

Flare Mixed-Mode Column: Triazine Herbicides

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Introduction

Triazine herbicides have been widely used, e.g., by Midwestern corn farmers in the United States for weed control.¹ And while generally effective, there is a major concern of these herbicides entering the water supply. In particular, the more hydrophilic herbicides and their degradation products can be carried by runoff into streams and the more hydrophobic varieties and their degradation products can be absorbed by the soil and ultimately enter the ground water.¹ Triazine herbicides act as photosystem II inhibitors, reducing the electron flow from water to NADPH₂⁺ at the photochemical step in photosynthesis, which causes intolerable oxidation in plants that eventually results in their death.²

Chromatographic methods, such as gas chromatography (GC) with electron capture detection (ECD), have been used to determine the concentrations of triazine herbicides in water. Nevertheless HPLC has some advantages over GC. HPLC allows analysis of polar, non-volatile, and/or thermally labile analytes, where these analytes may be separated together with non-polar analytes in a single run.³

The Flare mixed-mode column from Diamond Analytics was used to separate a mixture of five triazine herbicides at pH 12. Elevated pH values activate/accentuate the reversed-phase retention mechanism of this column, which is the first functionalized, carbon/nanodiamond-based phase. These materials give the column extraordinary stability under extreme pH conditions.⁴⁻⁵

Experimental

Analytes: Cyanazine, simazine, atrazine, propazine and prometryn were purchased from Sigma-Aldrich. (St. Louis, MO)

Sample: 2 mg of each analyte was dissolved in 6 mL mobile phase and 4 mL isopropanol

Column: Diamond Analytics Flare Mixed-Mode (4.6 x 33 mm, 4 μm)

System: Waters 1525 HPLC binary pump, Waters Column Heater (CH5), Breeze 3.30 SPA software

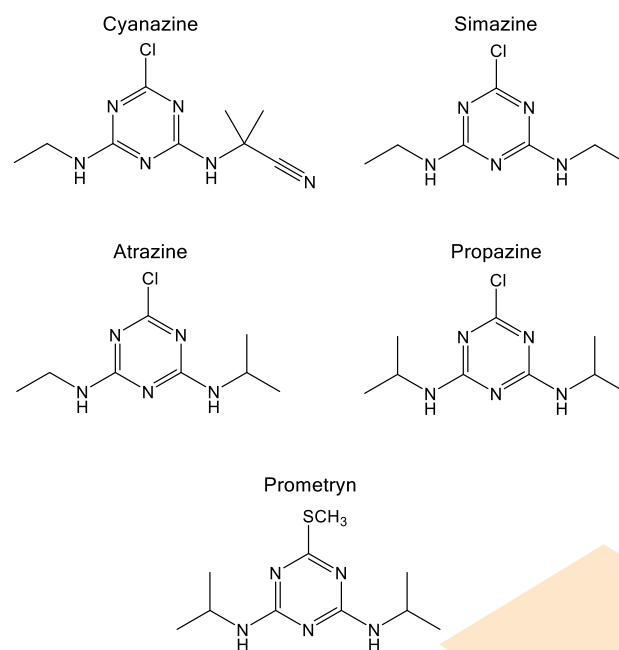
Injection volume: 5.0 μL

Temperature: 35 °C

Flow rate: 0.7 mL/min

Detection: Waters 2487 Dual λ Absorbance Detector @ 254 nm

Mobile Phase: 70:30 10 mM aqueous phosphate buffer (pH 12):acetonitrile, isocratic



Results and Discussion

Figure 1 shows separation of five triazine herbicides in less than 2.5 minutes. For the last compound in the separation, the efficiency exceeded 36,000 N/m and tailing factors were 1.4 – 1.5 for all analytes.

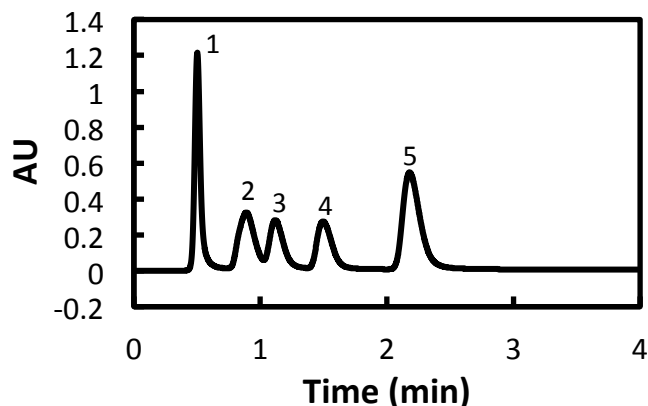


Figure 1. Separation of five triazine herbicides: (1) cyanazine, (2) simazine, (3) atrazine, (4) propazine, (5) prometryn.

References

- (1) Scribner, E.A., Thurman, E.M., Goolsby, D.A., Meyer, M.T., Battaglin, W.A., and Kolpin, D.W., 2005, Summary of significant results from studies of triazine herbicides and their degradation products in surface water, ground water, and precipitation in the Midwestern United States during the 1990s: U.S. Geological Survey Scientific Investigations Report 2005–5094, 27 p.
- (2) Stryer, L. *Biochemistry*; 4th ed.; W.H. Freeman and Company, 1995.
- (3) Lintelmann, J.; Mengel, C.; Kettrup, A. *Fresenius J Anal Chem* **1993**, *346*, 752-756.
- (4) Saini, G.; Jensen, D. S.; Wiest, L. A.; Vail, M. A.; Dadson, A.; Lee, M. L.; Shutthanandan, V.; Linford, M. R. *Anal. Chem.* **2010**, *82*, 4448-4456.
- (5) Wiest, L. A.; Jensen, D. S.; Hung, C.-H.; Olsen, R. E.; Davis, R. C.; Vail, M. A.; Dadson, A. E.; Nesterenko, P. N.; Linford, M. R. *Anal. Chem.* **2011**, *83*, 5488-5501.

Table 1. Retention of Triazine Herbicides

	t_r	N/m	T_f	R
1. Cyanazine	0.501	19636	1.42	—
2. Simazine	0.889	6242	—	2.40
3. Atrazine	1.117	14152	—	1.01
4. Propazine	1.495	22273	1.43	1.77
5. Prometryn	2.179	36394	1.53	2.91

