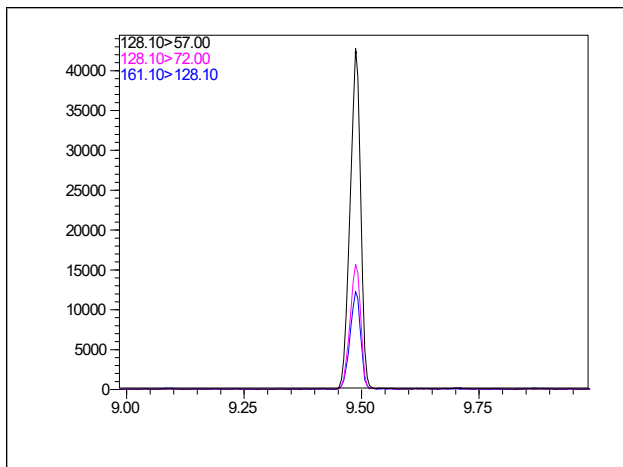
Fig S1: Individual Chromatograms of 200 pesticides.



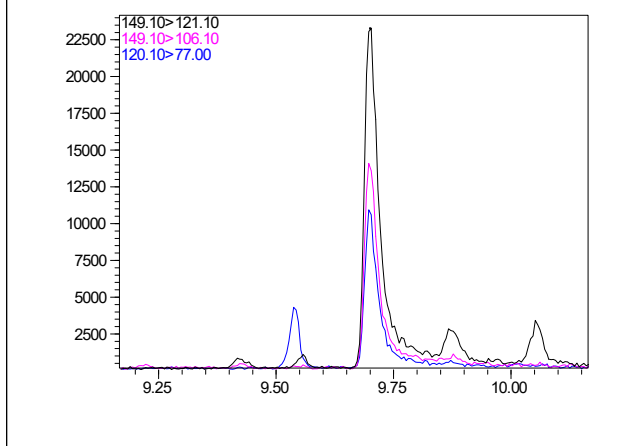


Pebulate

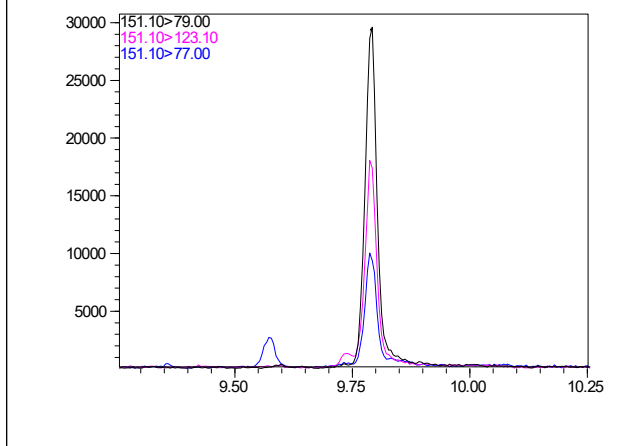
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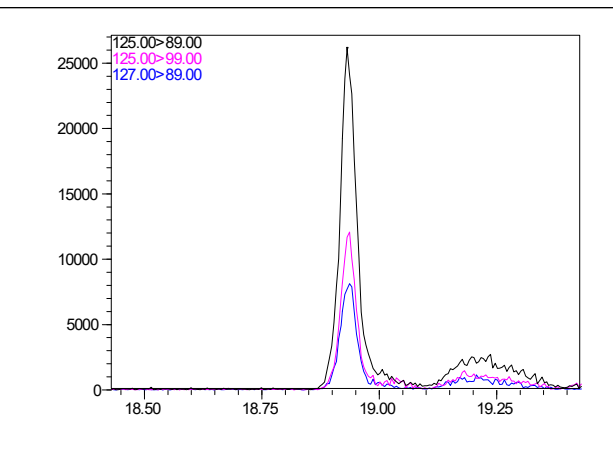
N-(2,4-dimethylphenyl) formamide



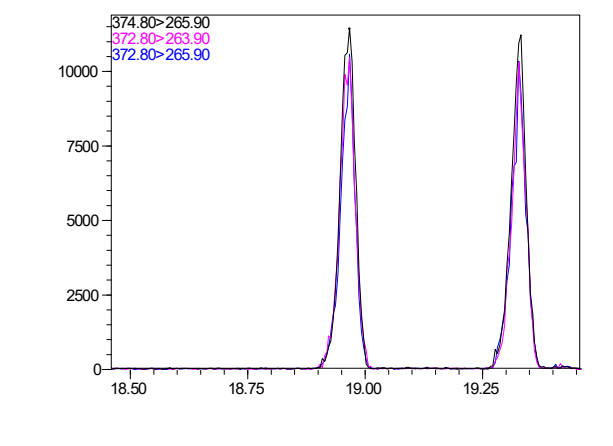
THPI (Tetrahydrophthalimide)



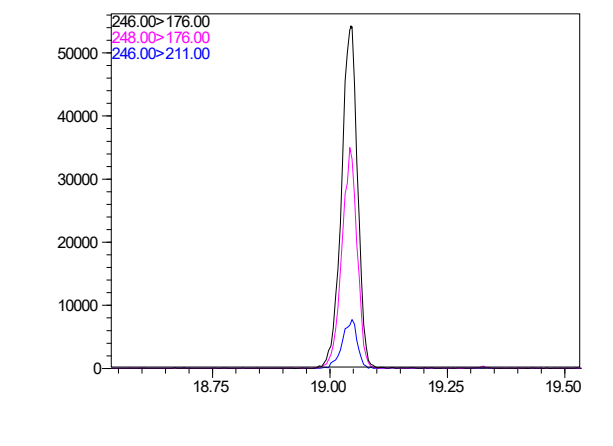
Methacrifos



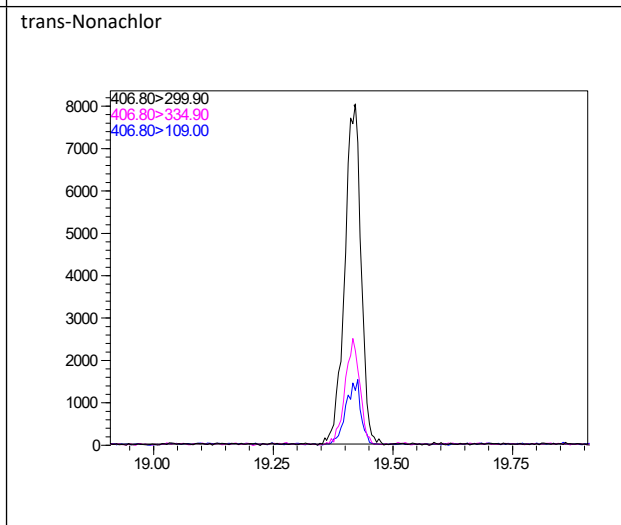
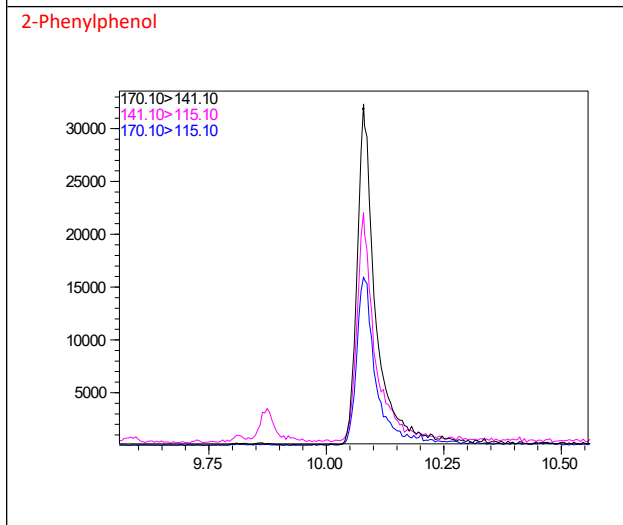
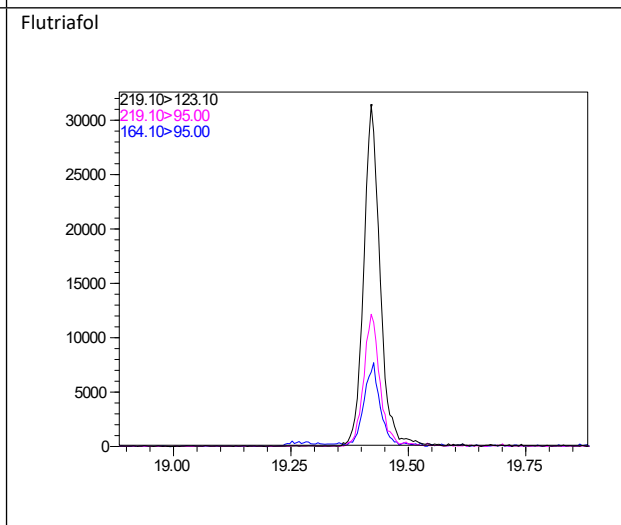
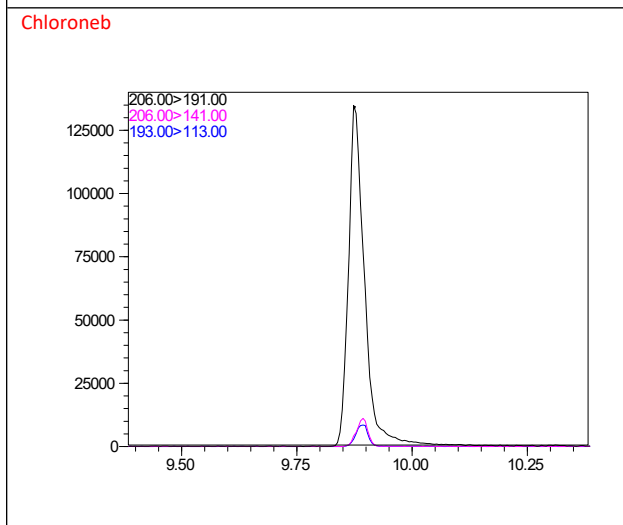
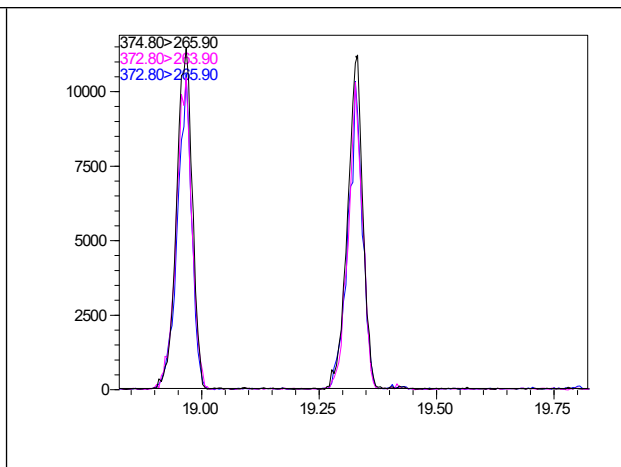
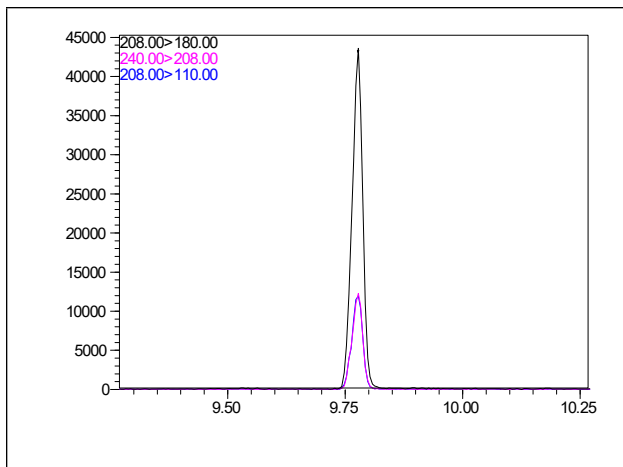
trans-Chlordane



o,p'-DDE

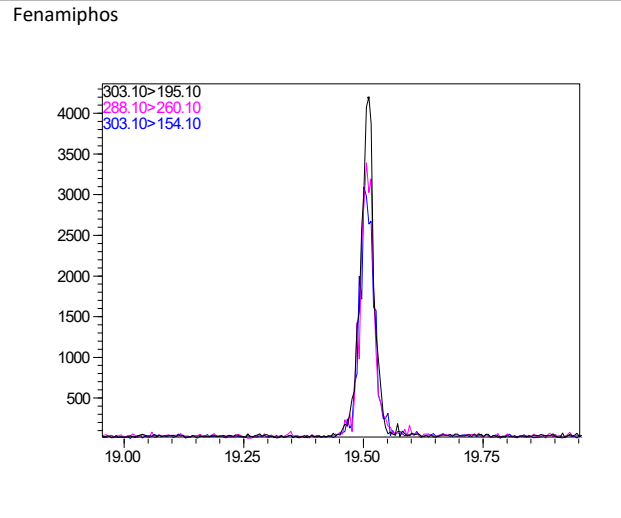
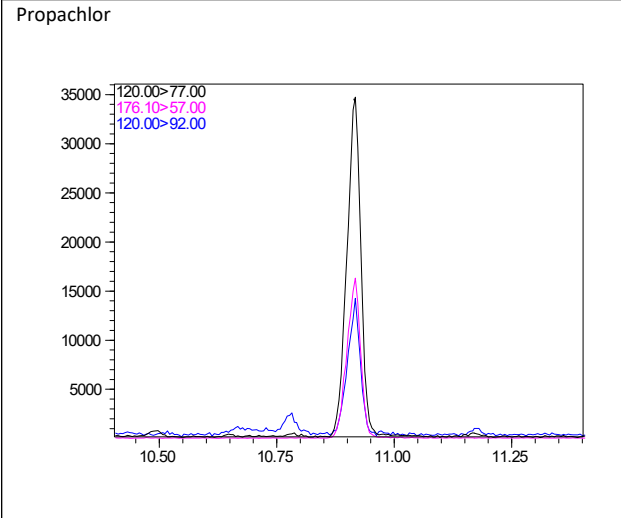
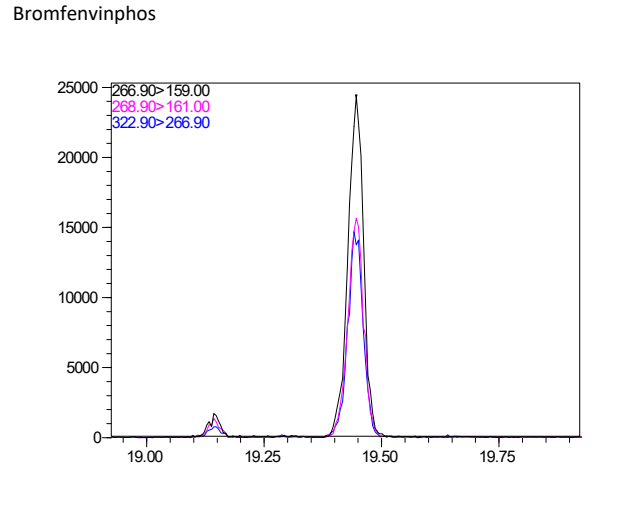
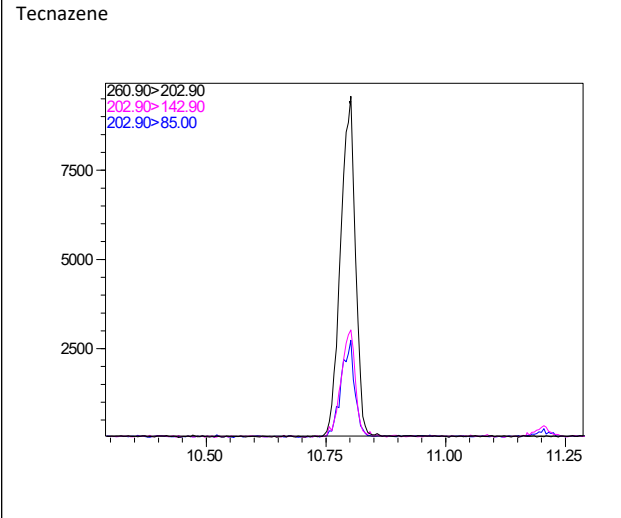
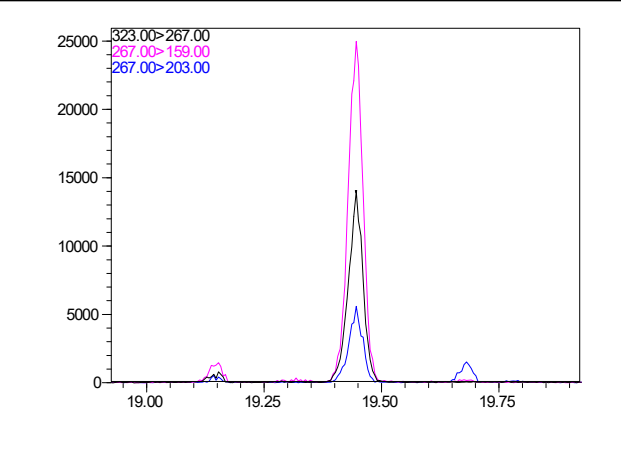
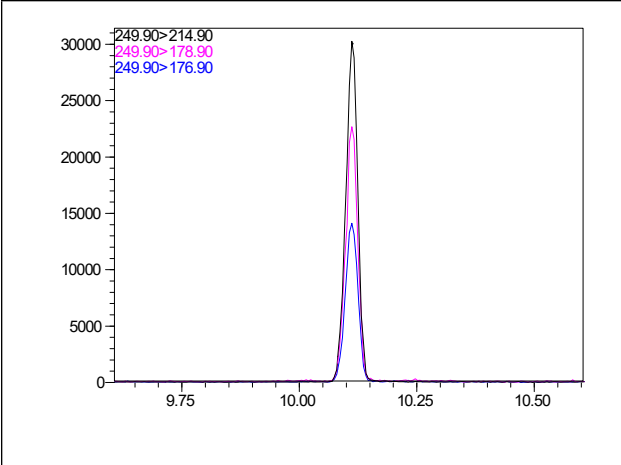


cis-Chlordane



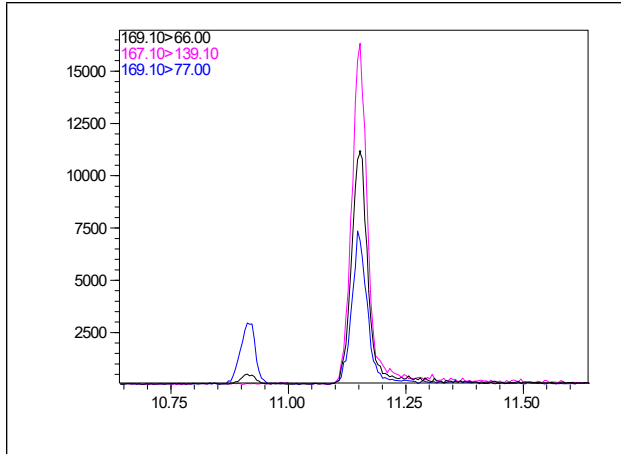
Pentachlorobenzene

(Z)-Chlorfenvinphos

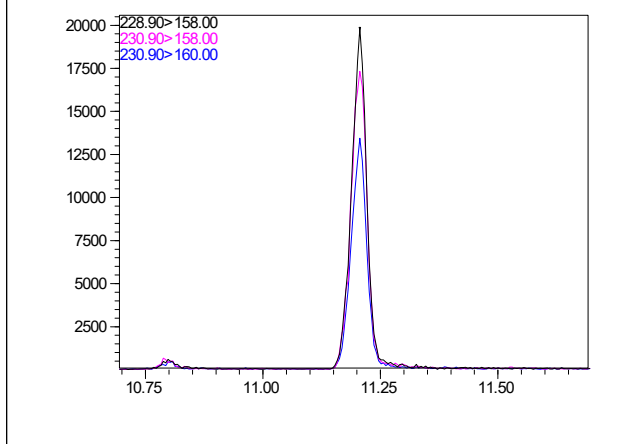


Diphenylamine

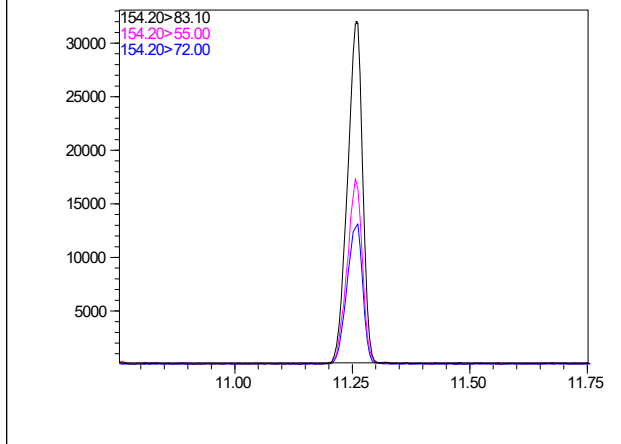
Flutolanil



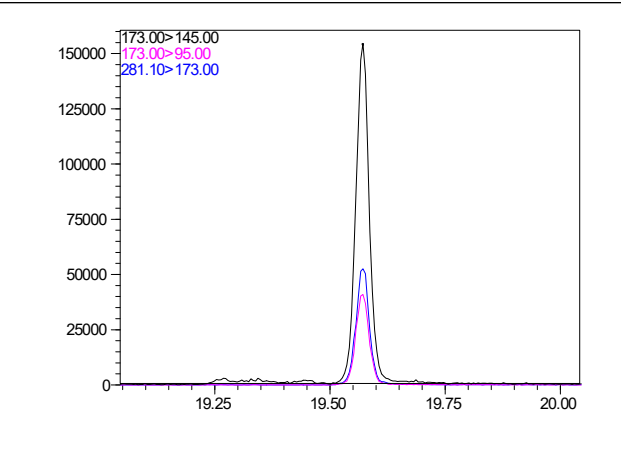
2,3,5,6-Tetrachloroaniline



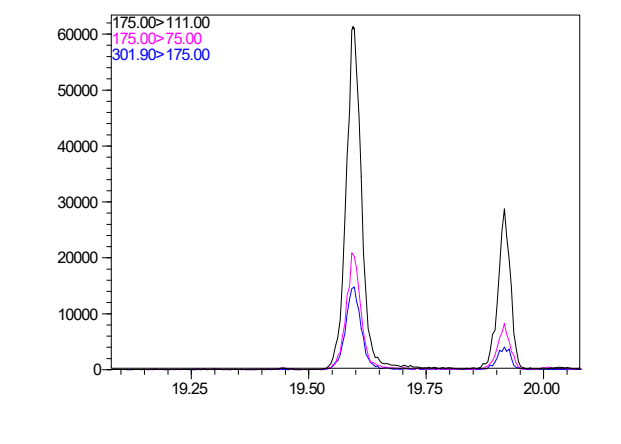
Cycloate



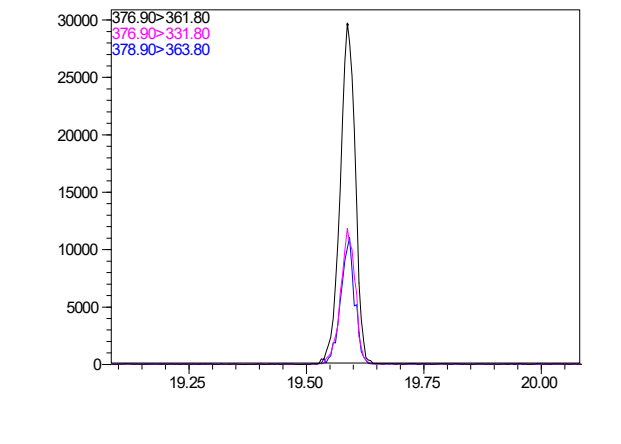
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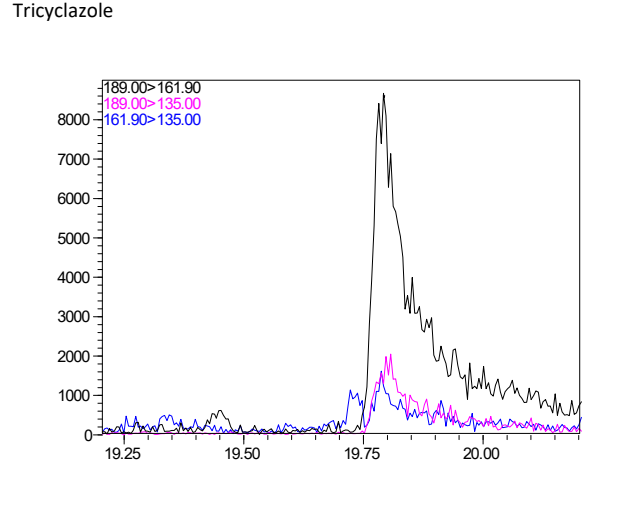
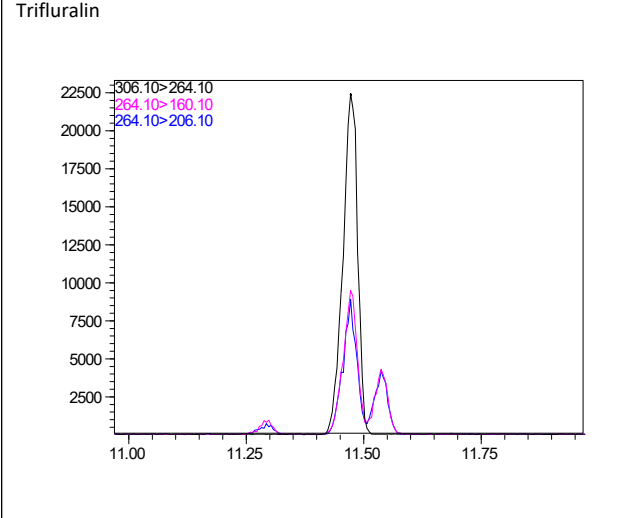
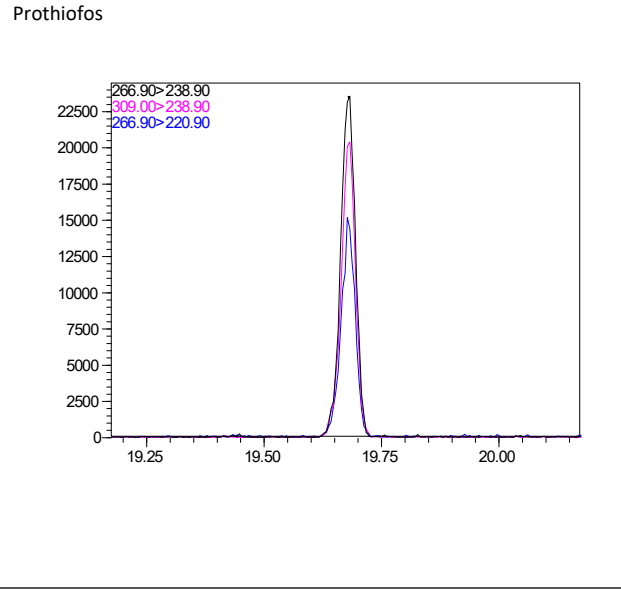
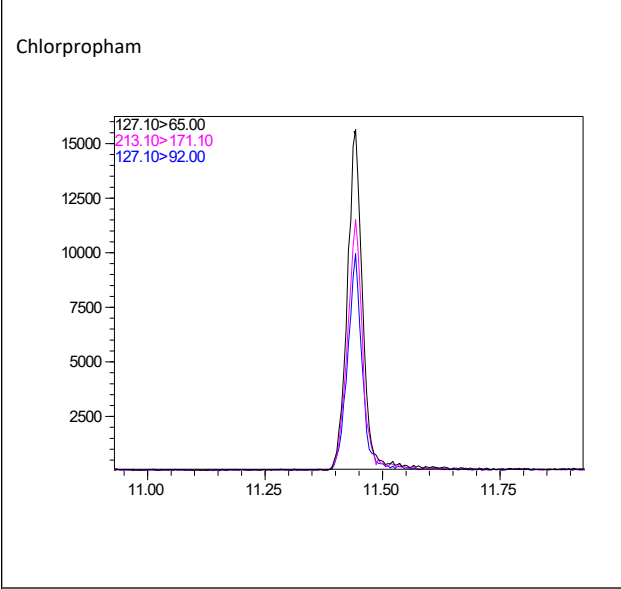
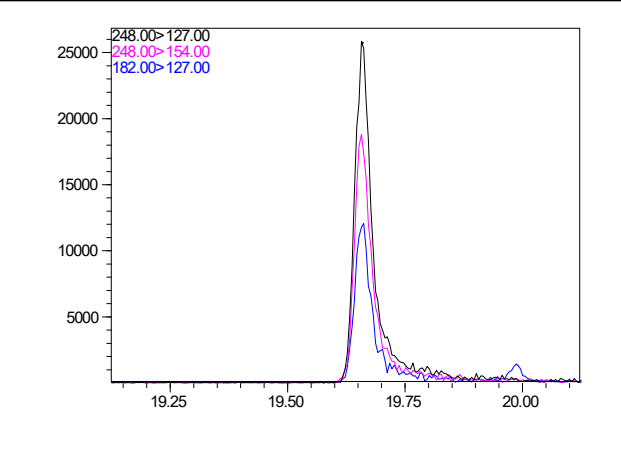
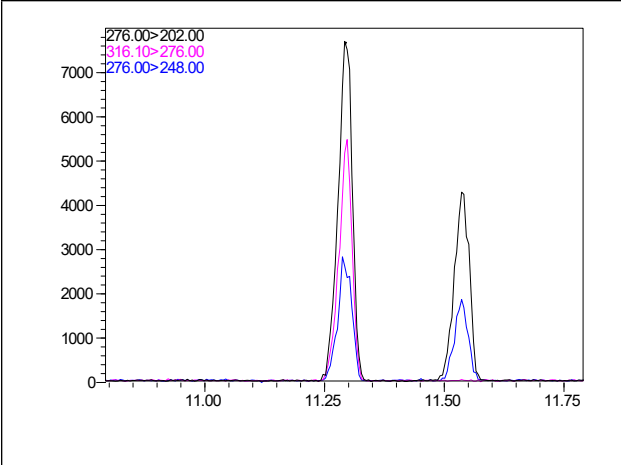
Chlorfenson



Iodofenphos

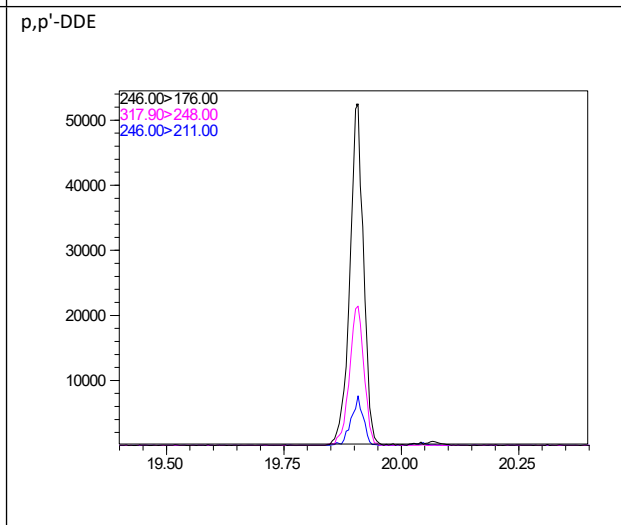
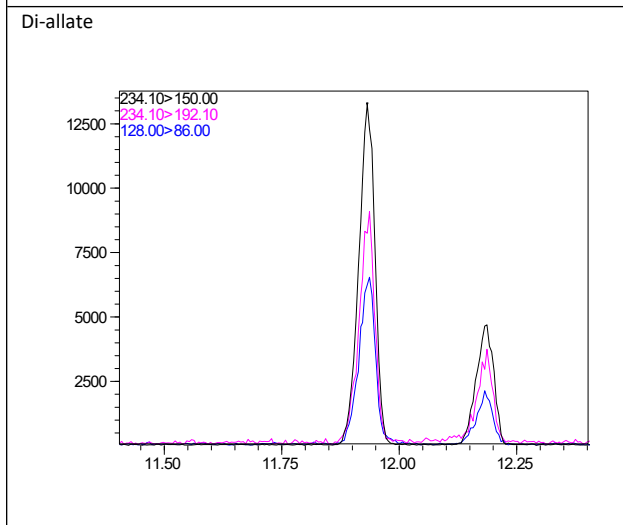
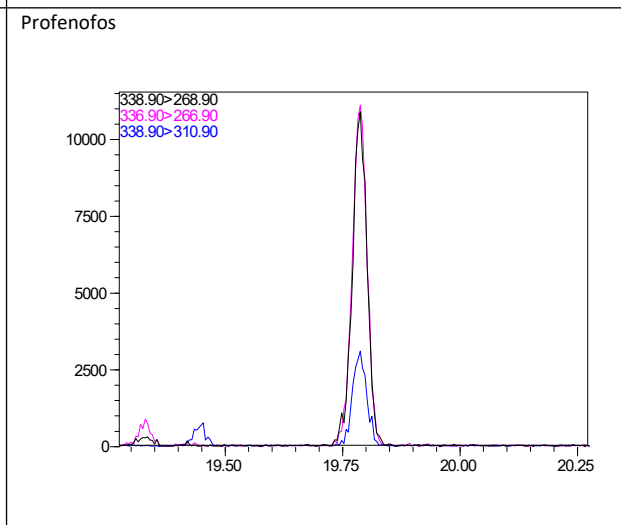
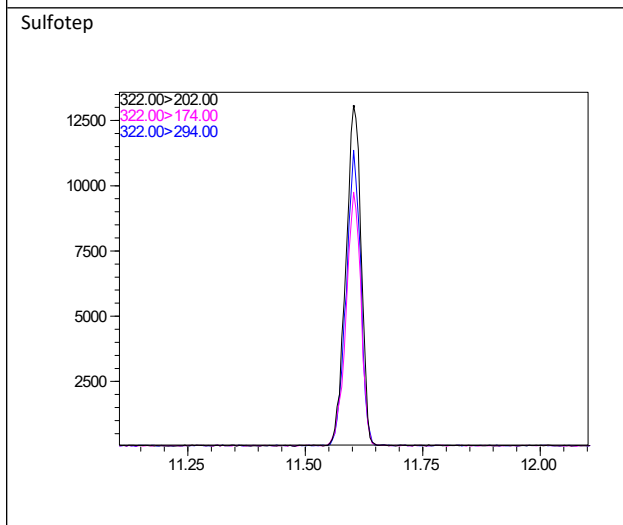
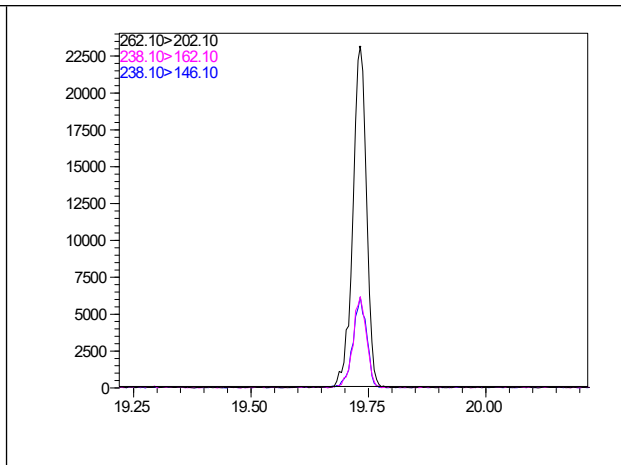
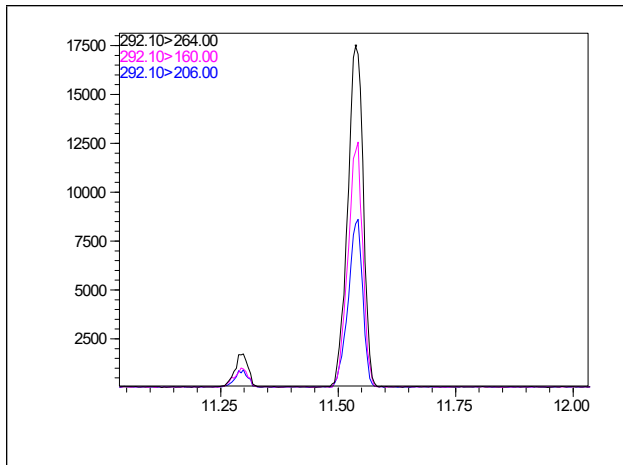


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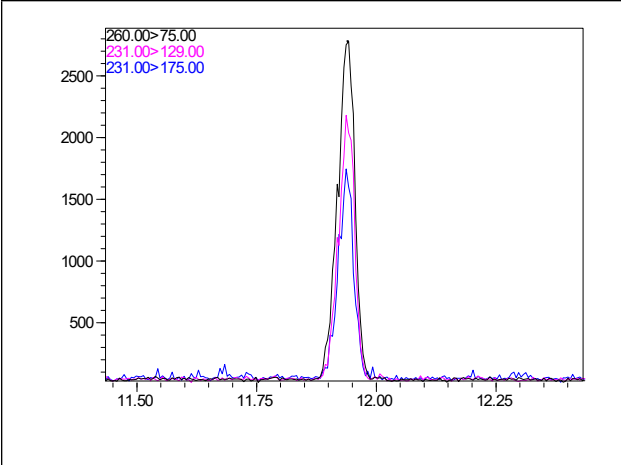
Benfluralin

Pretilachlor

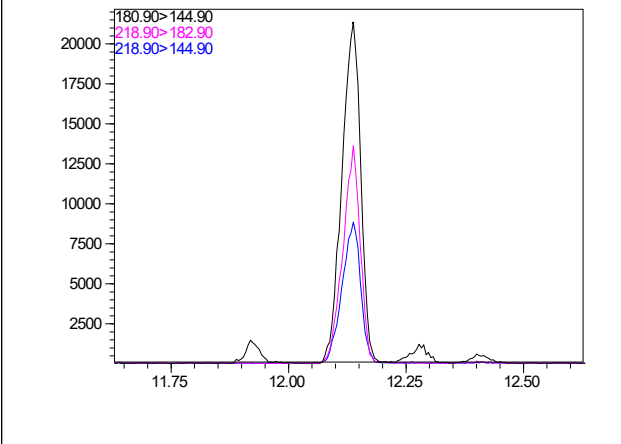


Phorate

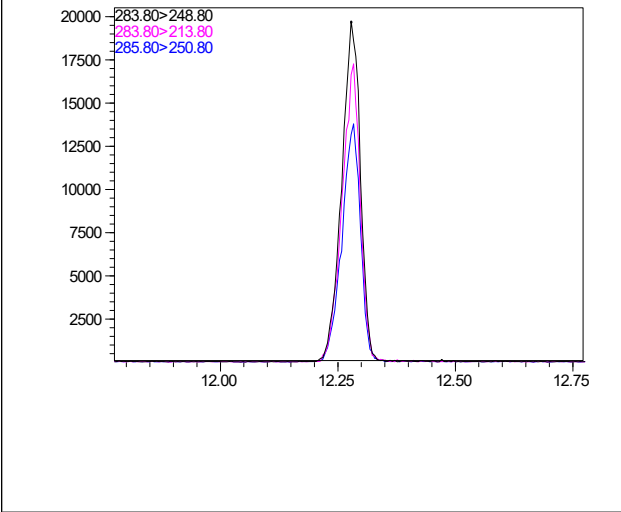
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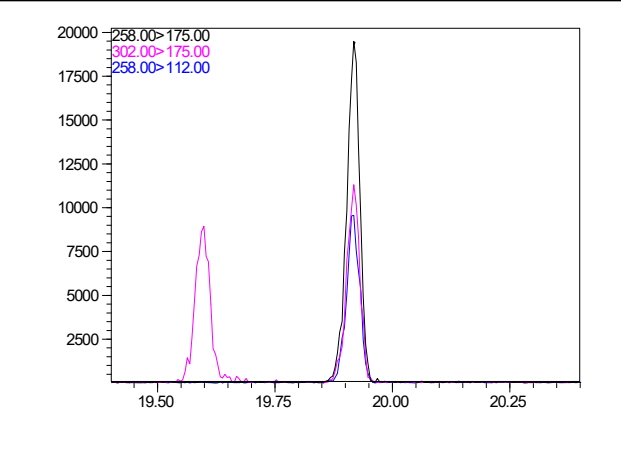
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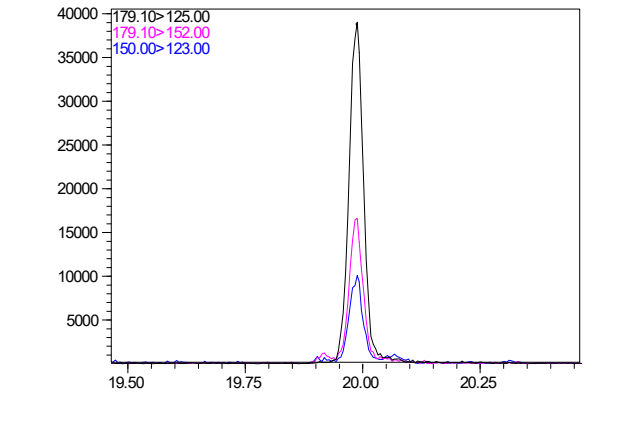
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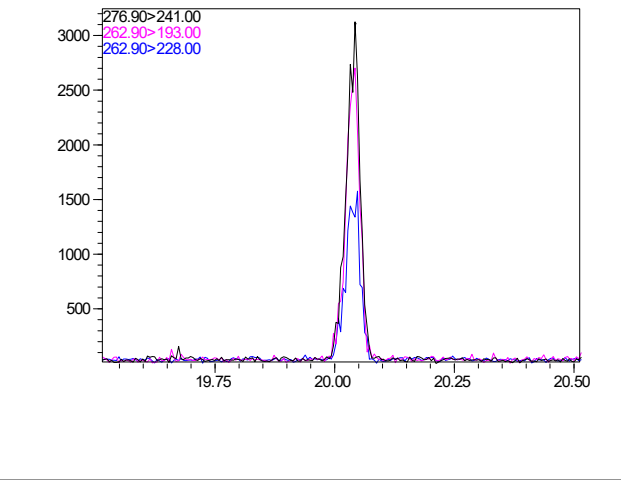
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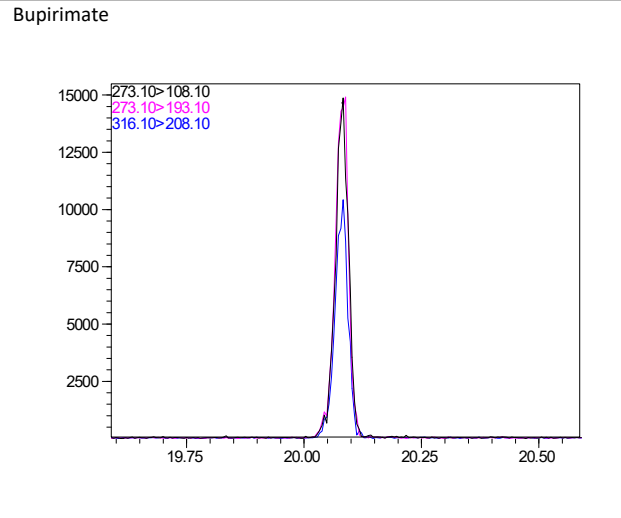
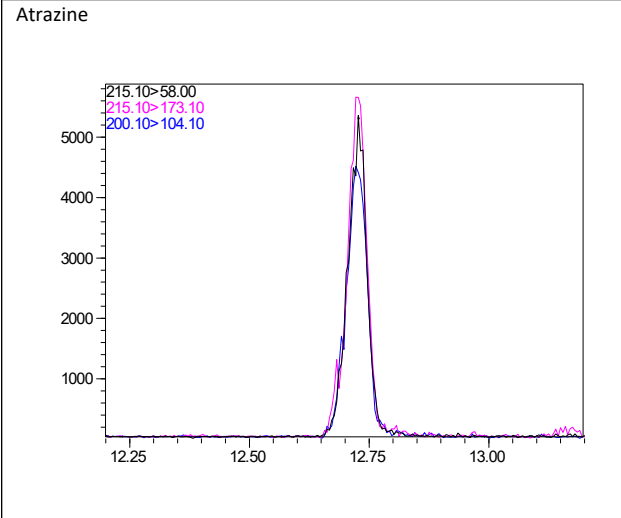
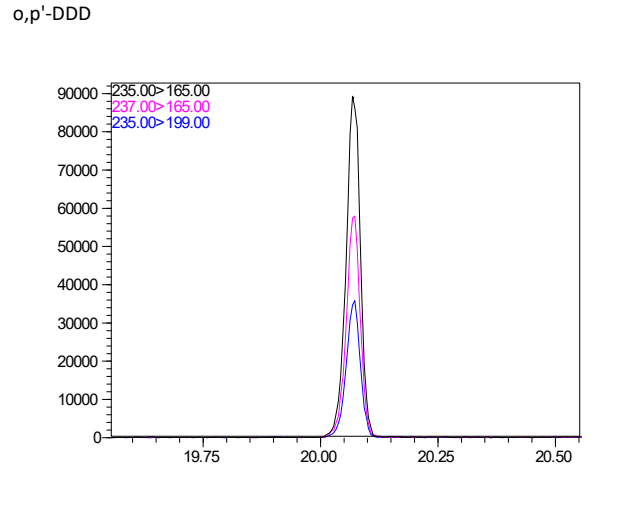
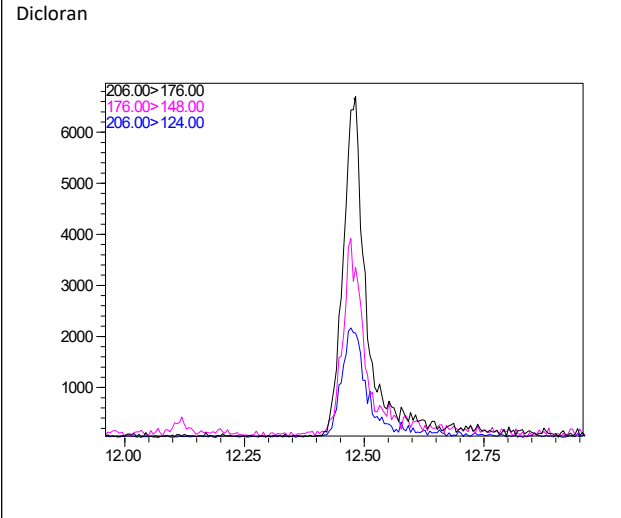
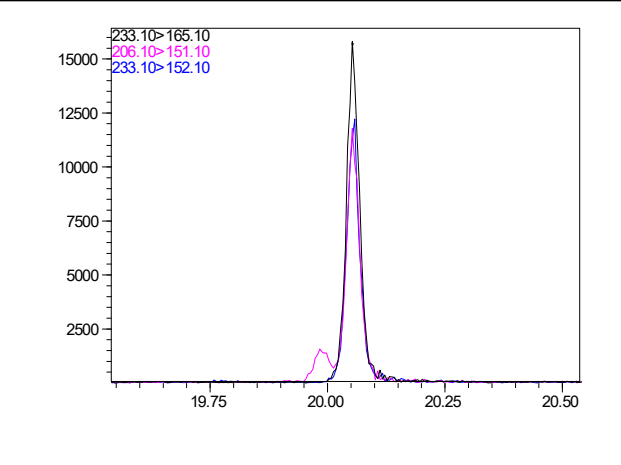
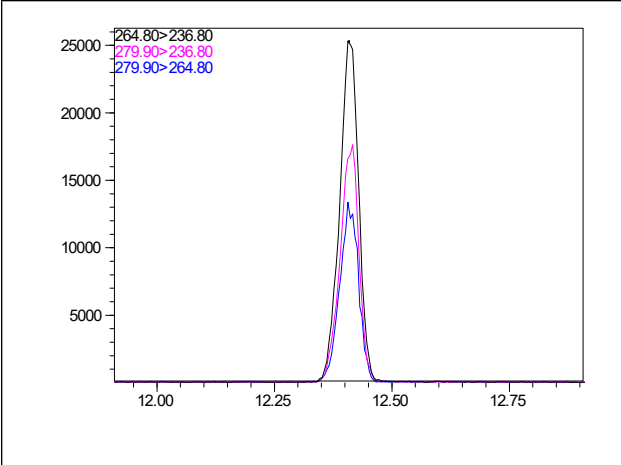
Myclobutanil



Dieldrin

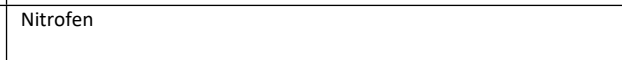
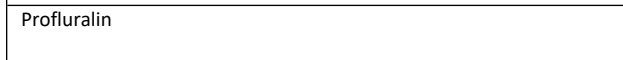
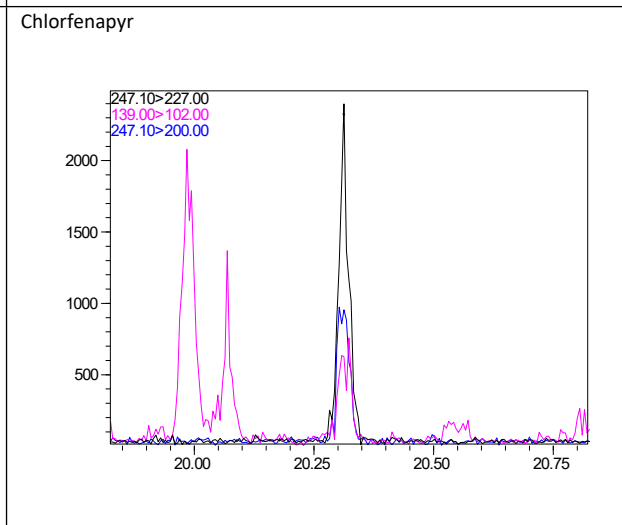
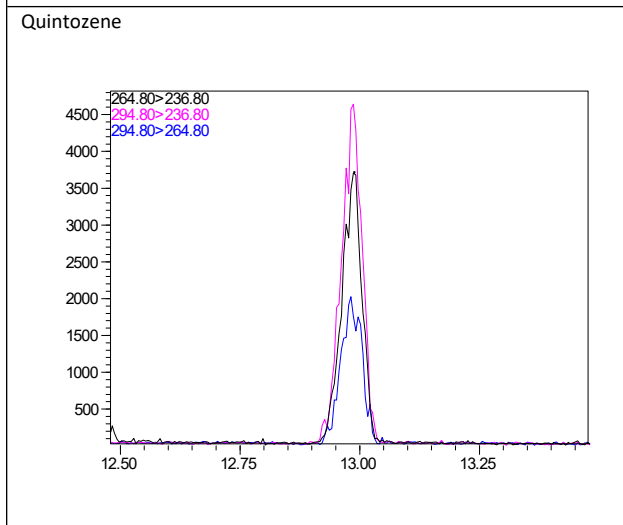
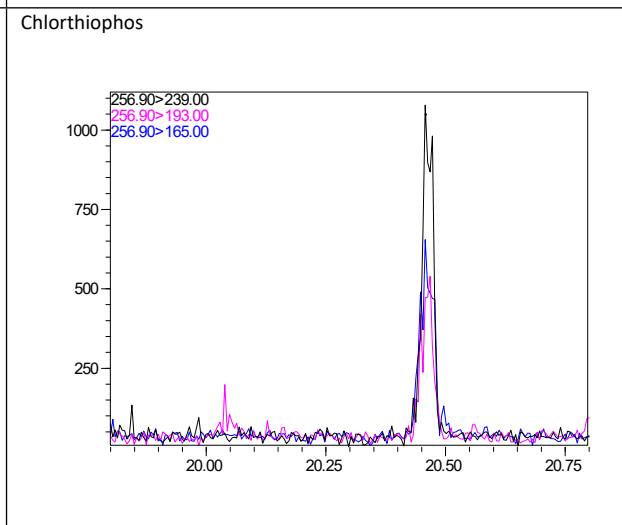
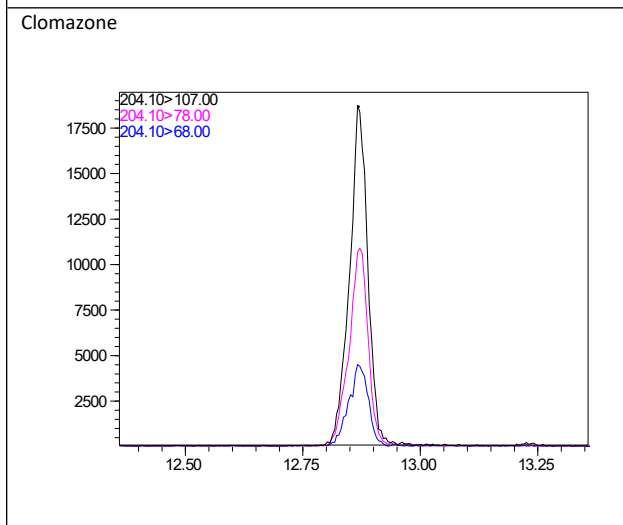
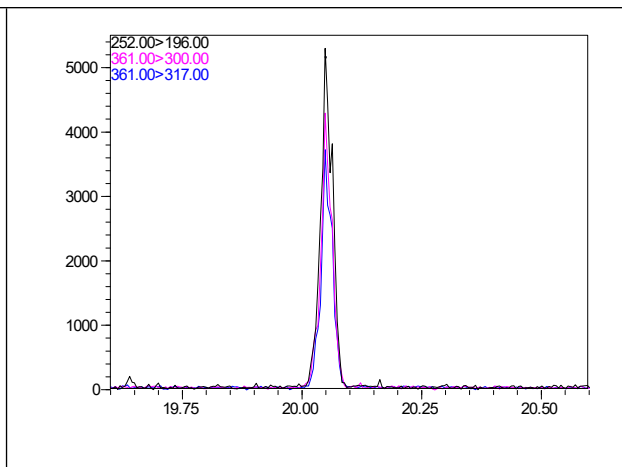
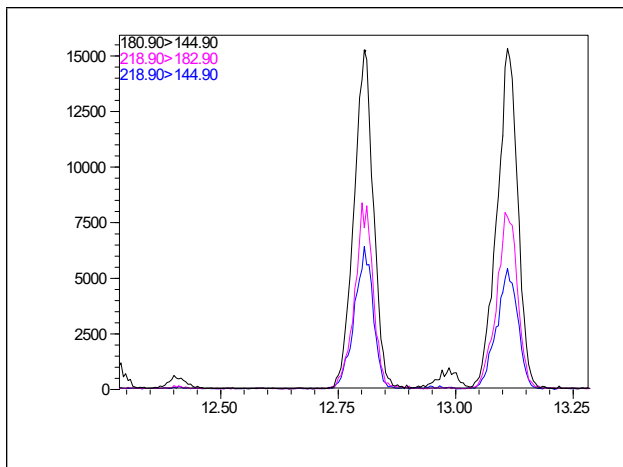


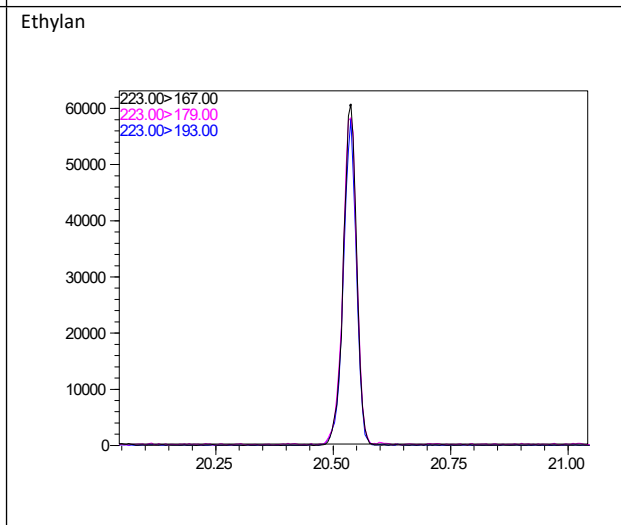
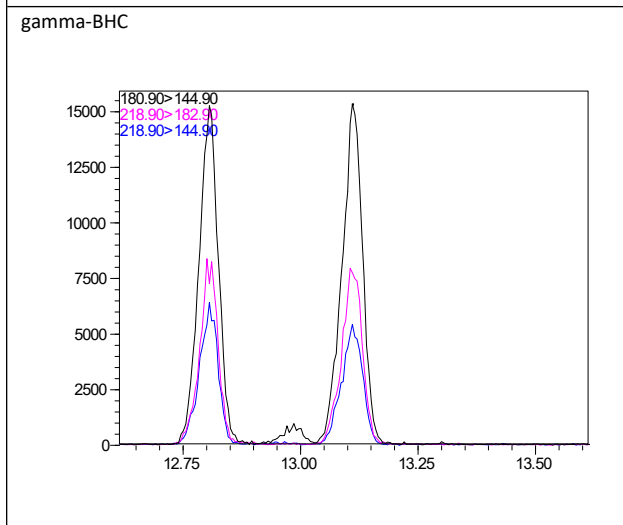
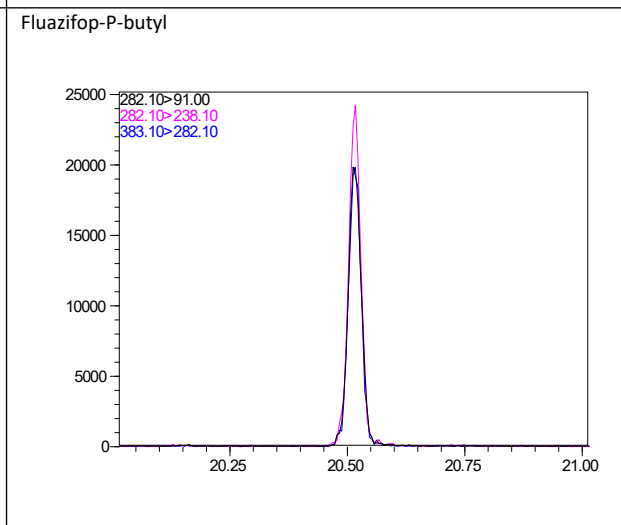
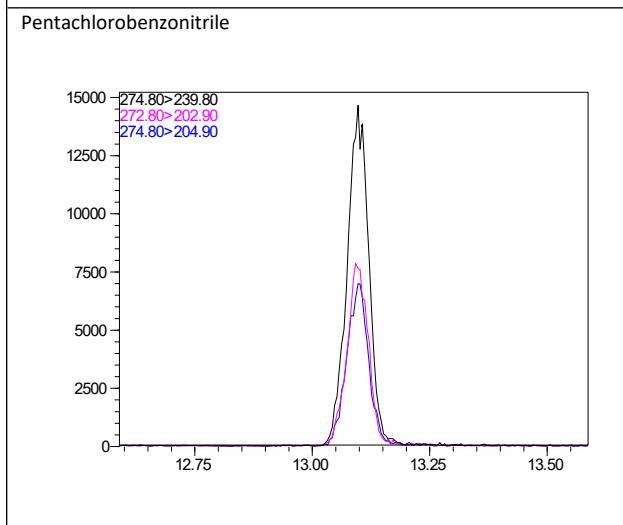
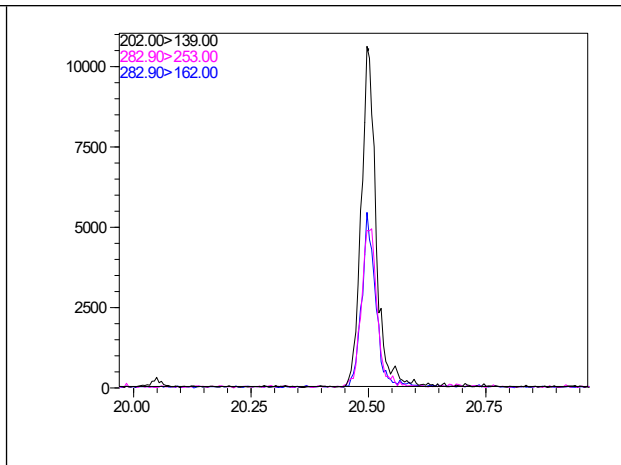
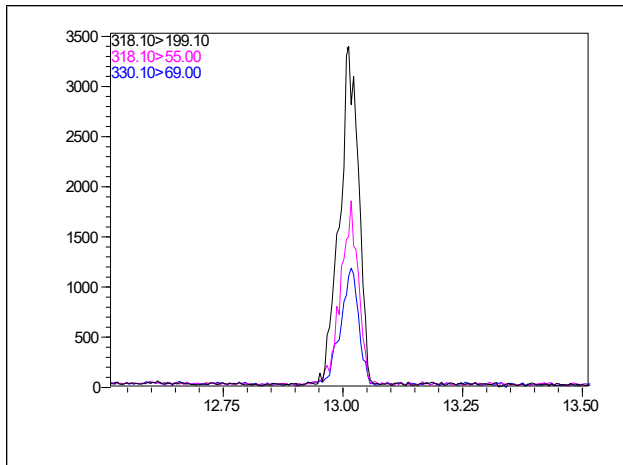
Flusilazole



beta-BHC

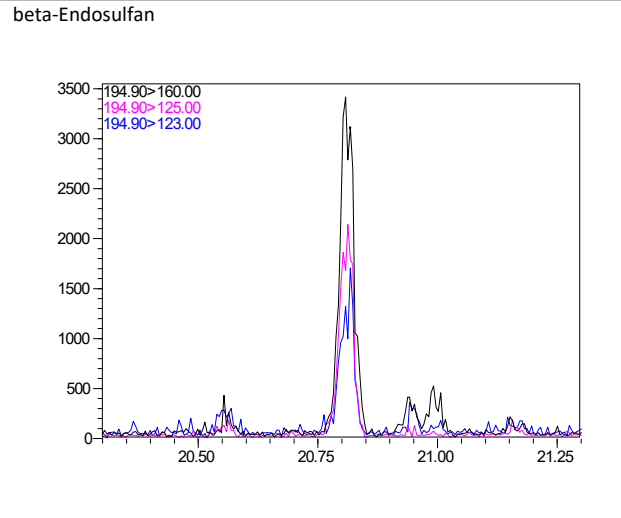
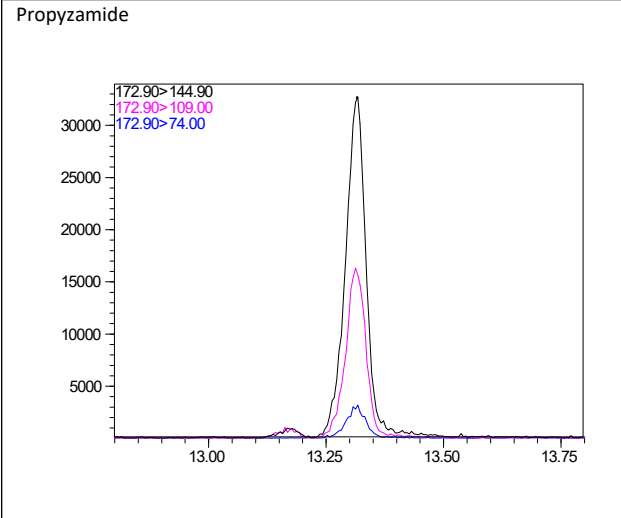
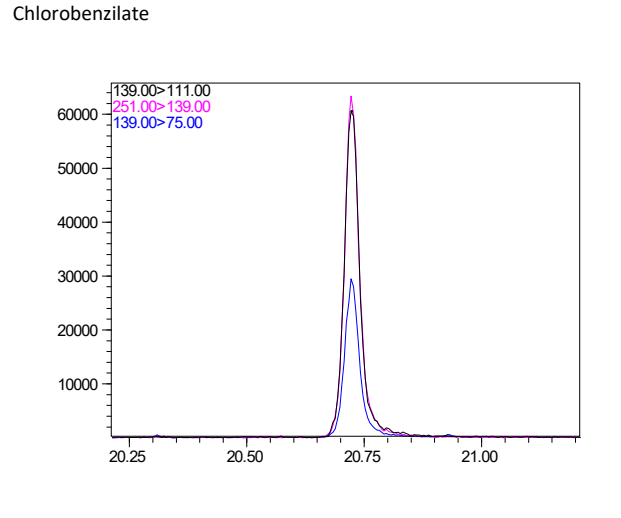
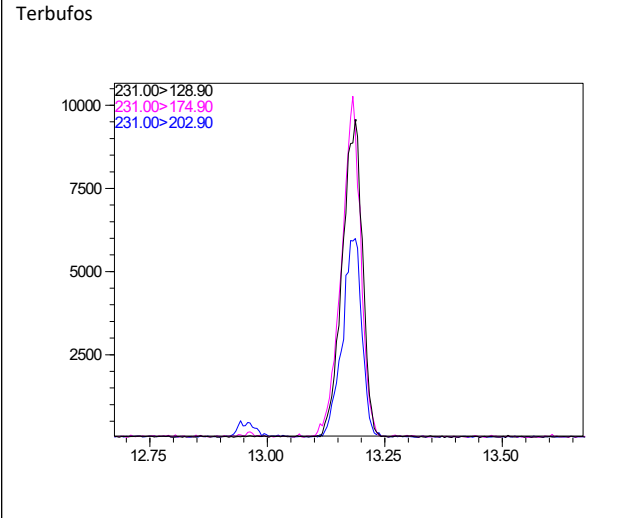
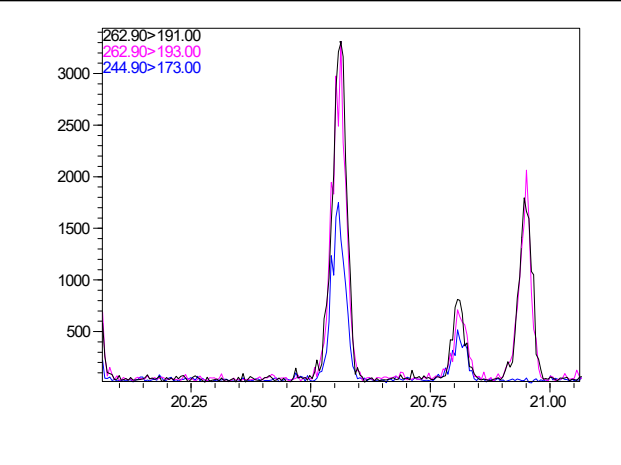
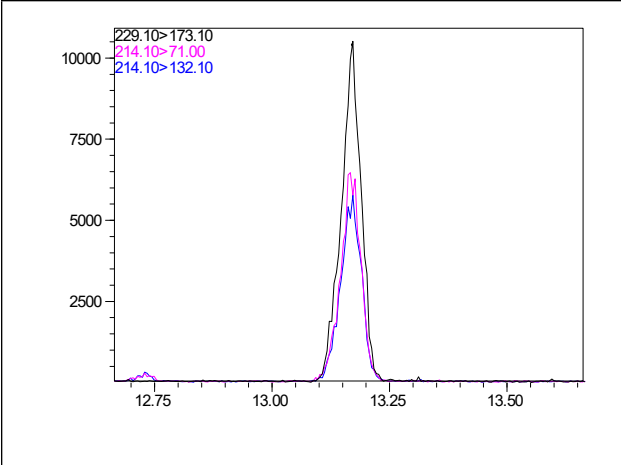
Oxyfluorfen





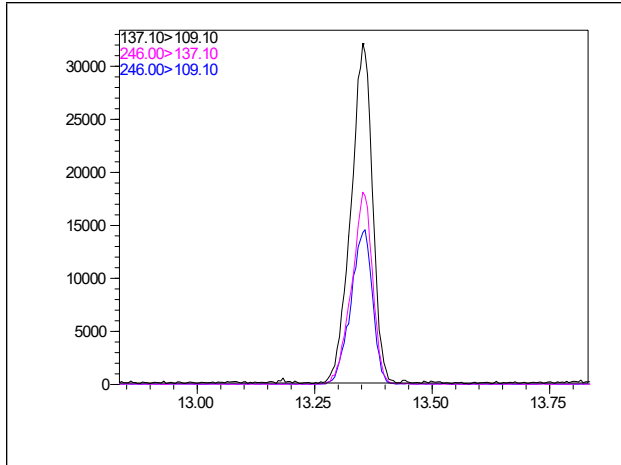
Terbuthylazine

Endrin

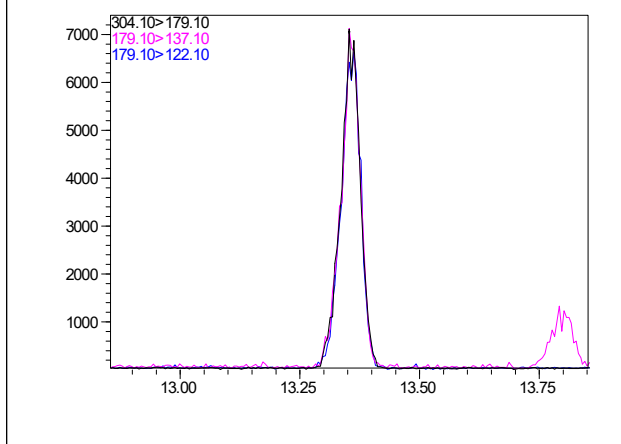


Fonofos

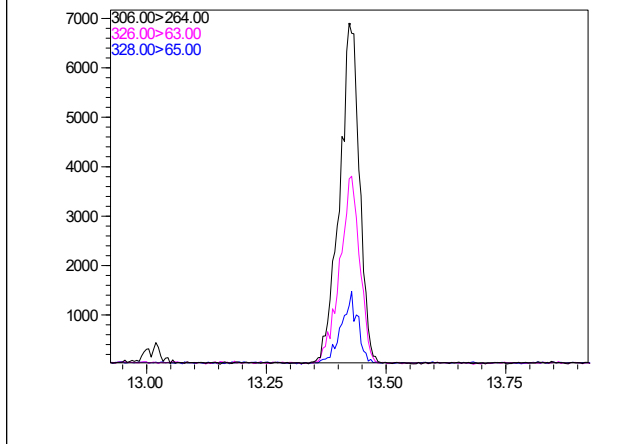
Ethion



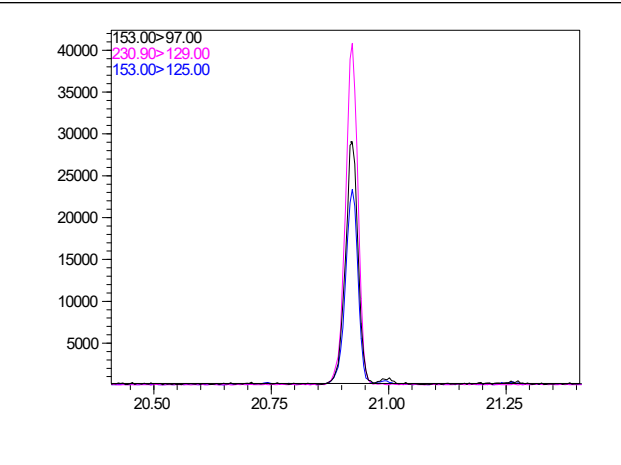
Diazinon



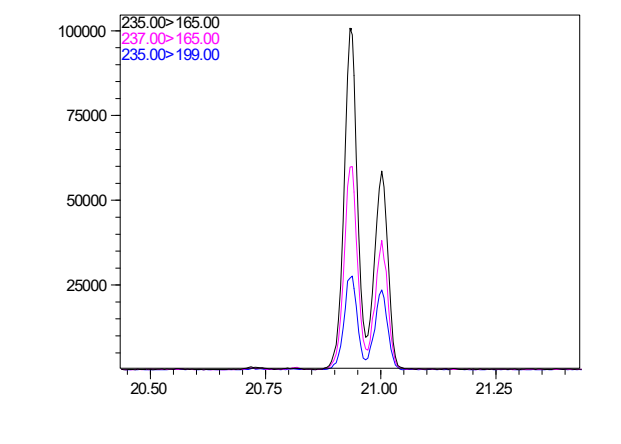
Fluchloralin



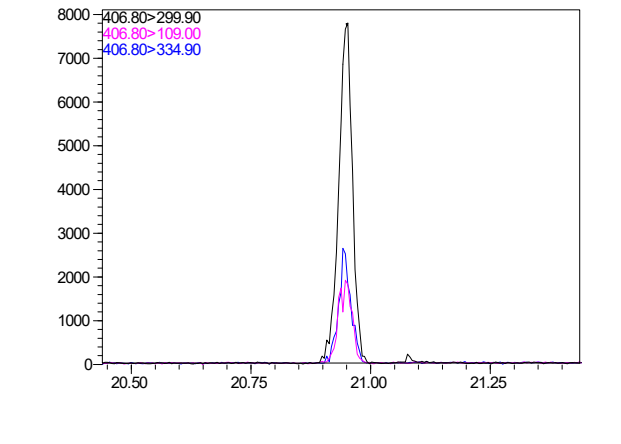
Pyrimethanil



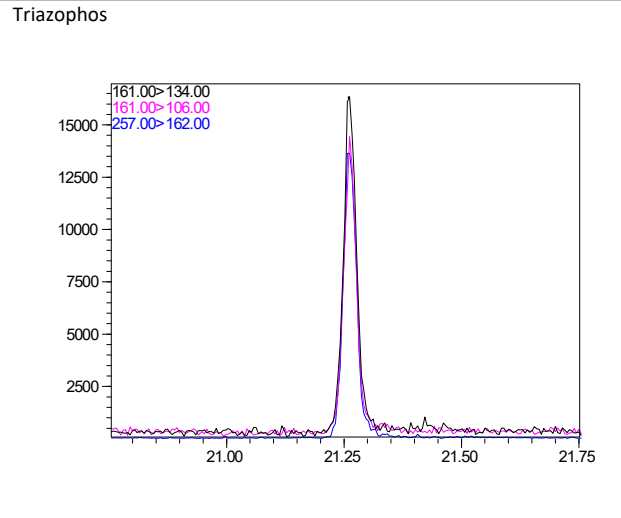
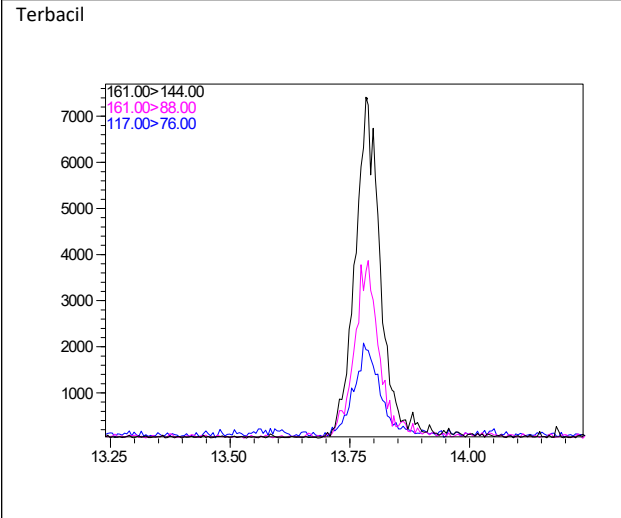
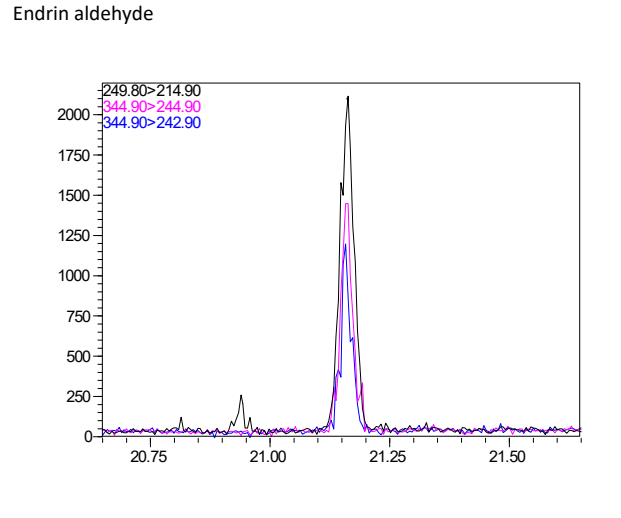
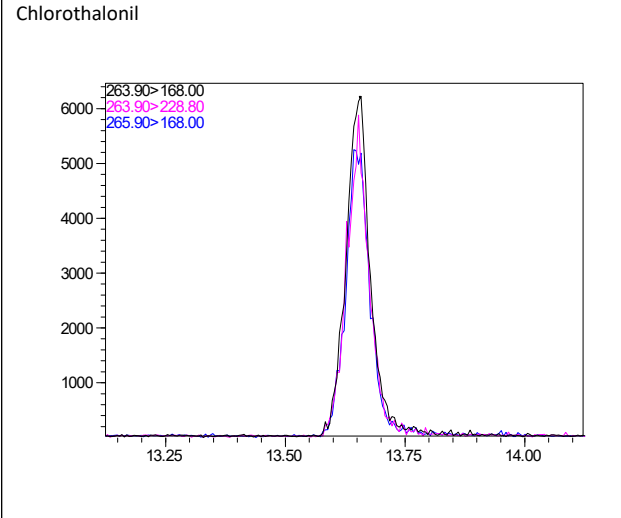
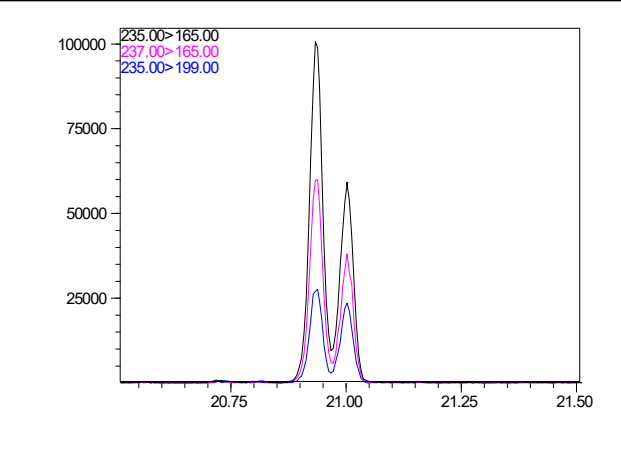
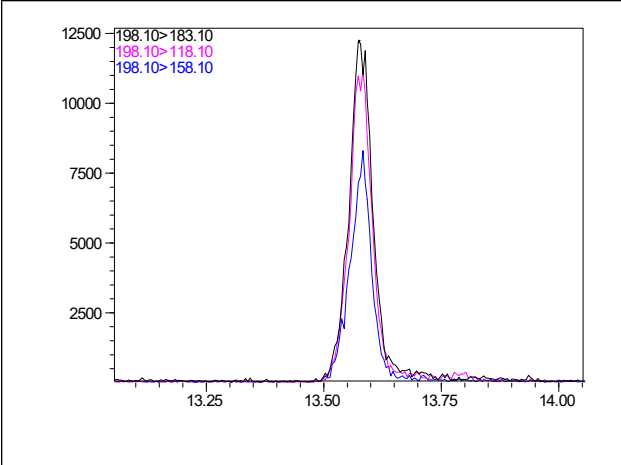
p,p'-DDD



cis-Nonachlor

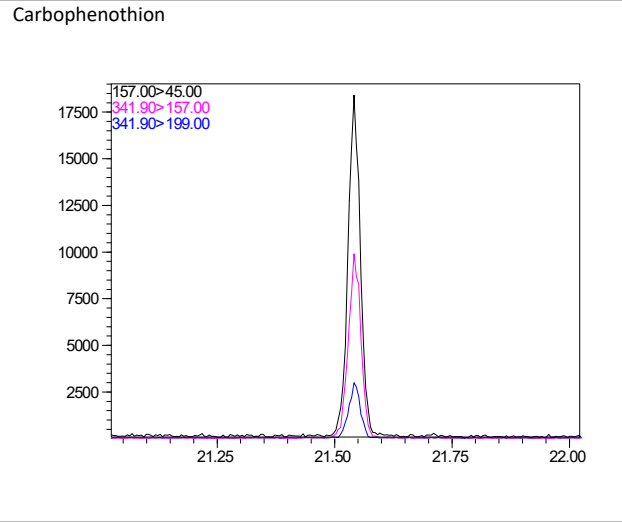
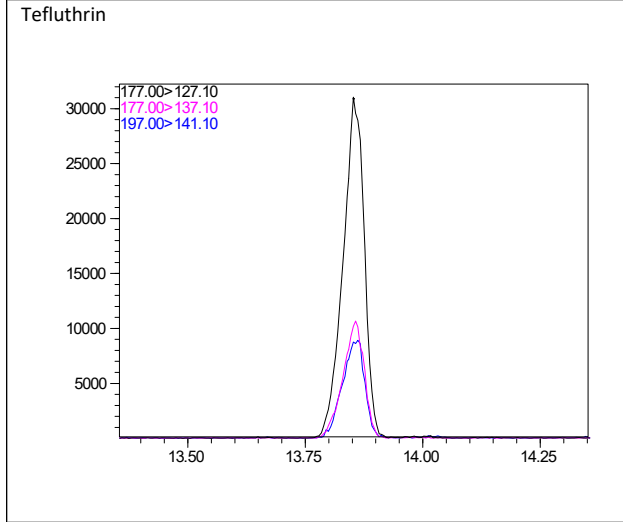
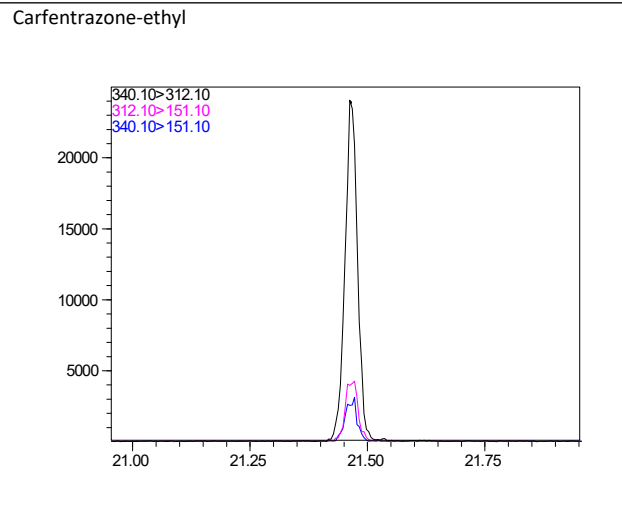
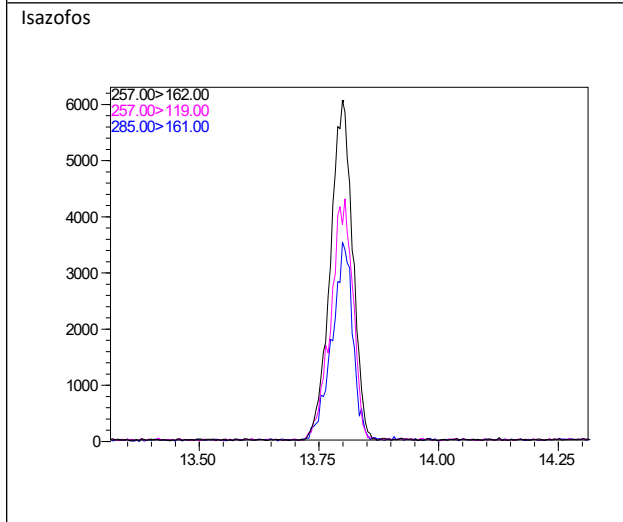
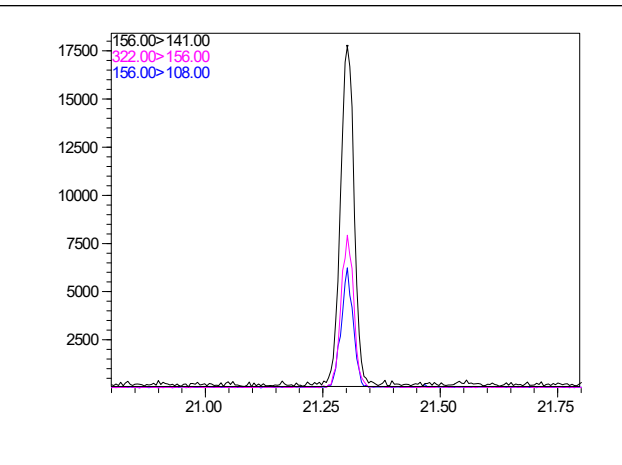
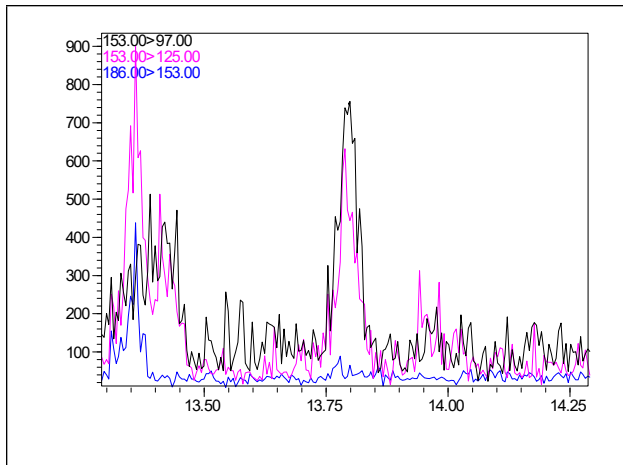


o,p'-DDT



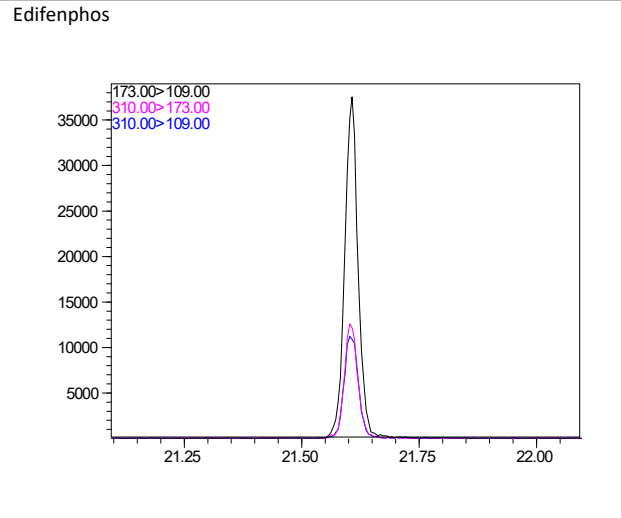
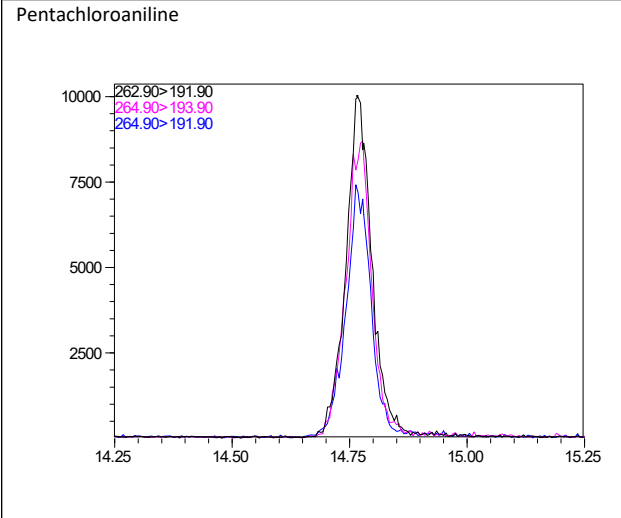
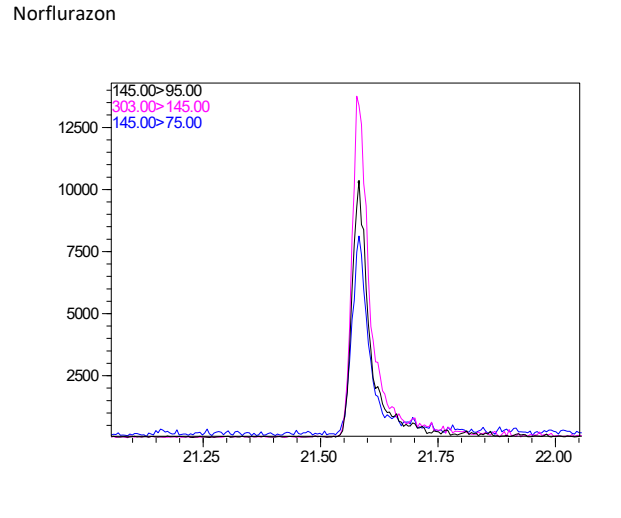
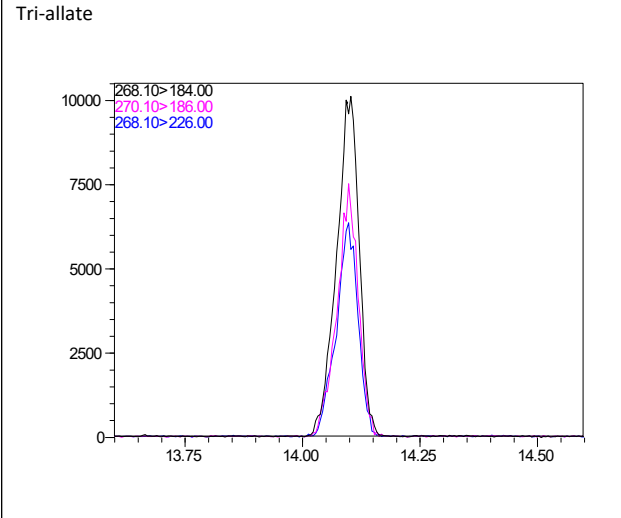
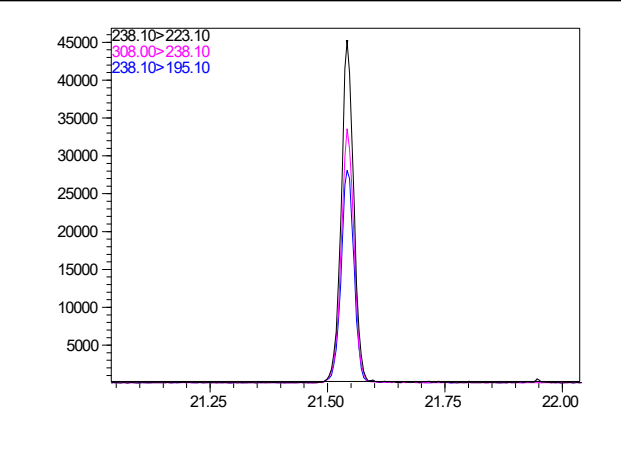
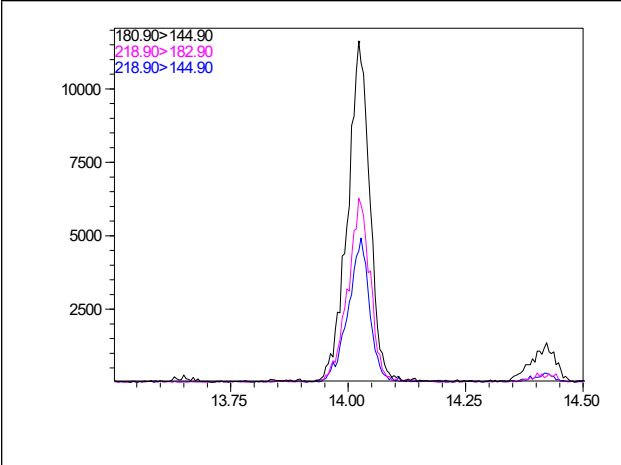
Disulfoton

Sulprofos



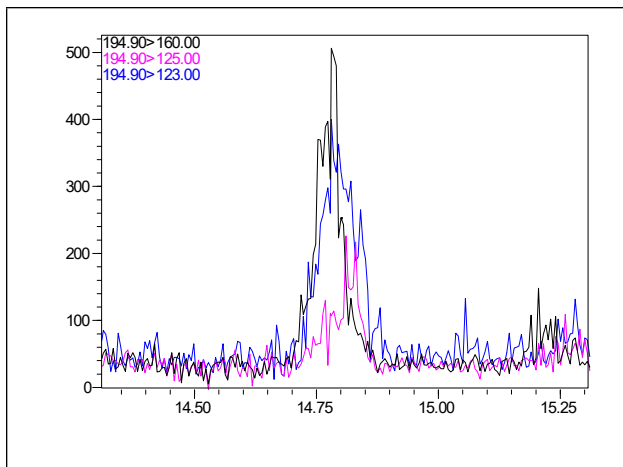
delta-BHC

4,4'-methoxychlor olefin

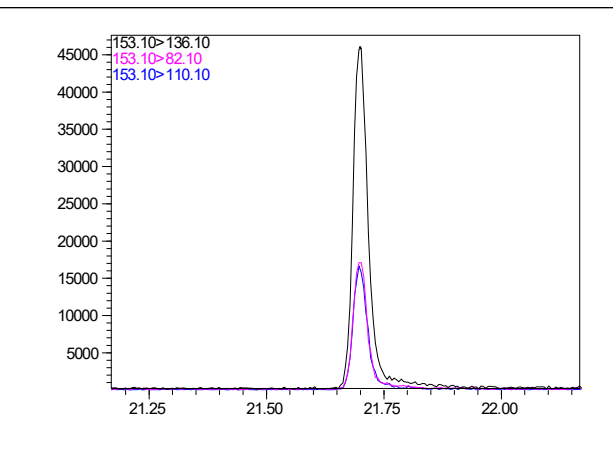
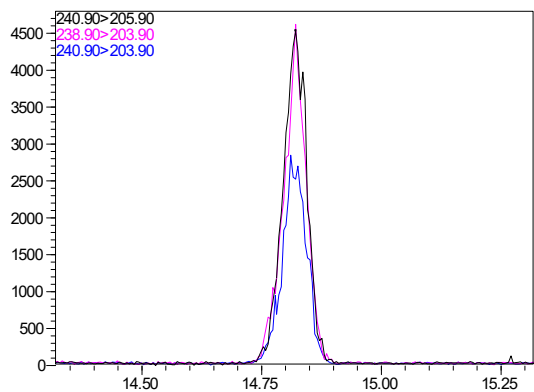


alpha-Endosulfan

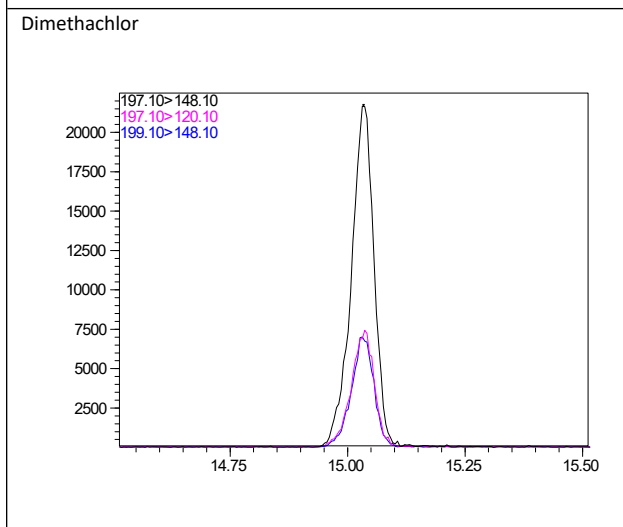
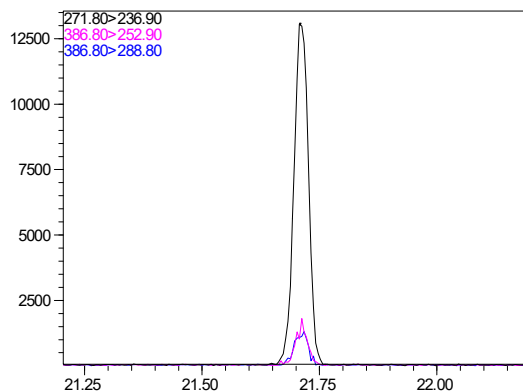
Lenacil



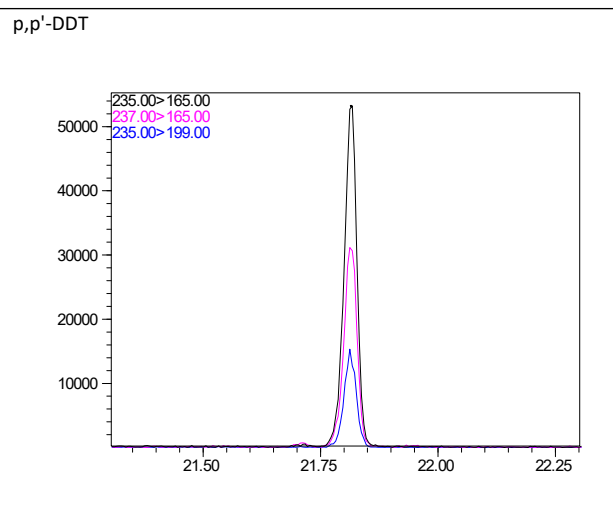
Endosulfan ether



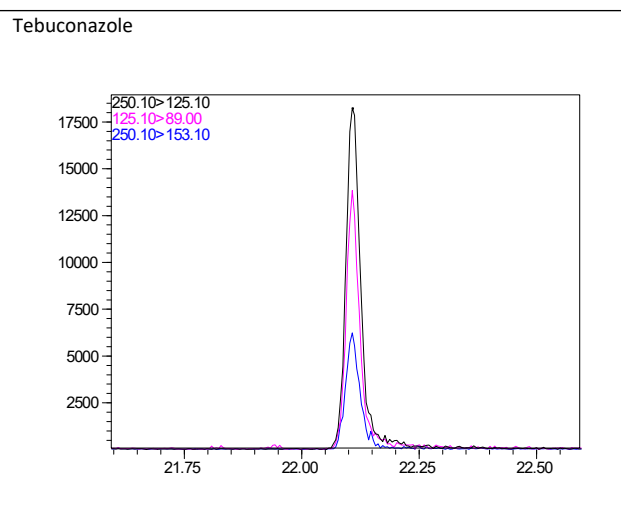
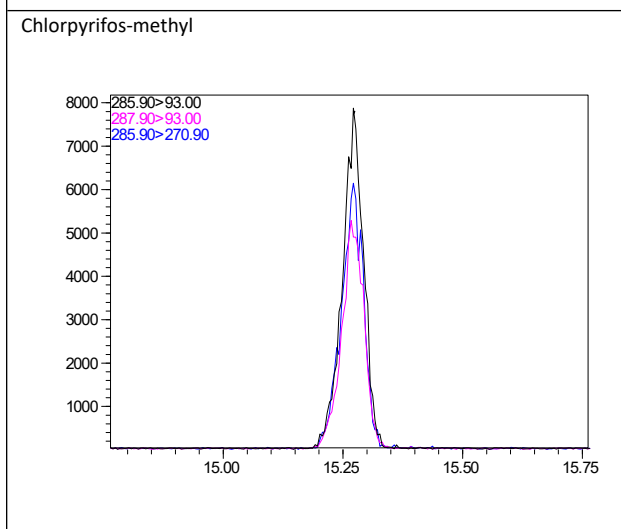
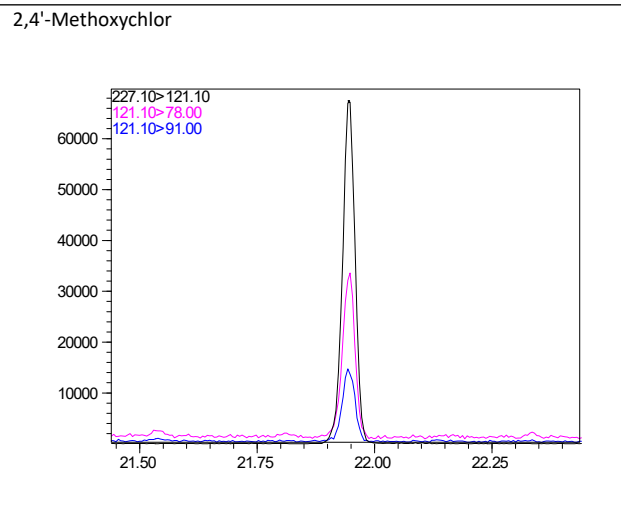
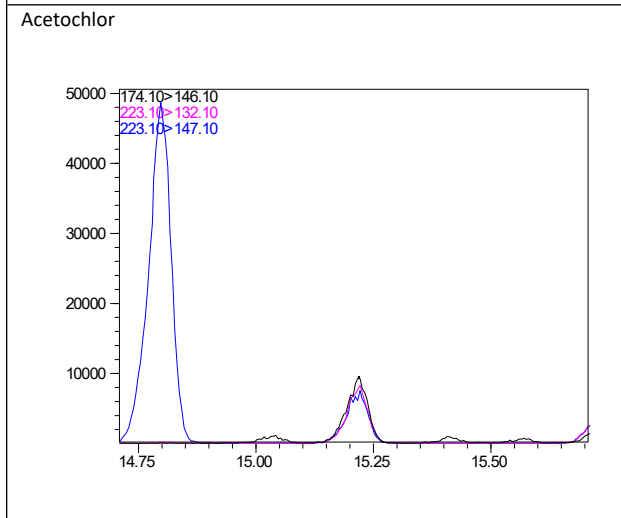
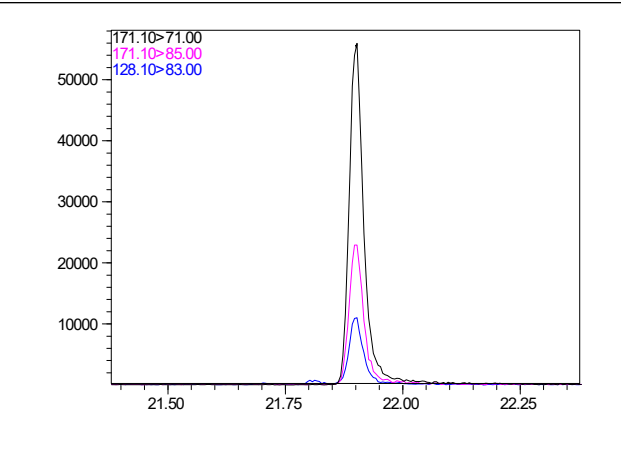
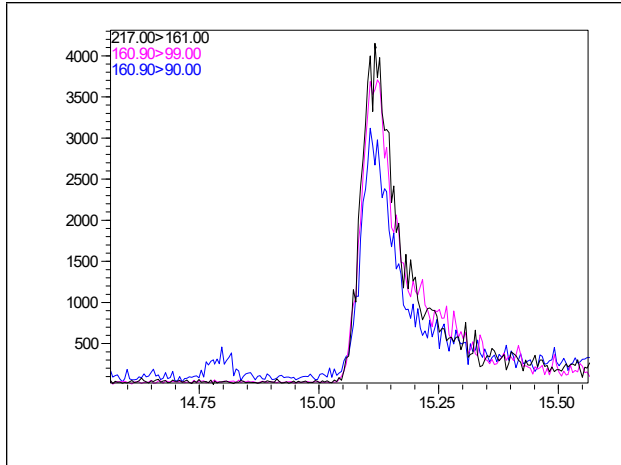
Endosulfan sulfate



Propanil

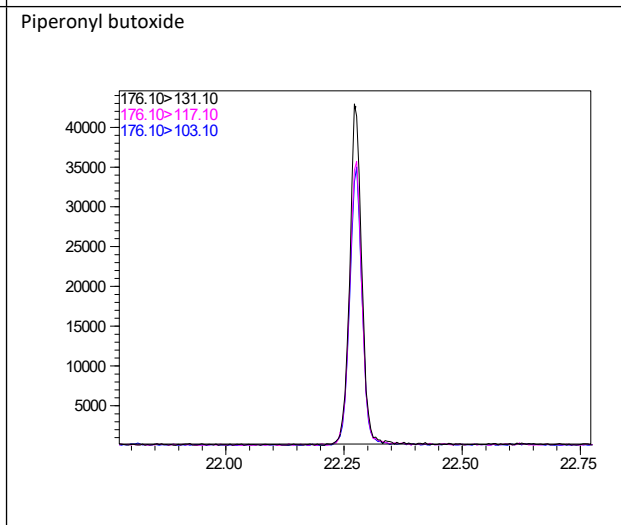
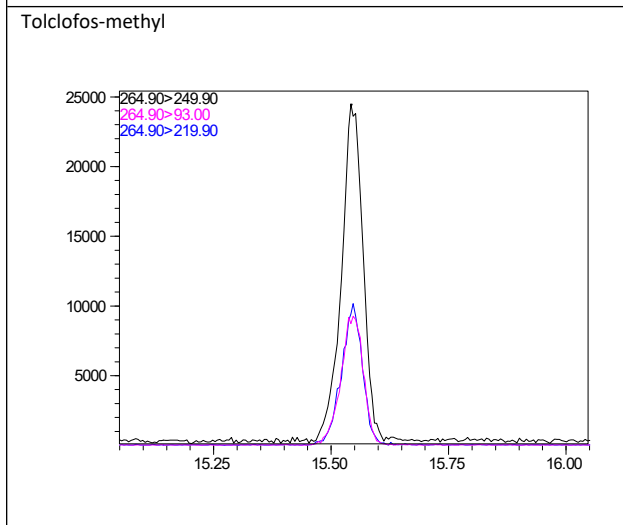
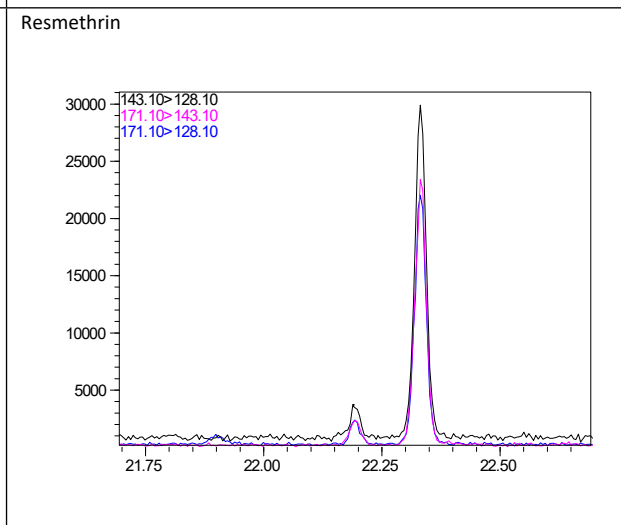
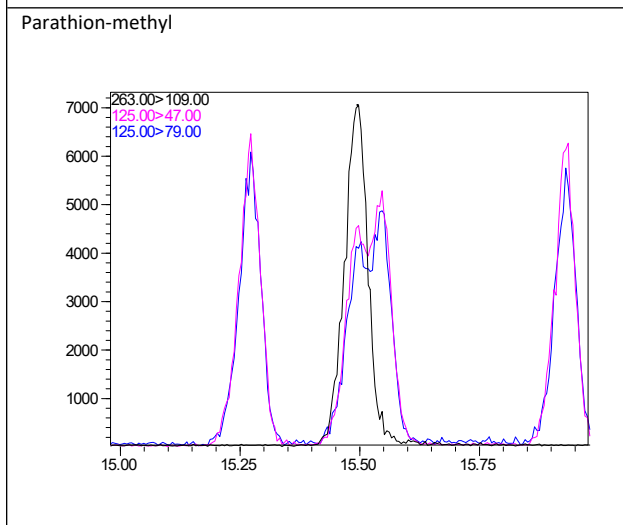
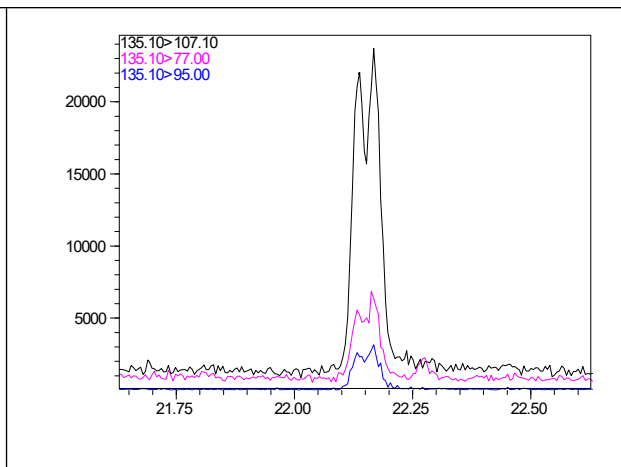
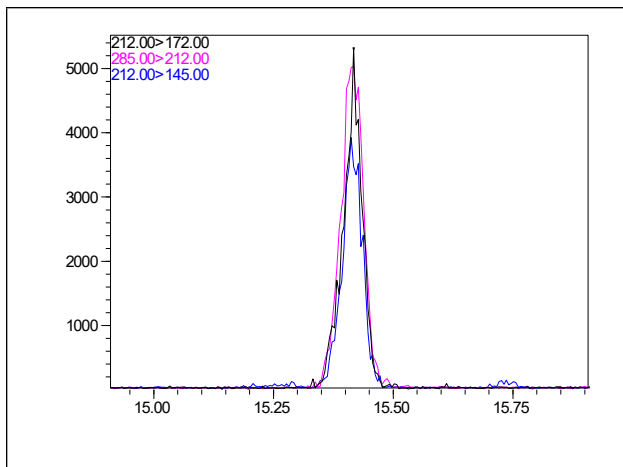


Hexazinone



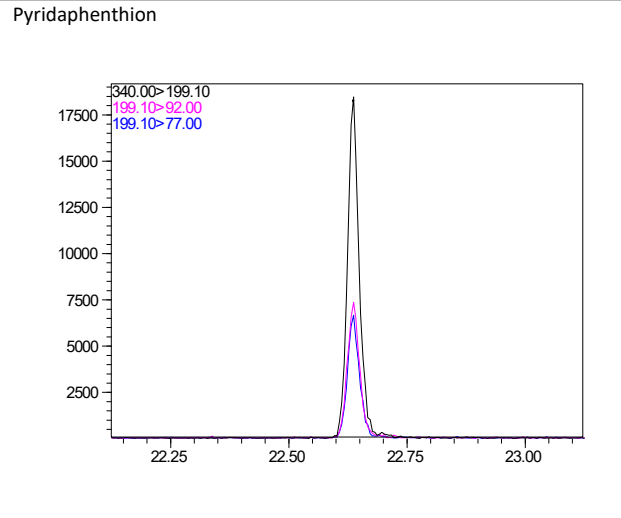
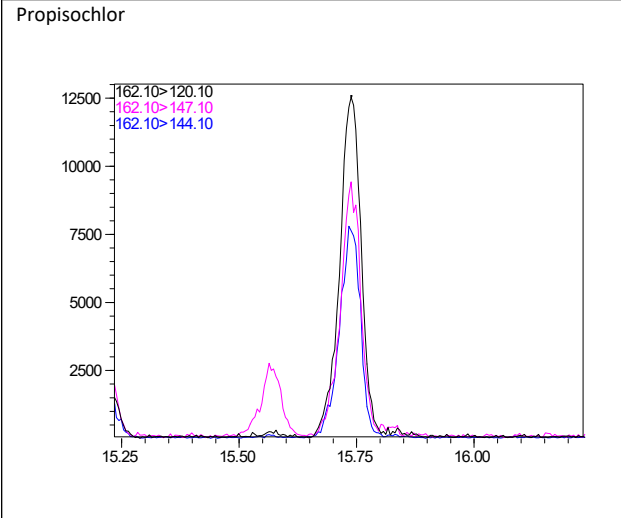
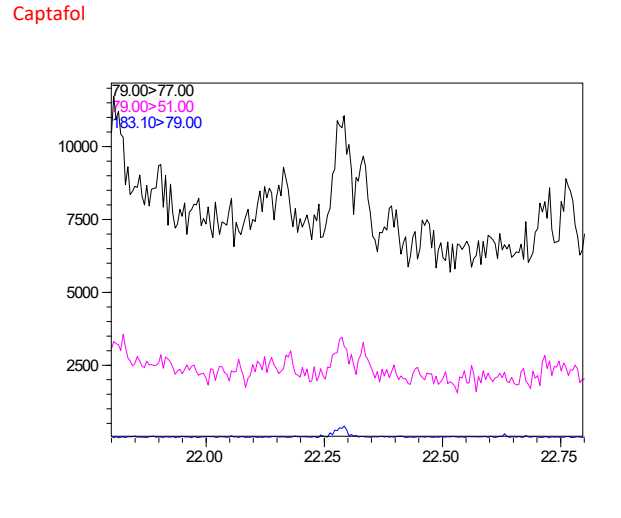
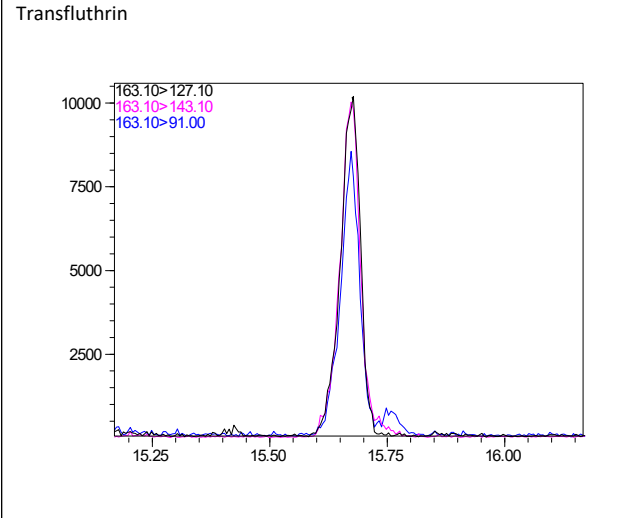
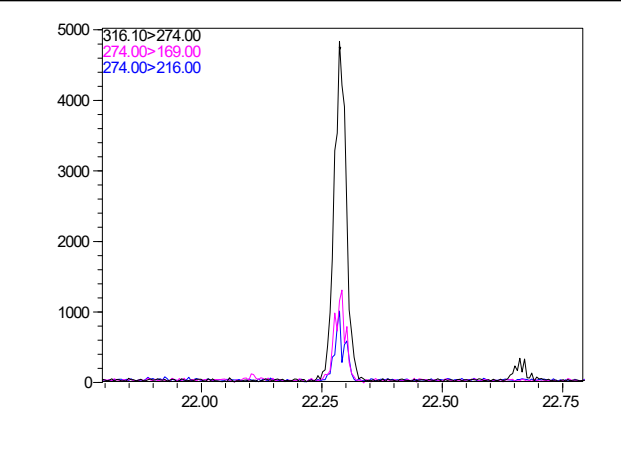
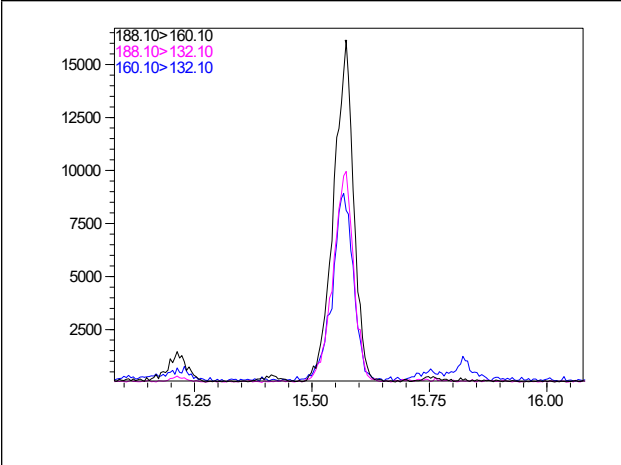
Vinclozolin

Propargite



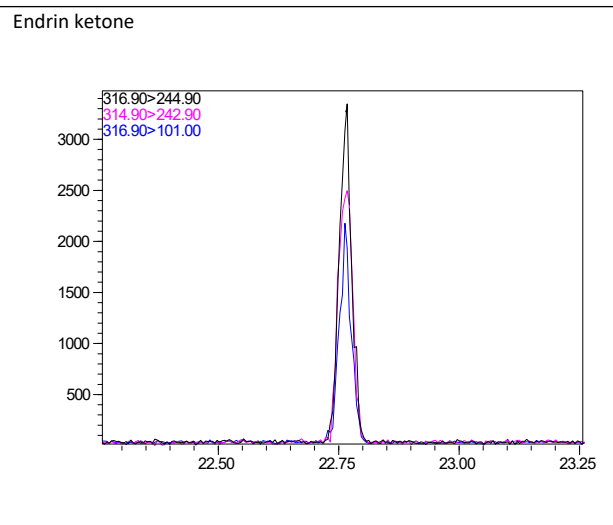
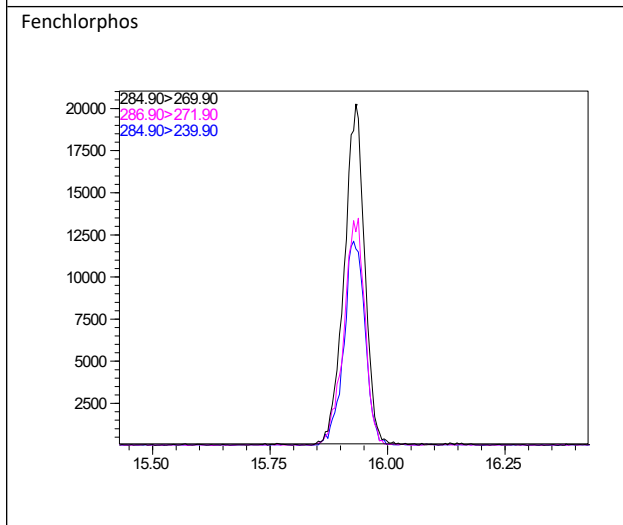
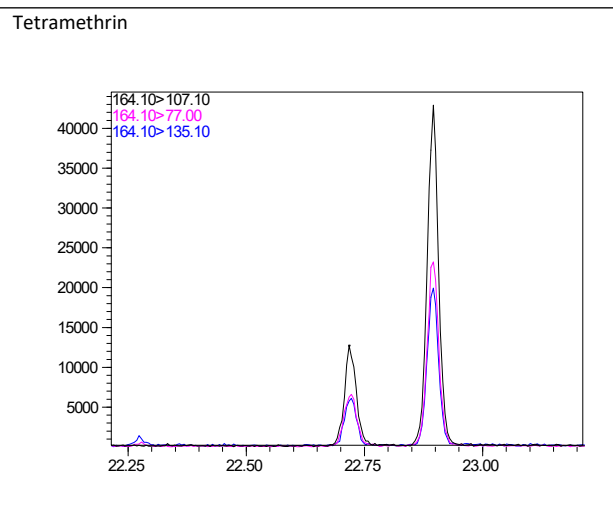
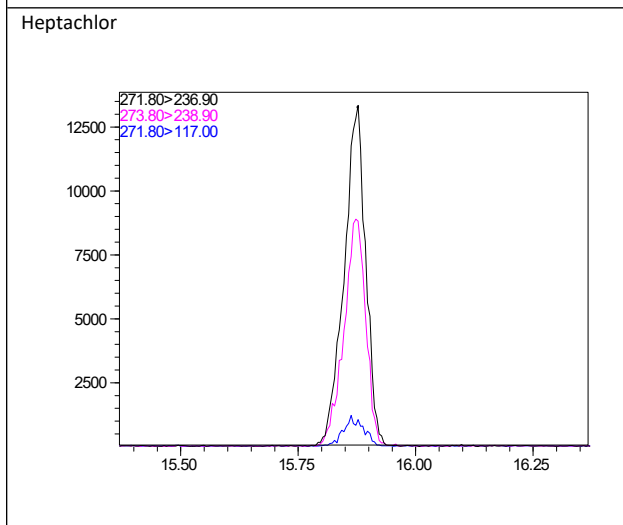
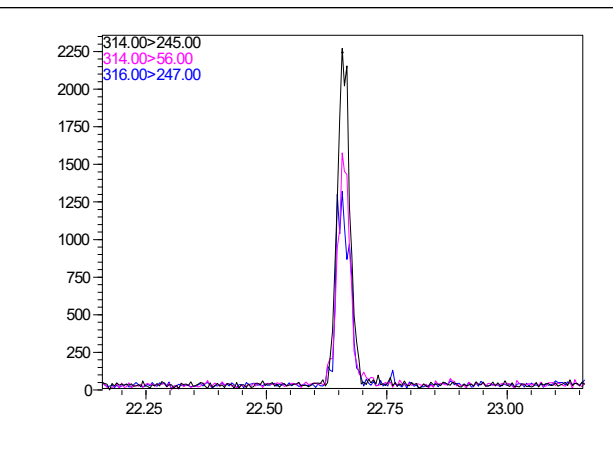
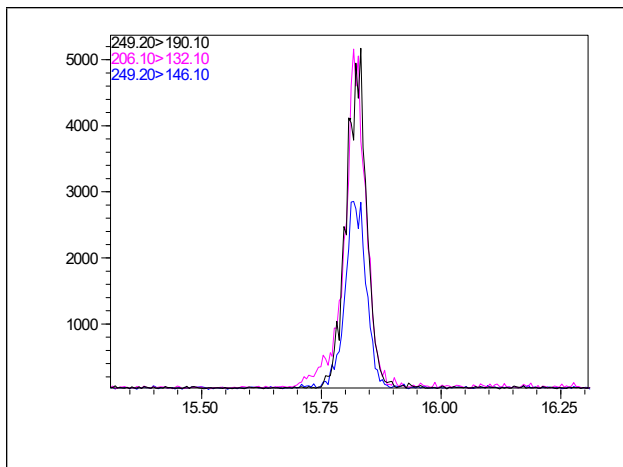
Alachlor

Nitralin



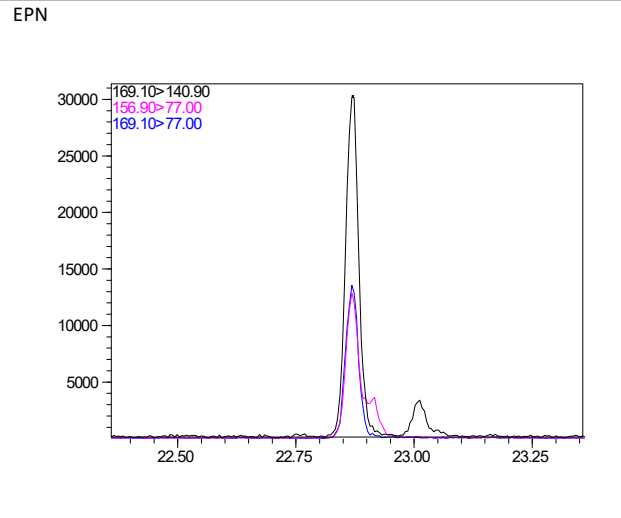
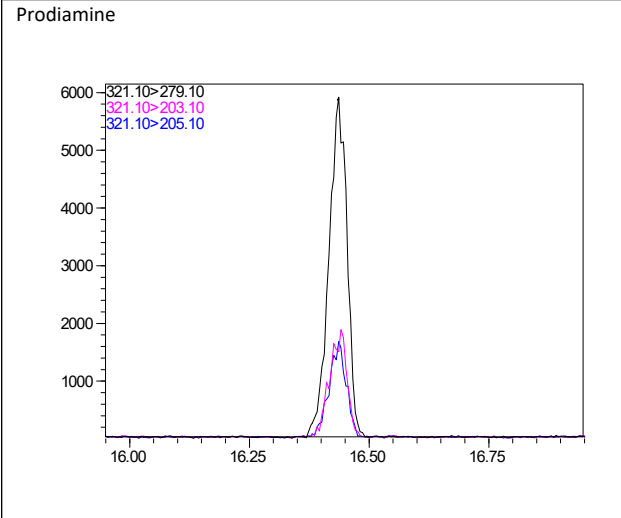
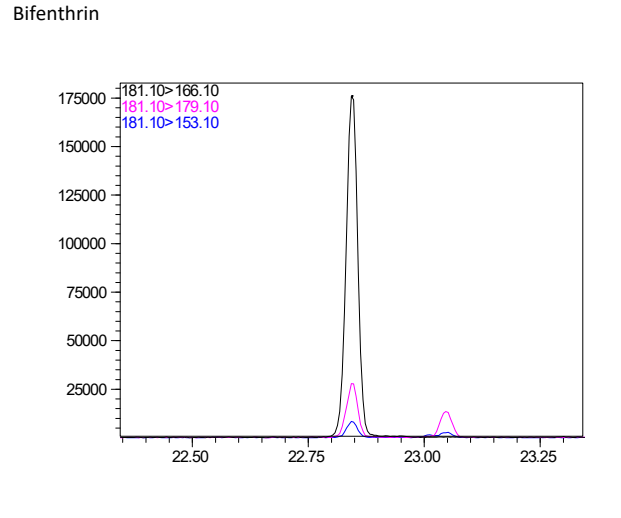
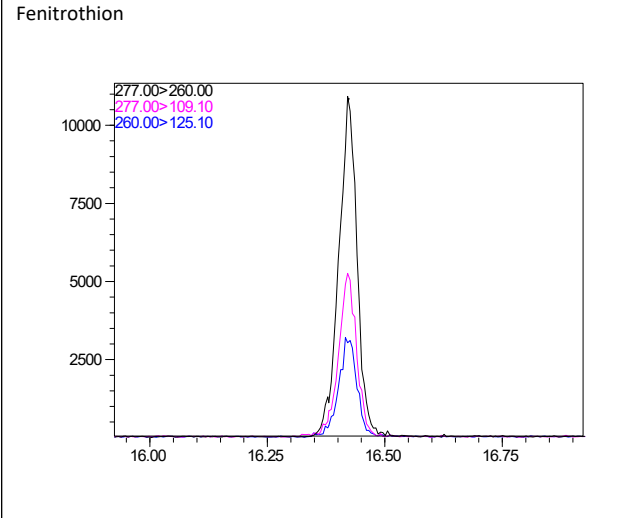
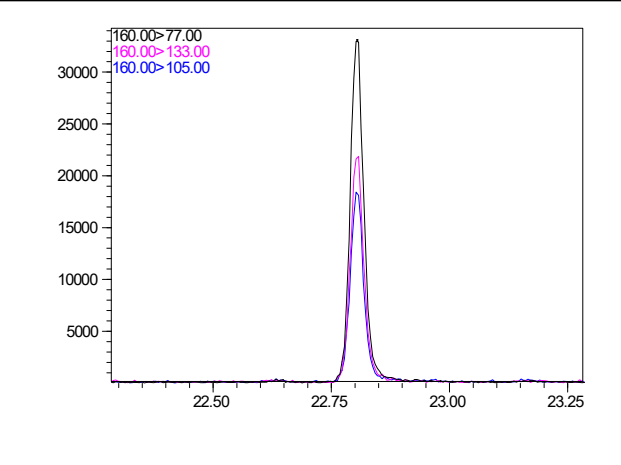
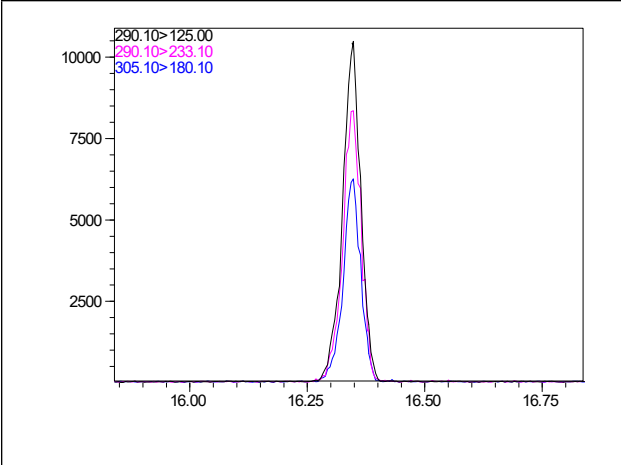
Metalaxyl

Iprodione



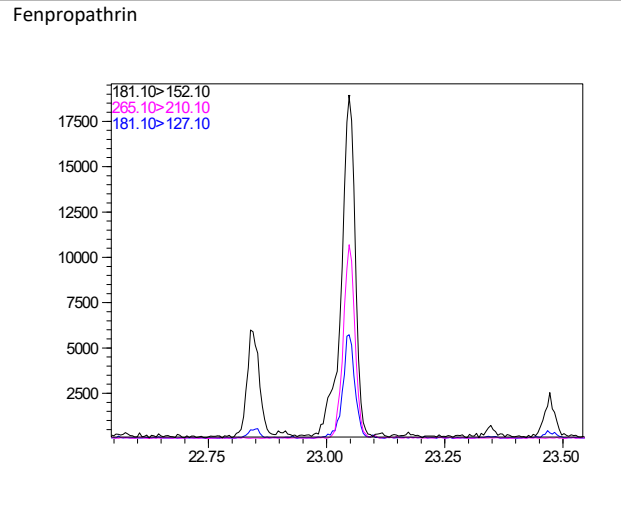
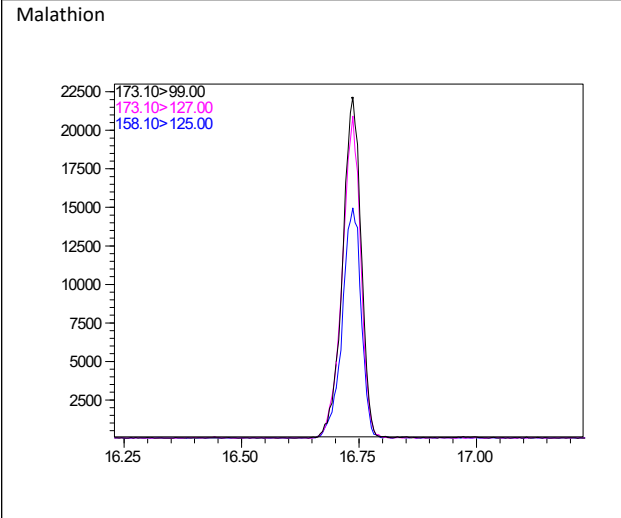
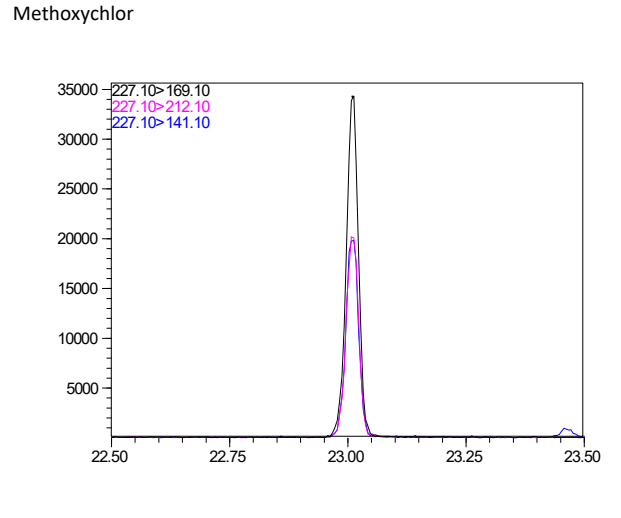
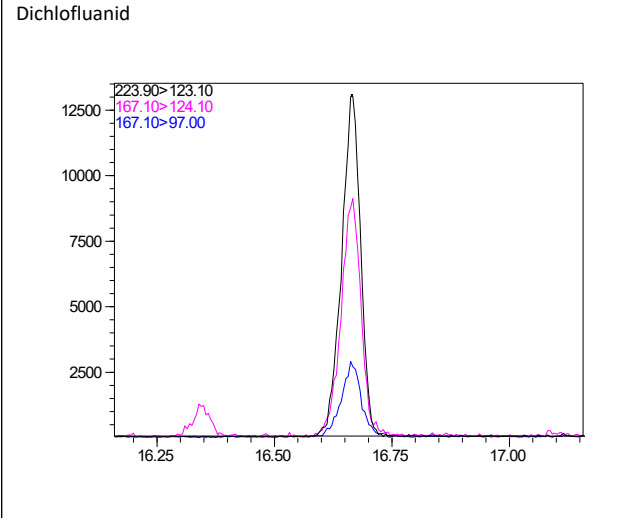
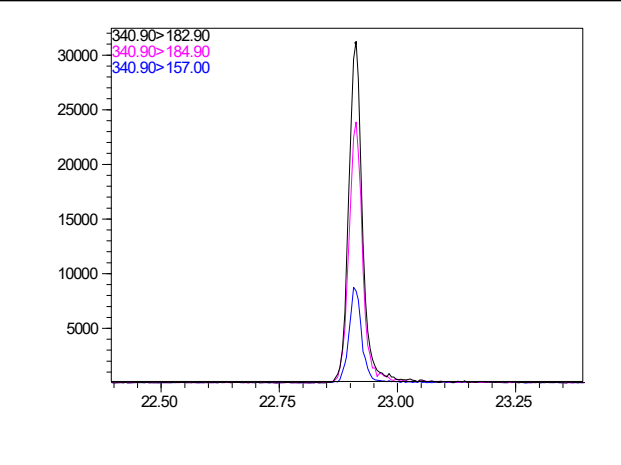
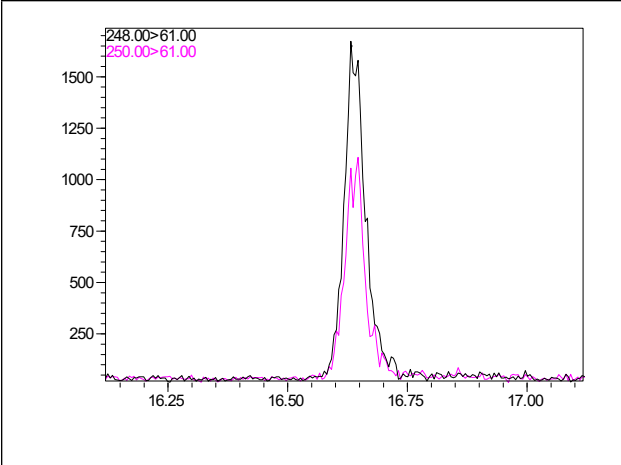
Pirimiphos-methyl

Phosmet



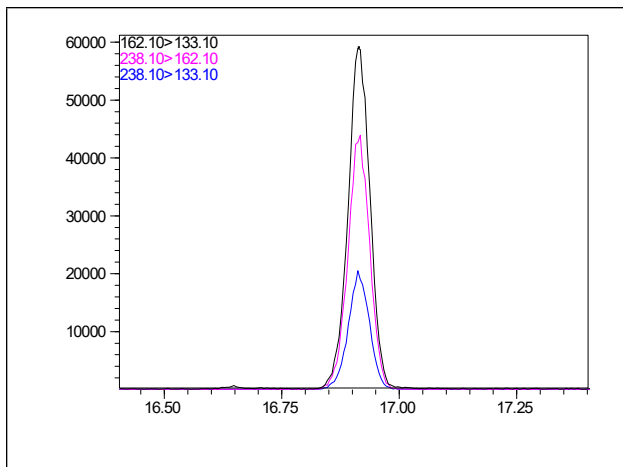
Linuron

Bromopropylate

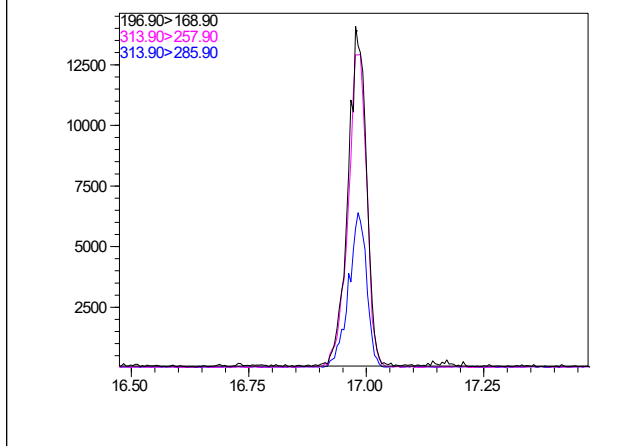


Metolachlor

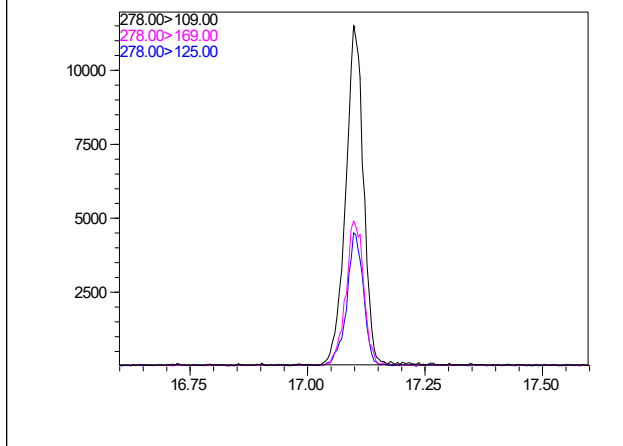
Tebufenpyrad



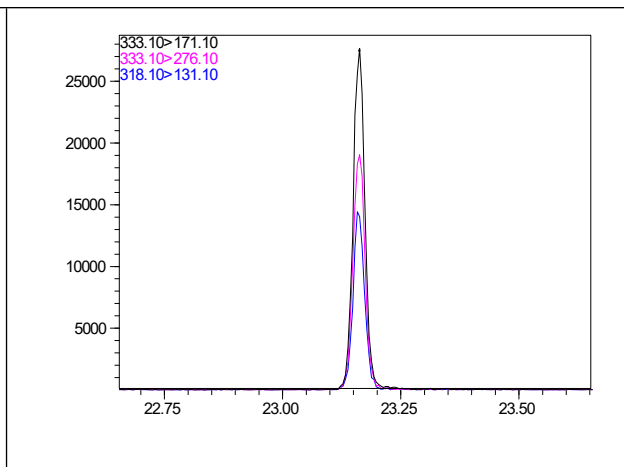
Chlorpyrifos



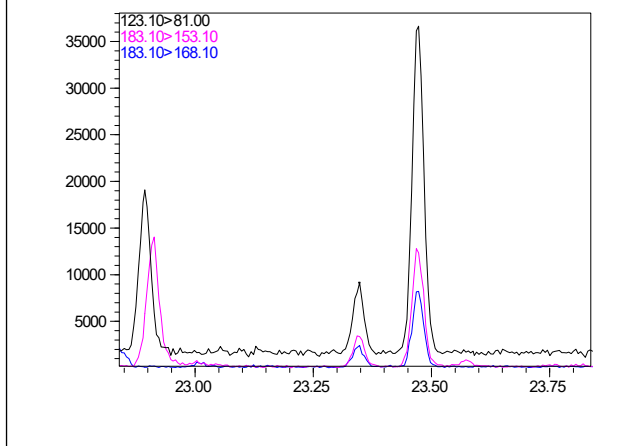
Fenthion



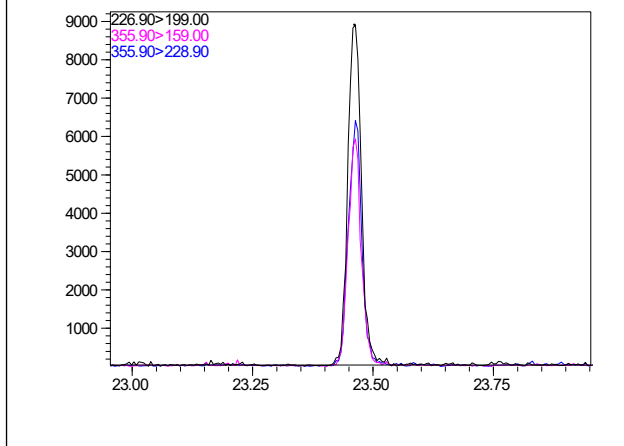
Anthraquinone



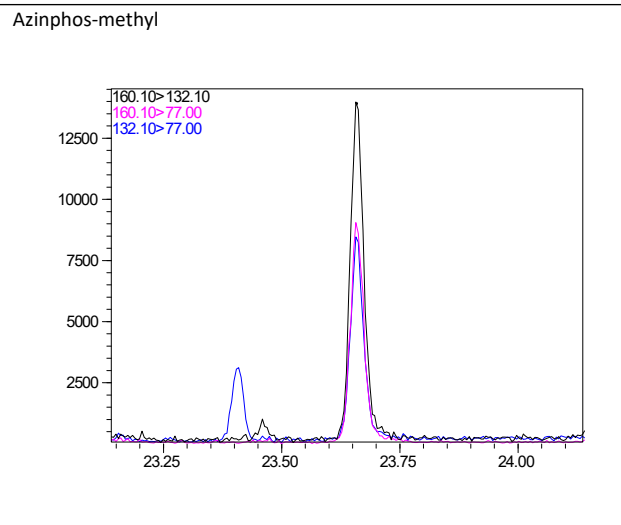
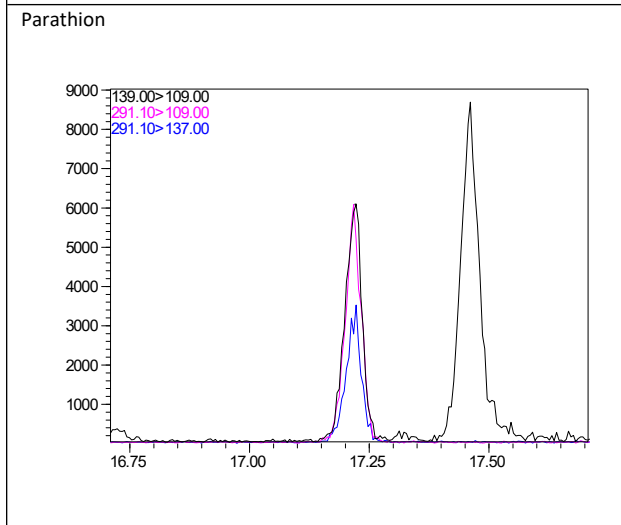
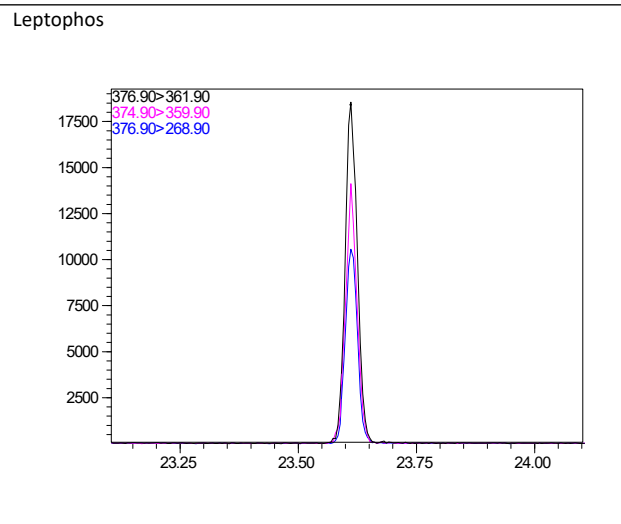
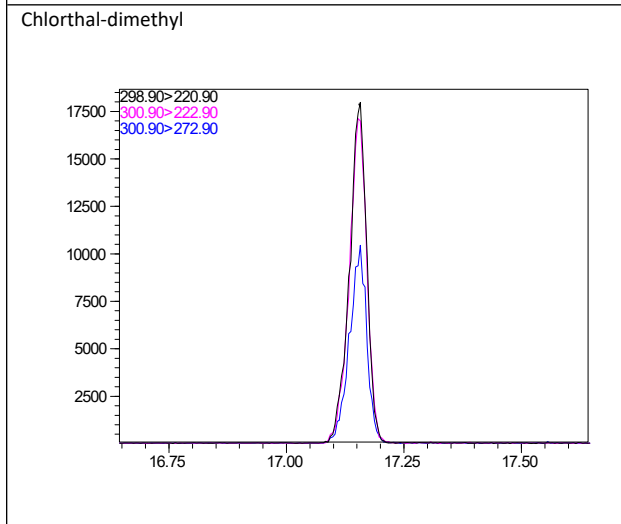
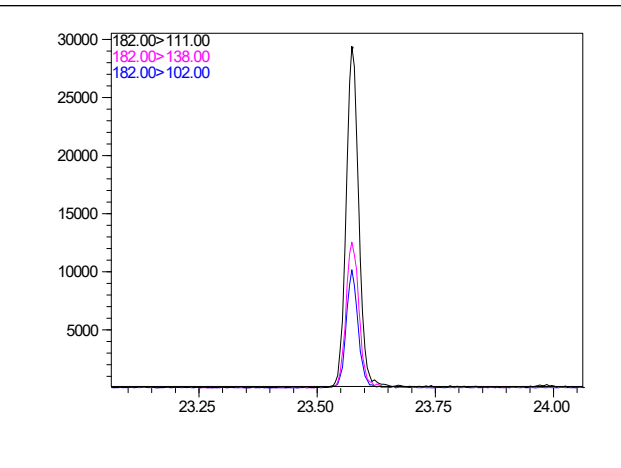
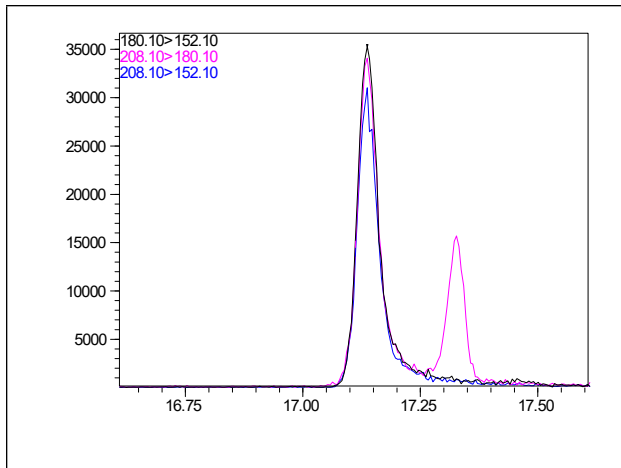
Phosalone



Tetradifon

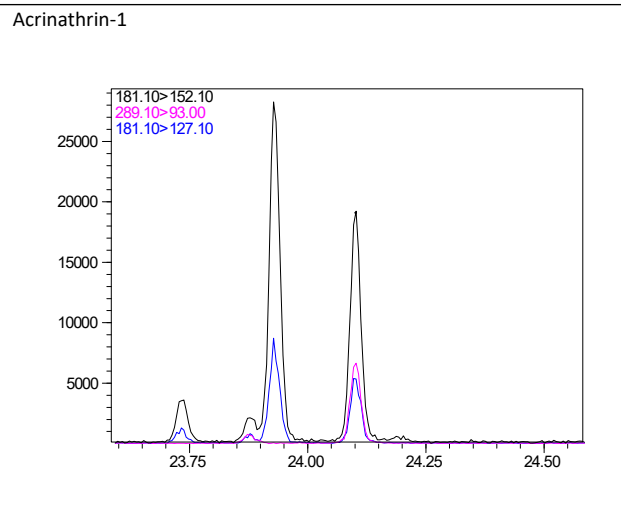
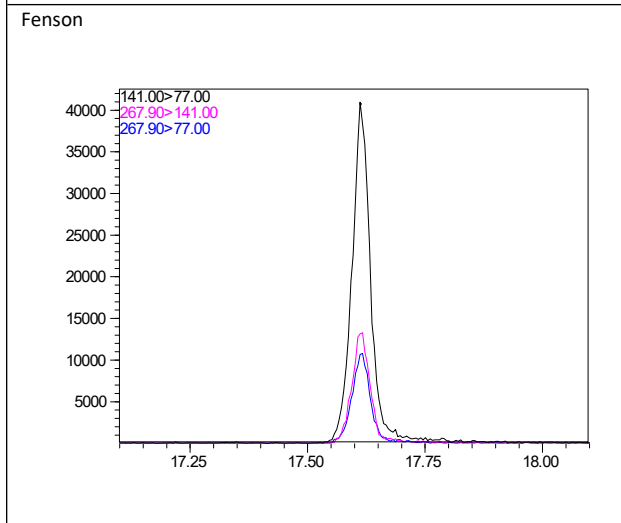
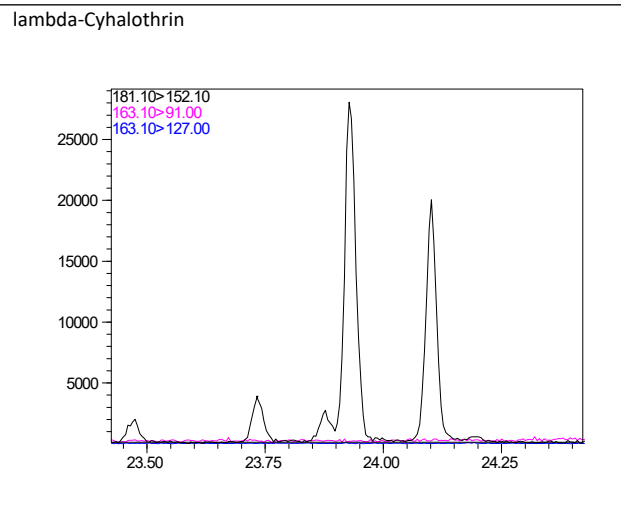
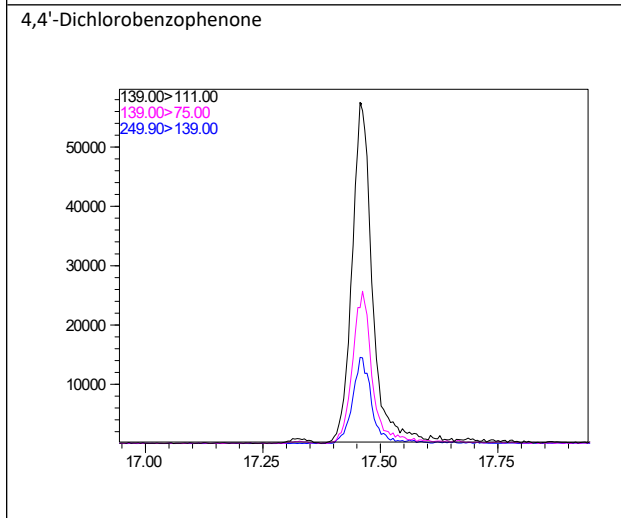
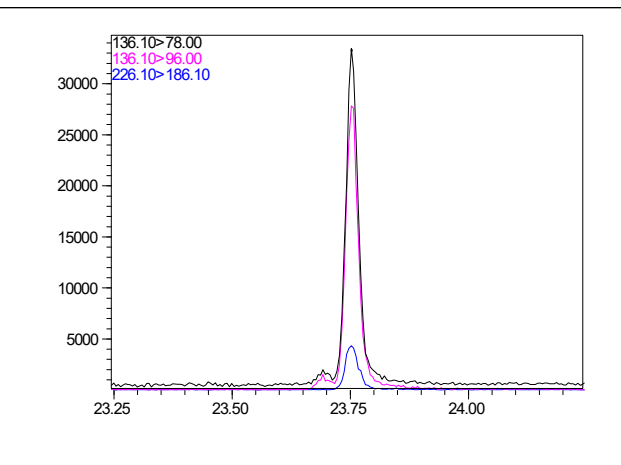
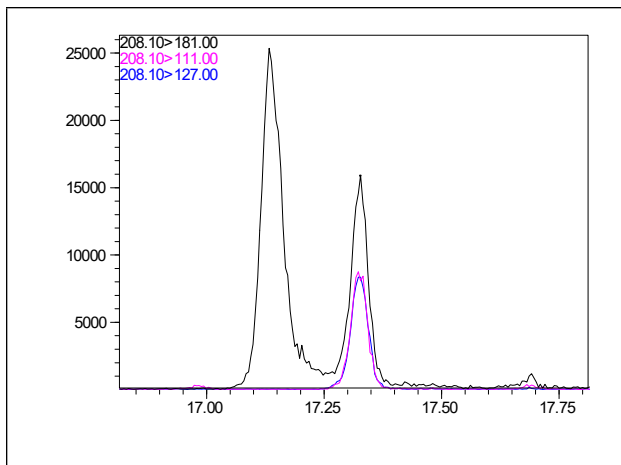


Phosalone



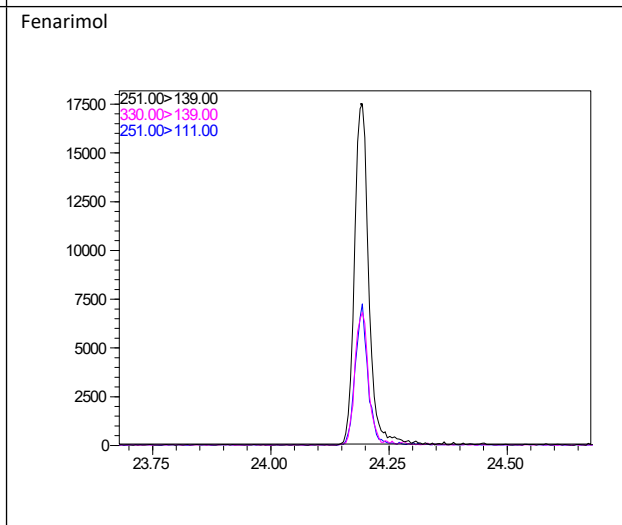
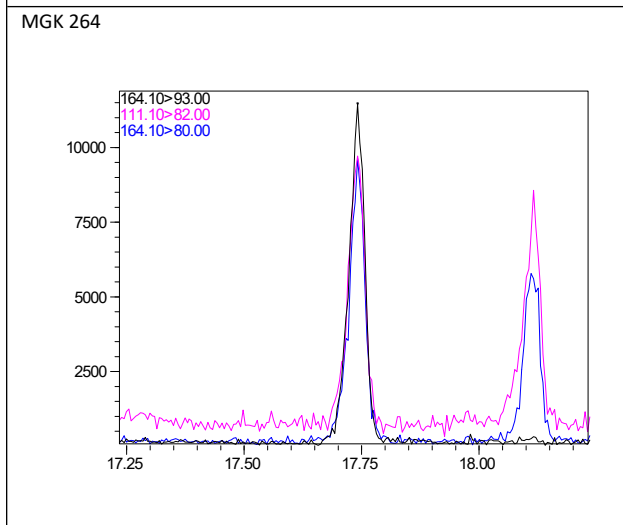
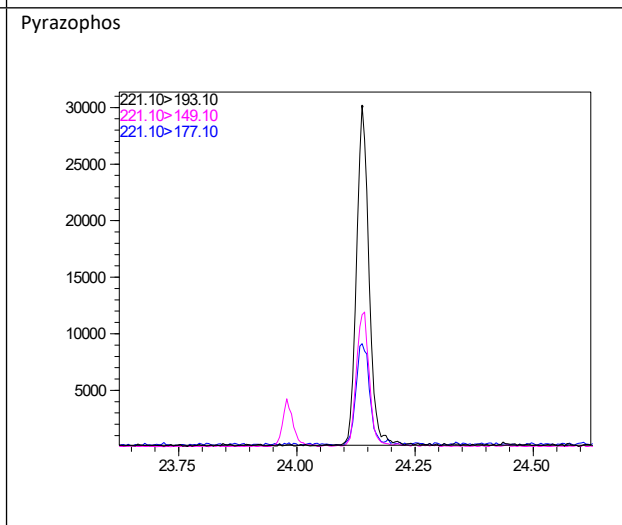
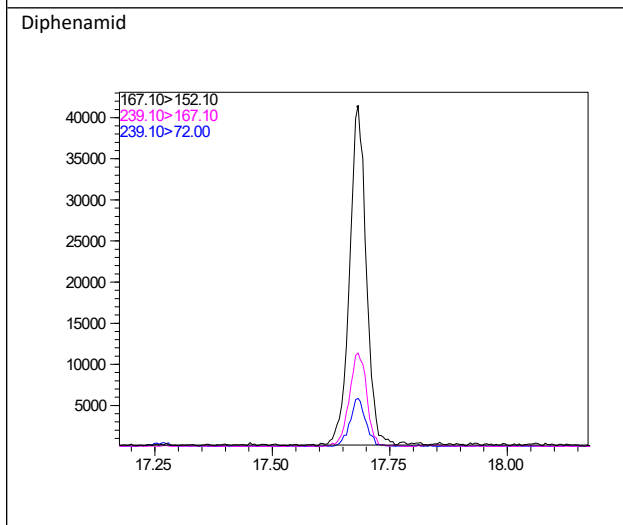
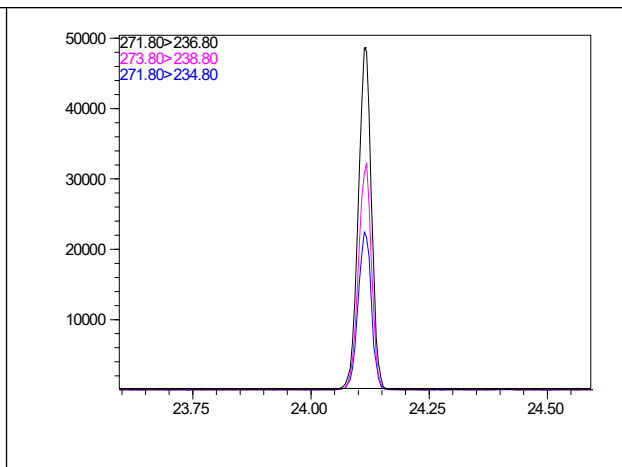
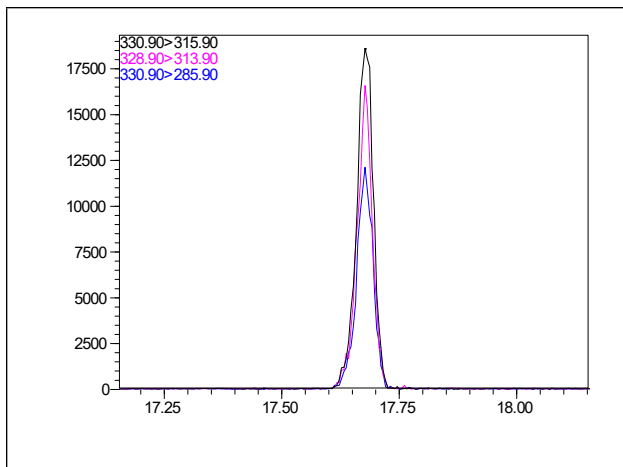
Triadimefon

Pyriproxyfen



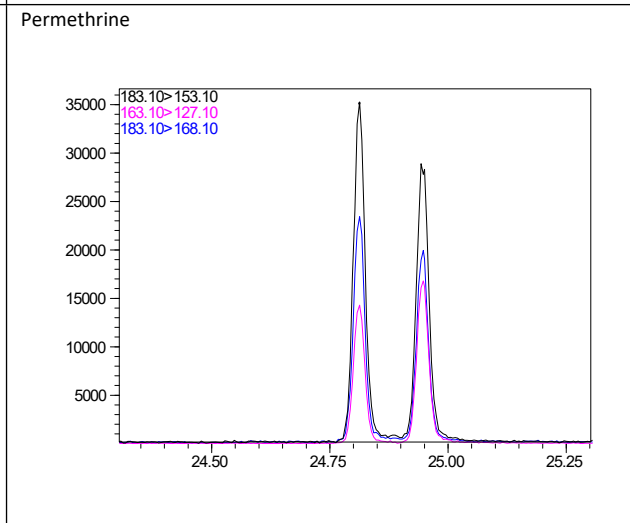
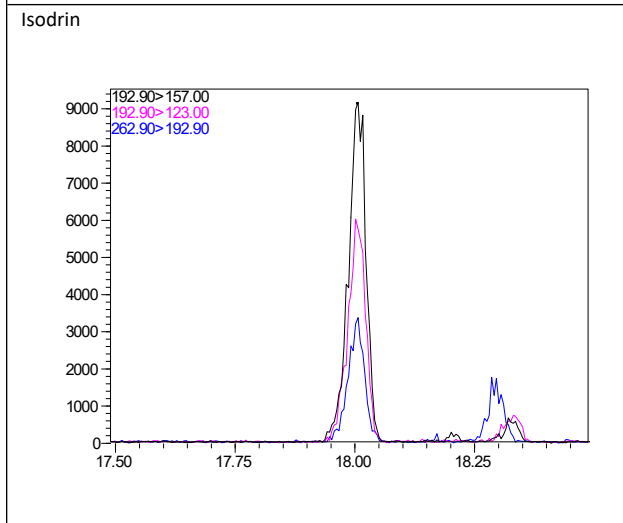
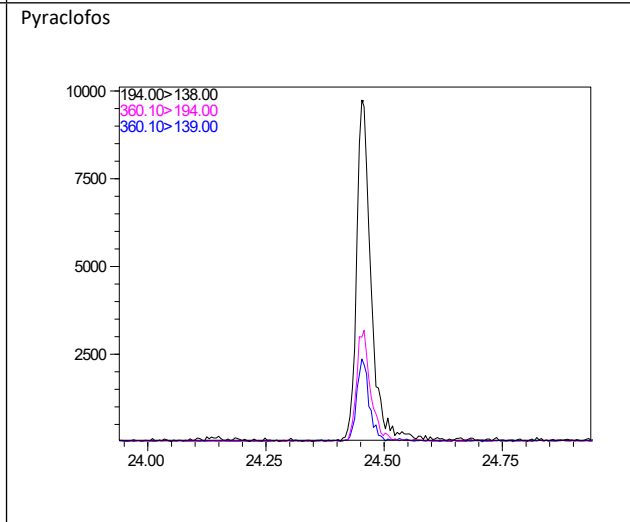
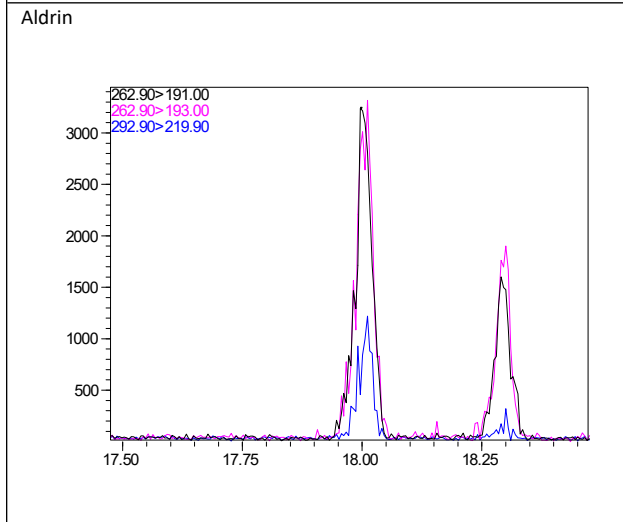
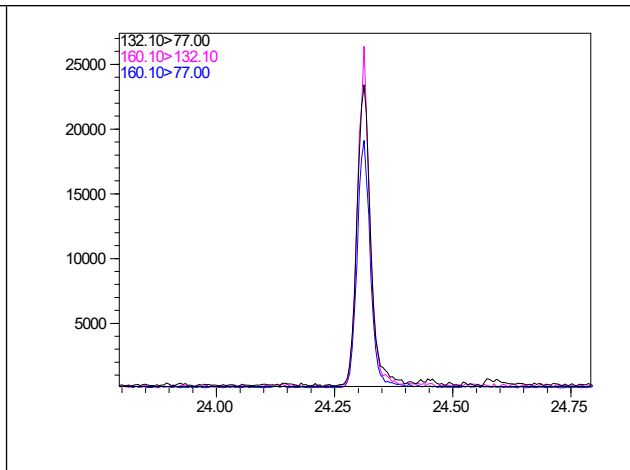
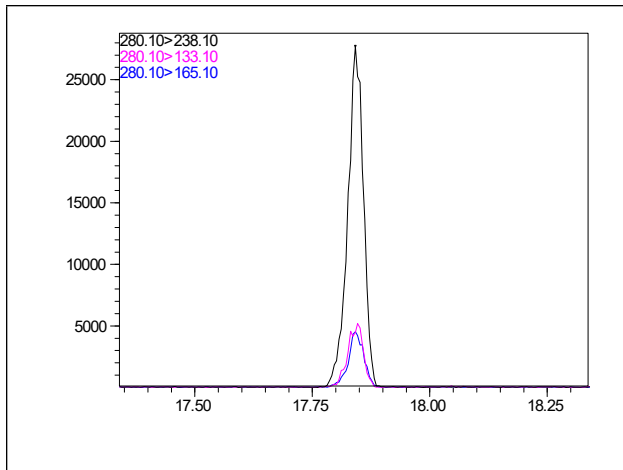
Bromophos

Mirex



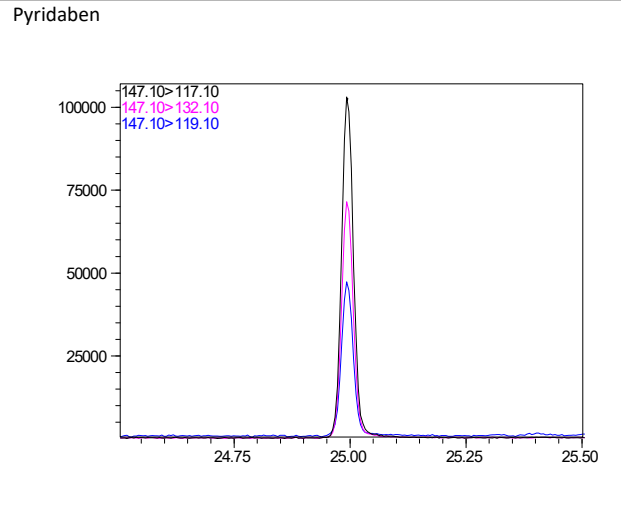
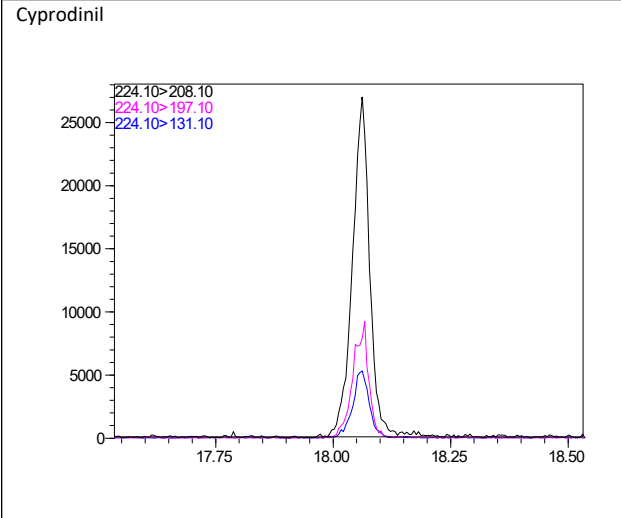
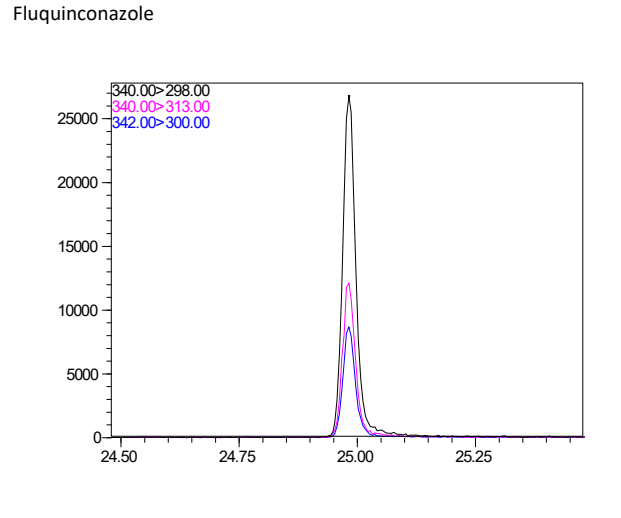
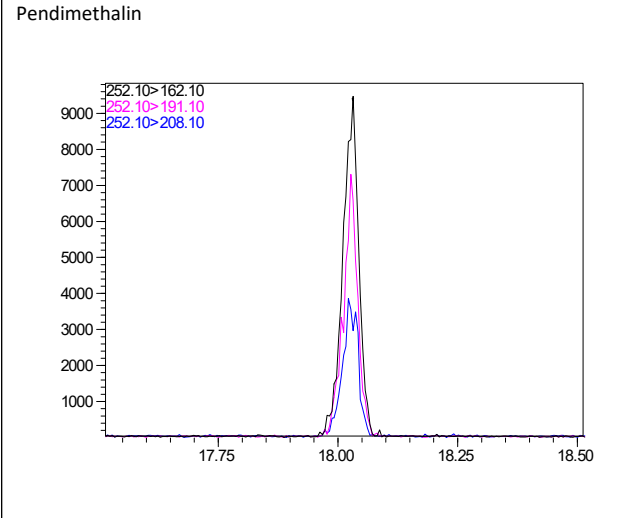
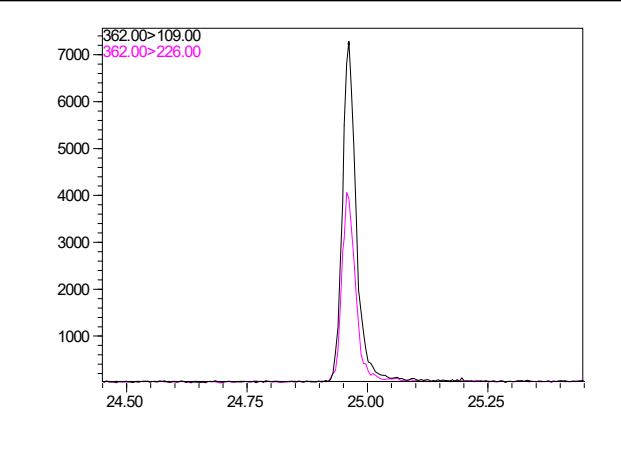
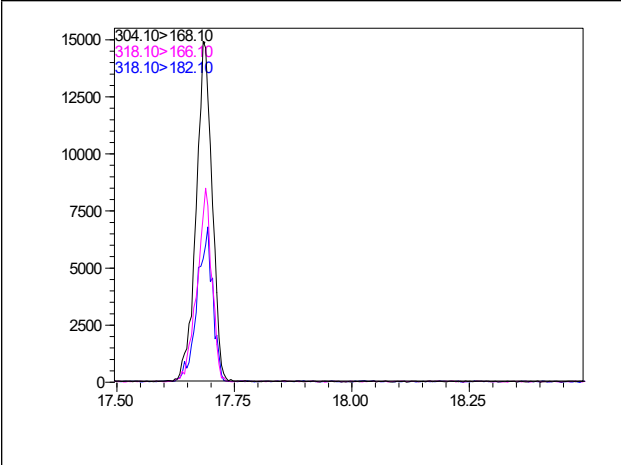
Isopropalin

Azinphos-ethyl



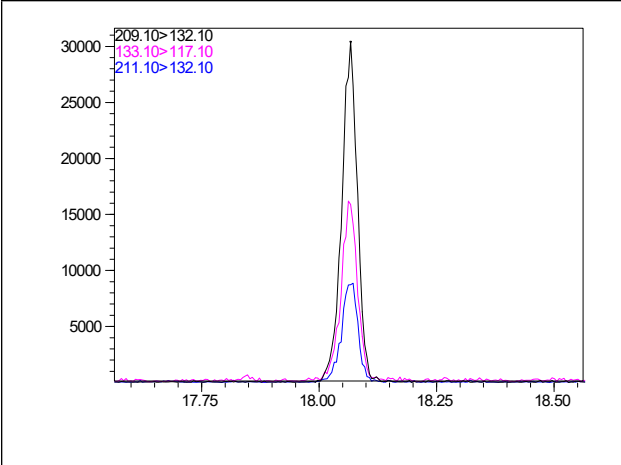
Pirimiphos ethyl

Coumaphos

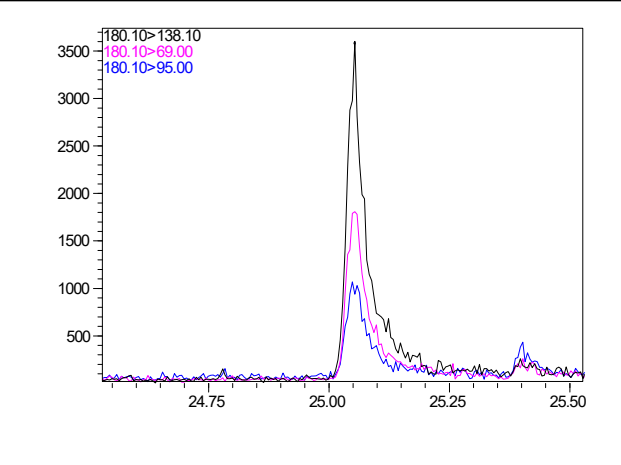
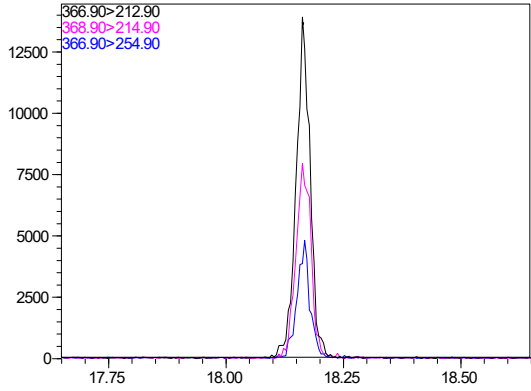


Metazachlor

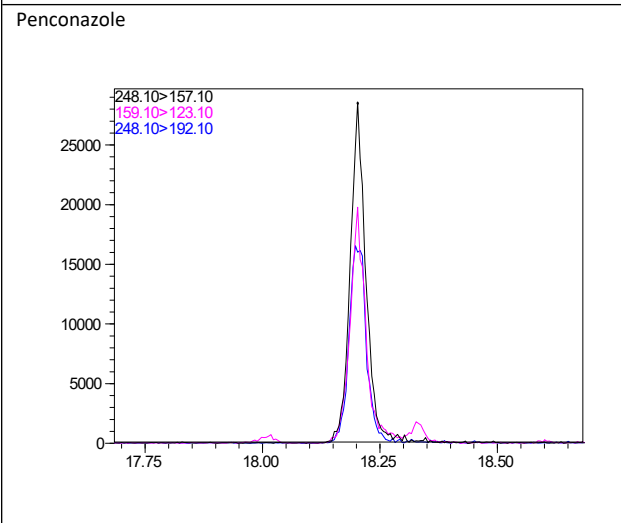
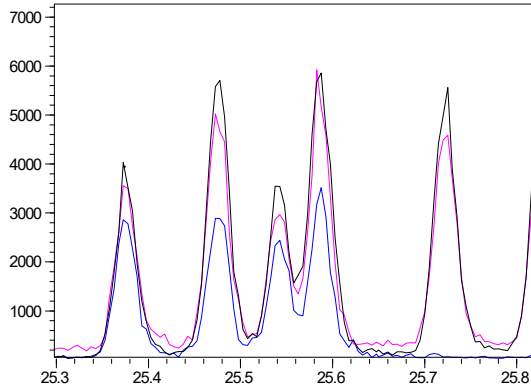
Prochloraz



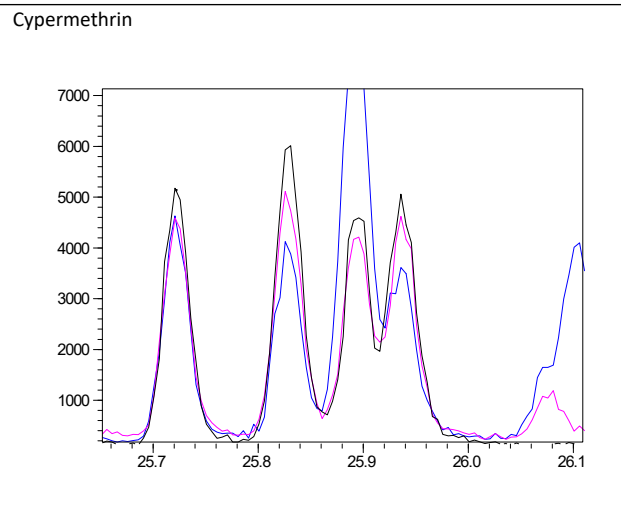
Fipronil



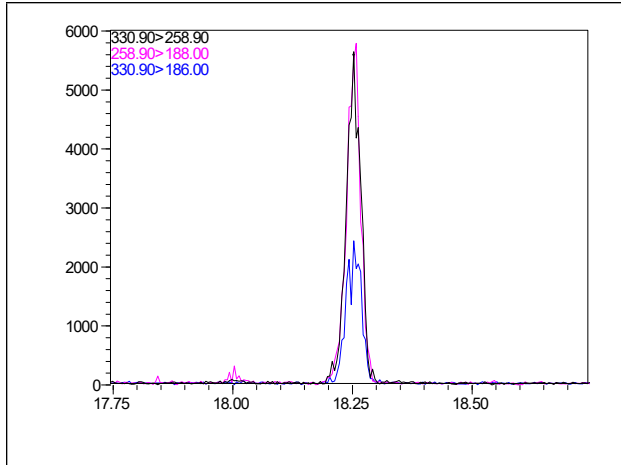
Cyfluthrin



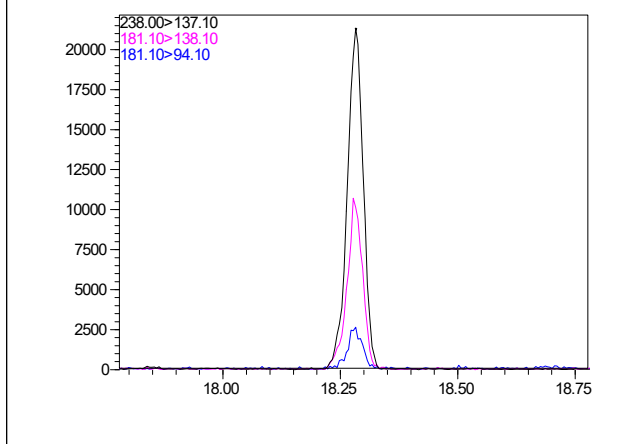
Chlozolinate



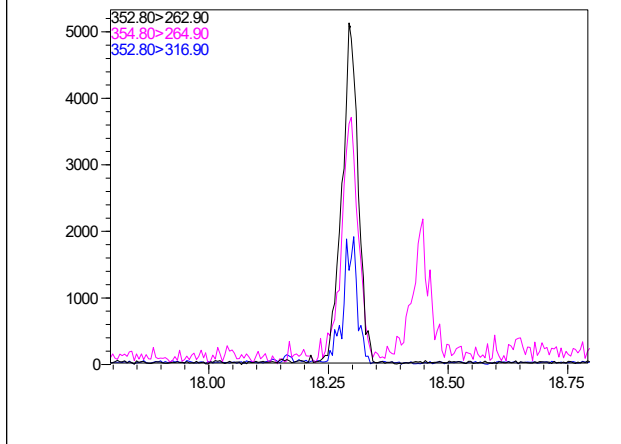
Flucythrinate



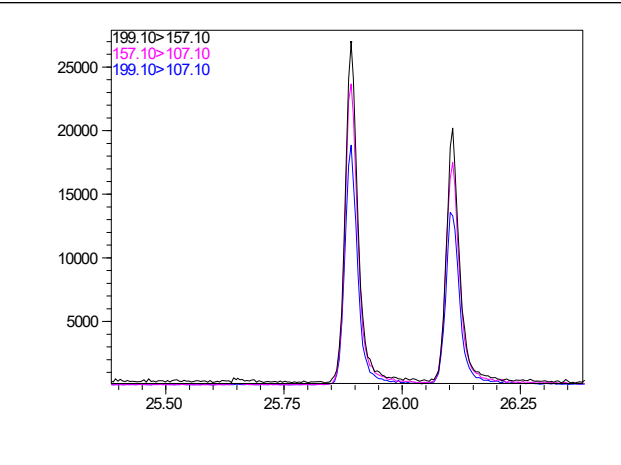
Tolyfluanid



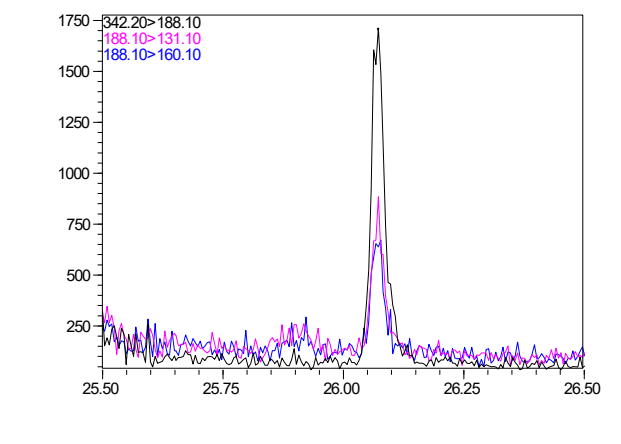
Heptachlor-exo-epoxide



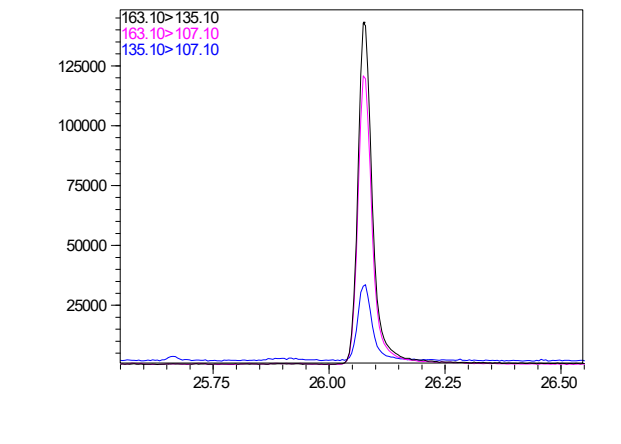
(E)-Chlorfenvinphos



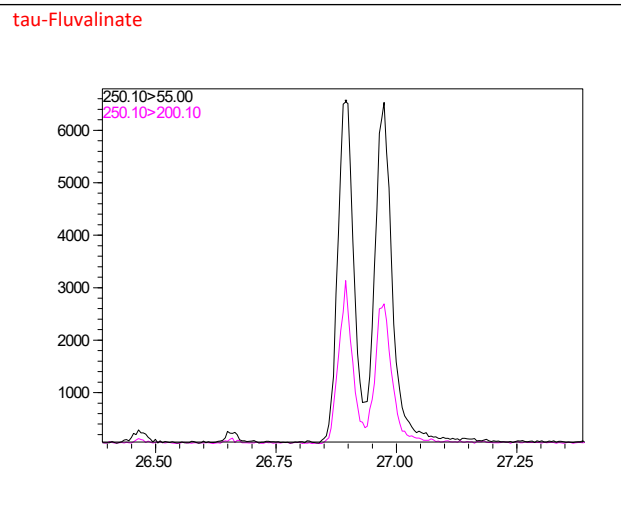
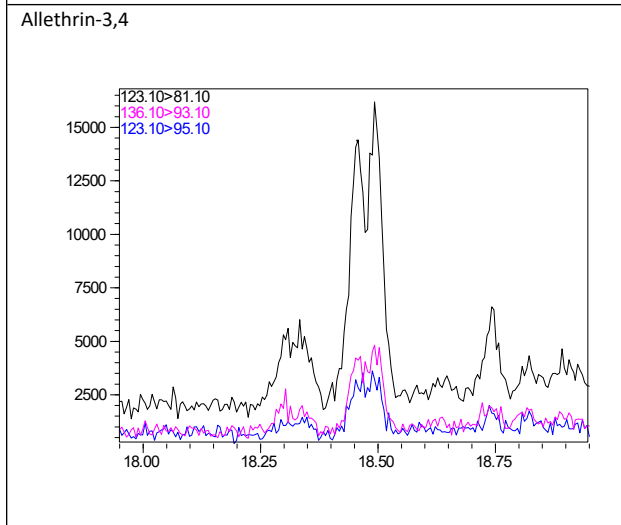
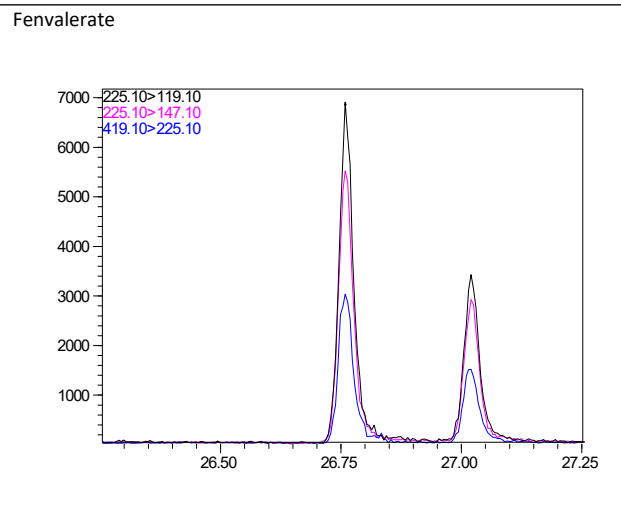
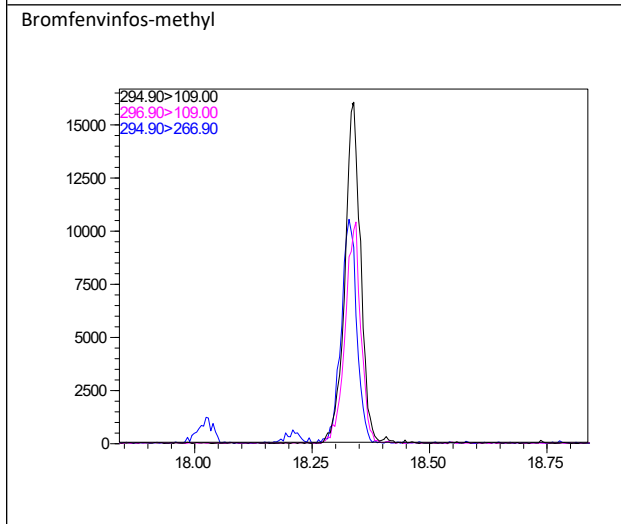
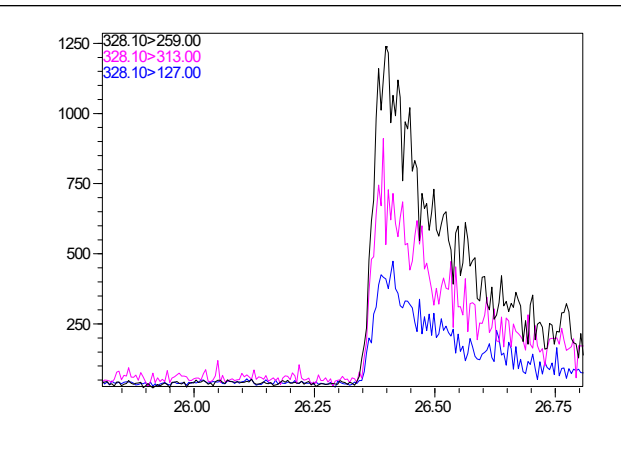
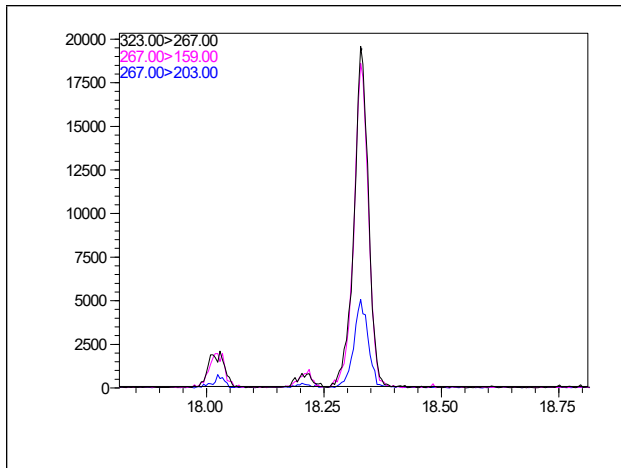
Acequinocyl



Etofenprox



Fluridone



Quinalphos

Deltamethrin

