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A Two Year Evaluation of Nitrate-N and Triazine Herbicides in Groundwater and Surface Water of an Intensively Row Cropped Agricultural Watershed in Western Kentucky

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Introduction

The quality of water in Kentucky's agricultural watersheds has received considerable attention in recent years. The main concerns in corn production areas usually center on water content of nitrate-N from commercial fertilizer and triazines from herbicide applications. Although N can be found naturally in Kentucky soils, it cannot supply all the N that corn needs to produce optimum yields. Therefore, fertilizer N is added to ensure ample nutrition. Triazines, on the other hand, do not occur naturally in the soil but are applied to the soil to effectively control weeds. Most commonly, these herbicides are applied at the time of corn planting.

With maximum contaminant levels (MCL) in drinking water of 10 parts per million (ppm) for nitrate-N and 3 parts per billion (ppb) for the most widely used triazine (atrazine), the question of agriculture's role in water quality has been a concern for many citizens in this state. A typical agricultural watershed in western Kentucky was selected for intense study of the content of nitrate-N and triazines in surface and groundwater within that watershed.

Materials and Methods

Surface and groundwater samples were collected monthly from February through September in 1996 and 1997, within the 71,500 acre Bayou de Chein watershed in Hickman County. Almost 76% or 54,235 acres of this watershed was cropped primarily to corn, wheat, and soybeans. Upland soils were developed from loess while stream terraces originated in alluvium washed from loess. These loessial soils overlie gravelly Coastal Plain sediment.

The creek that serves as the main outlet for the watershed is primarily spring-fed and receives runoff from numerous field ditches and springs along its stem. A riparian area of grass and trees is general along both sides of the creek. This creek was sampled at seven locations in 1996 and four locations in 1997 from the headwaters downstream

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through the row crop area. Field ditches that drained adjacent corn and soybean fields were also sampled each month when sufficient water was available for collection. Because some of these ditches were dry during a portion of the growing season, the sites where water was sampled varied from four to nine locations. All field ditch sample sites were located in cropped bottomland areas of the watershed. One spring and one well within the intensively cropped area were tested in 1996 in order to determine N and triazine content of the underlying groundwater. An attempt was made to collect water samples within 24 hours of rainfall events. Water was analyzed for nitrate-N, and triazines. Nitrate-N content was determined by the Griess reaction using a Technicon Autoanalyzer equipped with a Cd-Cu reductor. Triazine content was measured by immunoassay techniques, using a microplate spectrophotometer.

Results and Discussion

Corn and soybean yields in this watershed were excellent in 1996, but more variable in 1997 due to excess rainfall during the planting and early growth season. Corn was the dominant crop in 1996 followed by soybeans in 1997. Rainfall for the February through September sampling period totaled 38.0 inches in 1996 and 45.1 in 1997 **(Figure 1)**. Upland corn was planted during April and early May of each year. However, most of the corn planted in bottomlands in 1996 was planted after May 15.

Figure 2 shows the average monthly concentration of nitrate-N in the creek. Averages were below 3 ppm for each sample period. **Figure 3** shows average nitrate-N concentrations for field ditches in corn and soybean areas. None of the sample averages exceeded the MCL of 10 ppm for drinking water. The results of these samples are lower than those in surface water samples that have been analyzed from other agricultural areas in the state. Although the bulk of the row crop acreage in this watershed was planted in corn in 1996 and soybeans in 1997, we found no evidence of a drastic increase in surface water nitrate-N levels either year.

Average triazine concentrations for the creek are shown in **Figure 4**. Two distinct peaks each year can be distinguished, corresponding with peak corn planting periods. However, there was almost no triazine detected in creek samples for dates other than peak corn planting periods.

Average triazine concentrations in field ditches **(Figure 5)** were also at or above the MCL of 3 ppb for drinking water during peak corn planting periods in both years. Therefore, these data provide a good indication that elevated triazine levels are associated with periods of corn planting.

Well and Spring Water

One well and one spring, located on the same farm, were tested in 1996. The well was located at the base of the upland slopes along the perimeter of the bottomland. The spring was located in the middle of a corn field approximately 800 yards from the well. Nitrate-N concentrations were below 1 ppm for all sample dates for both the well and spring. The well and spring had triazine concentrations of 6.1 ppb and 6.7 ppb during June respectively **(Figure 6)**. Triazines were not detected in spring and well samples except for the June samples.

The study of springs and wells was expanded in 1997 to include three springs and five wells that represented most of the watershed. Average nitrate-N **(Table 1)** concentration in the springs

was less than 0.60 ppm throughout the season and generally less than 1 ppm **(Table 2)** in wells. Triazine levels **Figure 7)** for the three springs were near zero for all samples except one spring which tested 2.28 ppb after drainage work nearby. The 1997 triazine levels for the well and spring that had elevated levels in 1996 **(S-1 Figure 7** and **W-1 Table 2)** had low or non-detectable levels of triazines in 1997.

<u>Summary</u>

In two years of extensive evaluations, very low levels of nitrate-N were detected in surface and ground water sites within this watershed despite intensive row crop land use. Triazine concentrations were also very low except in surface runoff during peak corn planting season. Although groundwater triazine concentrations from well and spring samples were above the MCL of 3 ppb in June of 1996, they were below detectable limits in all other sample months of 1996 and throughout 1997.

Figure 1

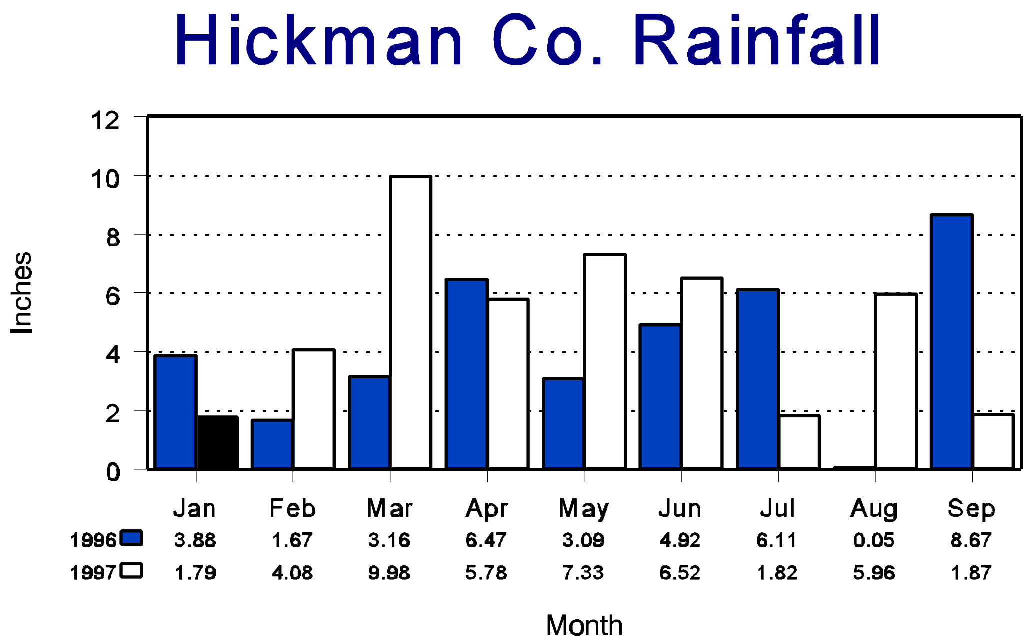
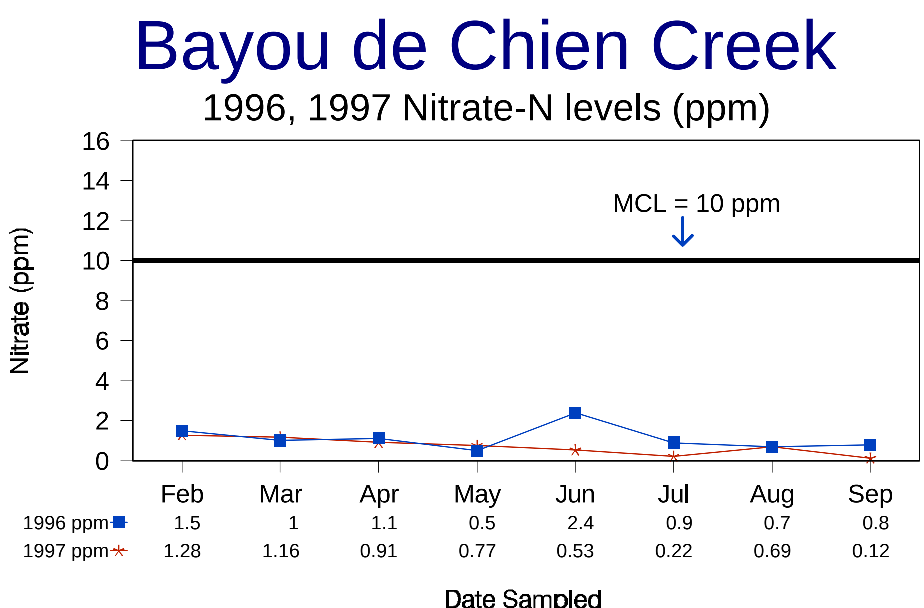
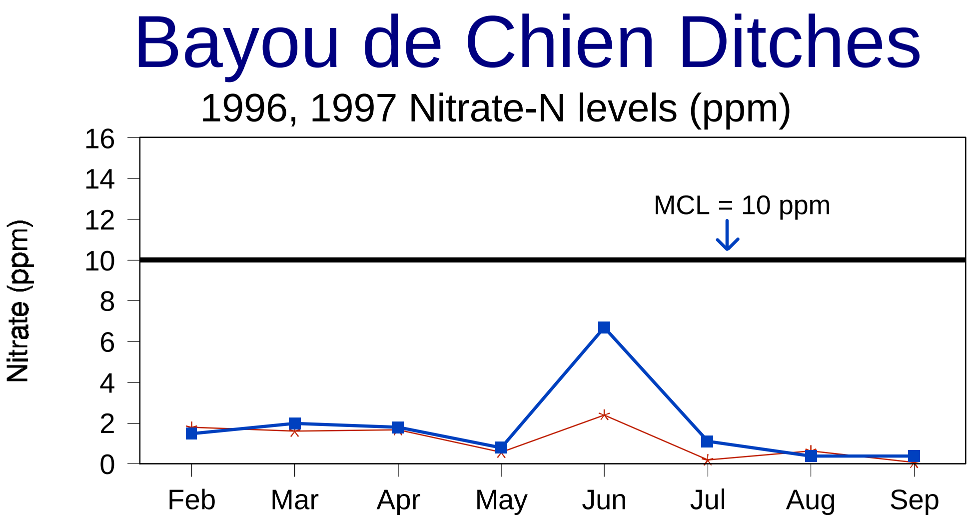


Figure 2



*Each point averaged from 7 locations in 1996 and 4 locations in 1997.

Figure 3

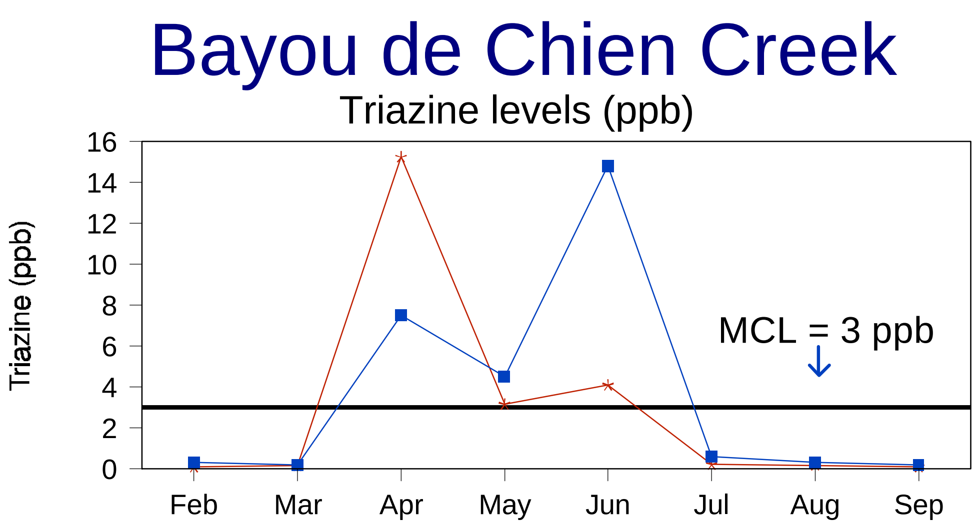


	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1996 ppm	1.5	2	1.8	0.8	6.7	1.1	0.4	0.4
1997 ppm	1.79	1.6	1.68	0.57	2.41	0.19	0.65	0.07

Date Sampled

*Each point averaged from 4 to 9 locations.

Figure 4

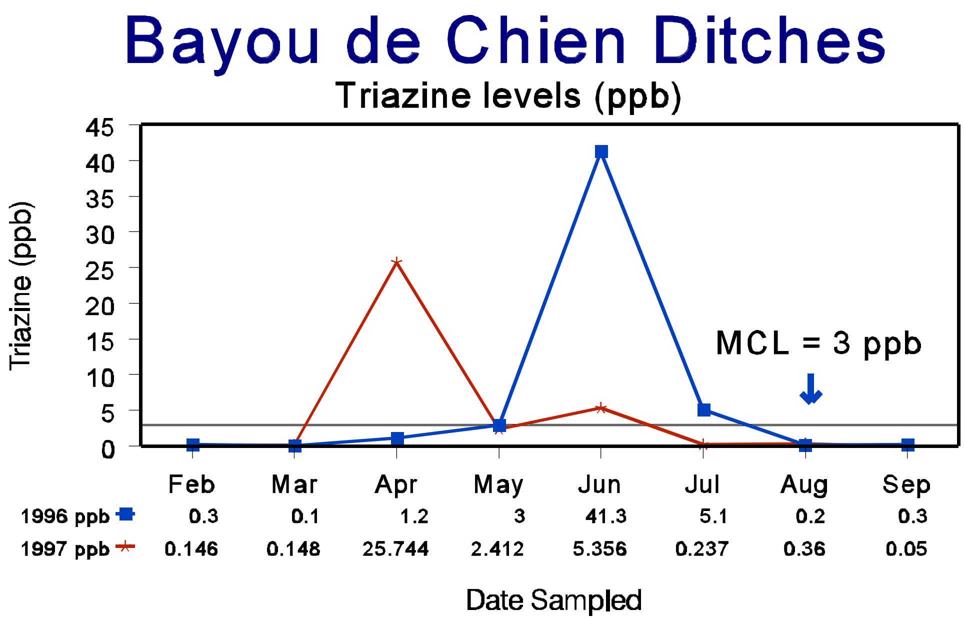


	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1996 ppb	0.3	0.2	7.5	4.5	14.8	0.6	0.3	0.2
1997 ppb	0.087	0.152	15.235	3.152	4.087	0.207	0.172	0.095

Date Sampled

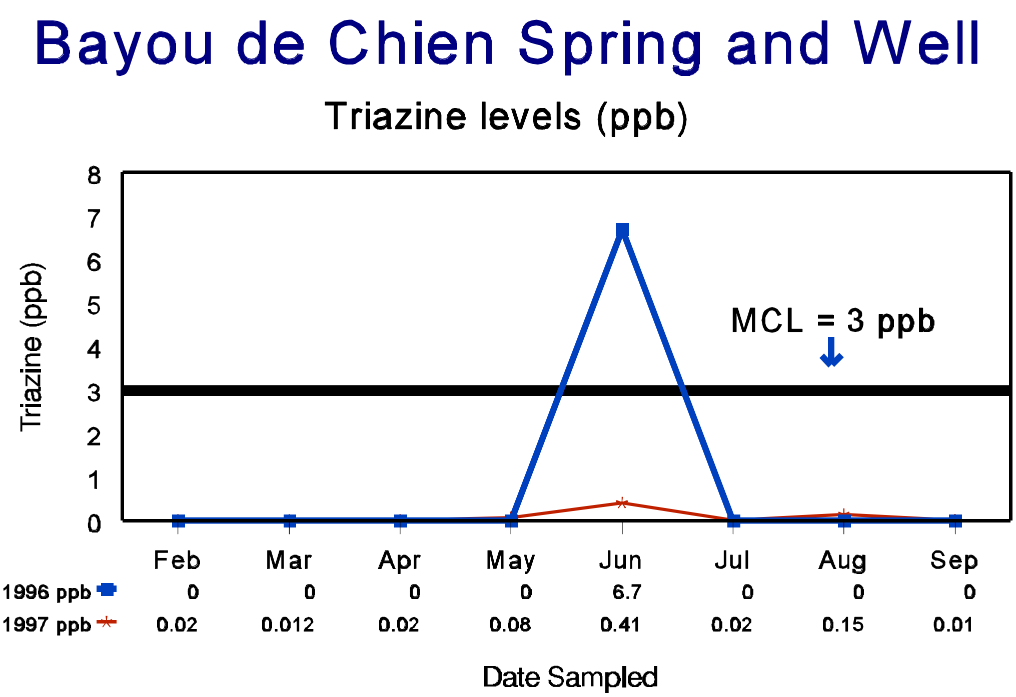
*Each point averaged from 7 locations in 1996 and 4 locations in 1997.

Figure 5



*Each point averaged from 4 to 9 locations.

Figure 6



*Each point averaged from 1 spring and 1 well in 1996 and 3 springs and 5 wells in 1997.

Figure 7

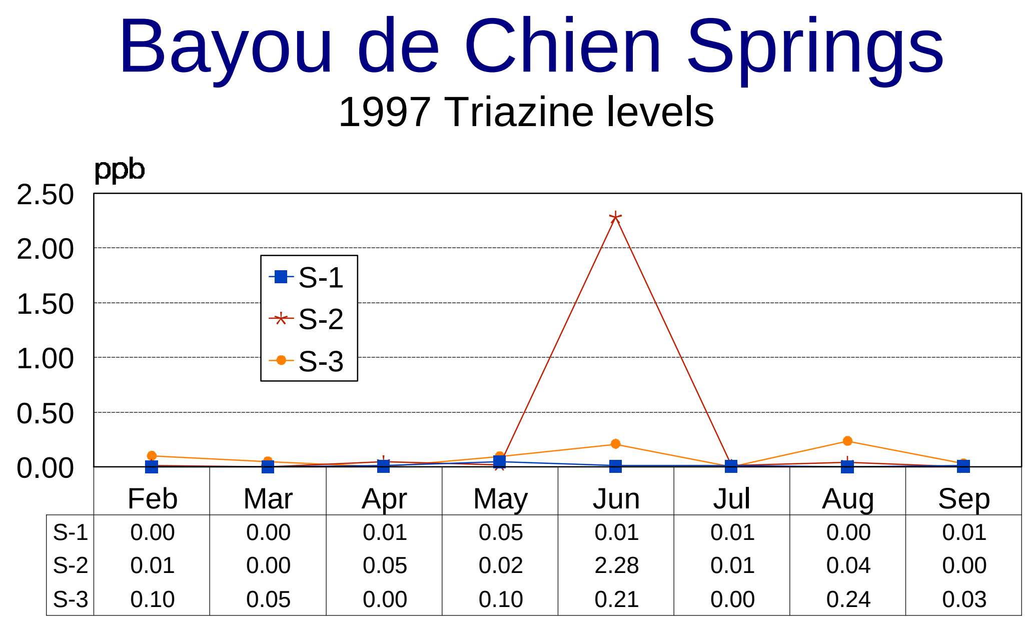


Table 1

Bayou de Chien Springs 1997 Nitrate-N (ppm)								
	Feb	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
S-1	0.28	0.24	0.25	0.37	0.16	0.21	0.22	0.27
S-2	0.39	0.52	0.51	0.50	0.46	0.15	0.45	0.11
S-3	0.00	0.02	0.00	0.10	0.21	0.00	0.24	0.03

Table 2

Bayou de Chien Wells 1997 Nitrate-N (ppm)								
Well	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
W-1	0.86	0.89	0.92	1.16	0.75	0.82	0.84	0.86
W-2	0.41	0.33	0.30	0.56	0.25	0.35	0.32	0.25
W-3	0.38	0.36	0.38	0.47	0.31	0.35	0.34	0.36
W-4	0.65	0.62	0.57	0.74	0.51	0.69	0.80	0.73
W-5	0.75	0.69	0.76	0.89	0.38	0.55	0.58	0.59