2007

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Groundwater Quality in Kentucky: 2,4-D

Bart Davidson and Stephen Fisher

Introduction

2,4-dichlorophenoxyacetic acid, commonly known as 2,4-D, is an herbicide used for selective control of broadleaf and grassy weeds in crops such as corn and wheat. It is usually mixed with surfactants andEmulsifiers, and is applied as a spray

- In soils that are well-drained and warm, it degrades quickly.
- In soils that are not well-drained, it can persist longer.

Concentrations in Groundwater

Data Sources

Data for this report were compiled from the Kentucky Groundwater Data Repository, maintained by the Kentucky Geological Survey. The repository was established in 1990 to archive and disseminate groundwater data collected by various agencies in Kentucky. The data sources for the repository include the Kentucky Division of Water, the Kentucky Geological Survey, the U.S. Geological Survey, the National Uranium Resource Evaluation Program, and the U.S. Environmental Protection Agency.

The repository contains 2,165 analyses of 2,4-D from 167 wells and 210 springs throughout Kentucky as of June 2007. (Table 1). Data from sites of known or suspected contamination (samples collected for the Resource Conservation and Recovery Act, Superfund, Solid Waste, or Underground Storage Tank programs) were not included.

Table 1. Summary of 2,4-D concentrations.

<table>
<thead>
<tr>
<th>Region</th>
<th>No. of Measurements</th>
<th>No. of Sites</th>
<th>No. of Sites with 2,4-D Detected</th>
<th>No. of Sites with &gt;6.0 μg/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inner Bluegrass</td>
<td>257</td>
<td>62</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Western Kentucky Coal Field</td>
<td>70</td>
<td>15</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Western Kentucky Coal Field</td>
<td>122</td>
<td>22</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Western Pennsylvania</td>
<td>40</td>
<td>8</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Nearly 98 percent of the results were less than analytical detection limits, which ranged from 0.000005 μg/L for recent measurements to 1.22 μg/L for older analyses. 2,4-D was detected in 22 springs and three wells, at concentrations ranging from 0.000004 to 0.954 μg/L. One measurement from a site in the Eastern Kentucky Coal Field exceeded the MCL of 0.07 μg/L. More than 99 percent of all measurements were less than 0.015 μg/L (Fig. 1).

Figure 1. Cumulative percentage distribution of 2,4-D values. Higher values were excluded to better show the majority of the data. MCL=0.07 μg/L.

Regional Variations in 2,4-D Concentrations

The map shows sites where 2,4-D was sampled, different symbols show concentration ranges. Sites that have been sampled more than once may have more than one symbol, and symbols may overlap if the sites are close to each other. Concentrations that were less than analytical detection limits indicate that 2,4-D was not found at that well or spring. Sites in the Inner Bluegrass, Outer Bluegrass, and Western Pennyrally Regions accounted for 22 of the wells and springs where 2,4-D was detected.

Figure 2 summarizes the 2,4-D concentrations for each physiographic region. Values below analytical detection limits were not plotted. Boxes enclose the central 50 percent of the values, the median value is shown by a vertical line through the box, and lines extend from each edge of the box for a distance of 1.5 times the interquartile range. These concentration range represented by the central box. Values beyond this range are shown as individual squares. The knobs and the Western Kentucky Coal Field each had one site where 2,4-D was detected.

Figure 2. Box-and-whisker plots of 2,4-D values for the major physiographic regions. Only values greater than the analytical detection limit are shown. One value of 0.954 μg/L from the Eastern Kentucky Coal Field was excluded to better show the majority of the data. MCL=0.07 μg/L.

Twenty-one springs and three wells had detectable 2,4-D groundwater from springs had higher 2,4-D concentrations and a larger range of values than water from springs (Fig. 1).

Water-Quality Concerns

The pesticide 2,4-D was detected at only 25 of 377 sites and exceeded the MCL at one site. Most of the sites where 2,4-D was detected are springs; wells where 2,4-D was found are all less than 140 μg/L. Current analytical detection limit occurred primarily in the carbonate, karst terrain of the Inner Bluegrass, Outer Bluegrass, and Western Pennyrally Regions, where agriculture is common, soils are thin, and solution channels allow rapid transport from land surface to shallow groundwater.

2,4-D concentrations exceeded the MCL at only one site, a spring in the Eastern Kentucky Coal Field. Records from the Kentucky Groundwater Data Repository indicate the spring issues from Mississippian limestone, probably from a solution channel in the carbonate. The spring was sampled 21 times from 1994 to 2003, and only once (in 2002) was 2,4-D detected. Subsequent sampling in 2003 did not detect 2,4-D. These records suggest that the occurrence of high 2,4-D levels once over a 10-year period is an anomaly and the spring is not permanently contaminated.

Although only 99 percent of the sampled sites showed no detectable 2,4-D, the presence of this pesticide at a few sites shows some contamination of the shallow groundwater system. These findings should be viewed as general patterns. Individual wells or springs should be tested for the occurrence of 2,4-D and other potential contaminants before being used as drinking-water supplies. Citizens with concerns about the quality of water in private wells or springs should contact their local health department or the Groundwater Branch of the Kentucky Division of Water, a division of the Kentucky Natural Resources and Environmental Protection Cabinet. The Groundwater Branch can provide information on maintaining private wells and springs and information on sampling for water-quality analysis. The Kentucky Groundwater Data Repository receives new results of analyses periodically. To view the latest data, visit kgsww.uky.edu/DataSearching/water-search.asp.

The Kentucky Interagency Groundwater Monitoring Network

This publication is a product of the Kentucky Interagency Groundwater Monitoring Network, which was established in 1998 by legislative resolution (KRS 151.629) to collect groundwater quality data, characterize groundwater resources, and distribute the resulting information. The network is assisted by an Interagency Technical Advisory Committee. The network was also created by statute (KRS 151.629). Additional information and a list of member agencies can be found at www.uky.edu/KGS/water/gnet/gnet.htm.

References Cited

Cornell University Cooperative Extension Office, 1993, Extension toxicology network pesticide information profile on 2,4-D: pmsp.cee.cornell.edu/profiles/estoxnet/244-captan/244-est.html [accessed 07/25/2005].


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https://doi.org/10.13023/kgs.ic18.12
2,4-D CONCENTRATIONS IN WELLS AND SPRINGS IN KENTUCKY

EXPLANATION

Physiographic regions
- Eastern and Western Kentucky Coal Fields
- Inner Bluegrass
- Outer Bluegrass
- The Knobs
- Eastern Pennyroyal
- Western Pennyroyal
- Alluvium or glacial deposits
- Jackson Purchase

2,4-D (mg/L) MCL = 0.07 mg/L
- > 0.07 mg/L
- ≤ 0.07 mg/L
  - Below detection

Data from Kentucky Groundwater Data Repository, July 2005

Cartography by Terry Houserwald