Using Atrazine Wisely

Atrazine is a triazine herbicide widely used in Kansas for selective weed control in corn and grain sorghum. It has application flexibility and is a relatively low-cost herbicide on a per-acre basis. Atrazine is included in many soil-applied and postemergence herbicide programs and often enhances effectiveness when applied in combination with other postemergence herbicides. In some situations, however, atrazine and its metabolites pose water-quality concerns.

Water quality concerns

The Environmental Protection Agency (EPA) has established a maximum contaminant level (MCL) for atrazine in drinking water sources based on concentrations recognized as not causing adverse effects over a 70-year lifetime. This level is set at an annual average of 3 parts per billion (ppb). In addition, Kansas has water quality criteria for atrazine to protect aquatic life. Those criteria are 170 ppb for acute effects and 3 ppb for chronic impacts on aquatic communities. Both levels are enforced by the Kansas Department of Health and Environment (KDHE).

The enforceable levels are subject to change as the EPA regularly reviews the registration of atrazine to ensure use restrictions align with the current knowledge of safe use. Several streams and lakes in eastern and central Kansas have exceeded the chronic criterion for brief periods following herbicide application and heavy springtime rainfalls (Figure 1).

In 1998, KDHE submitted its list of impaired waters to EPA, in which several streams and lakes were identified as impaired by atrazine runoff (Figure 2). For some atrazine-impaired watersheds, a total maximum daily load (TMDL) has been established. Other watersheds use a management plan, such as in the Delaware River Watershed, where a pesticide management area was established in the early 1990s. In all cases, an implementation plan was developed to reduce atrazine levels, chiefly through changing application practices.

Atrazine best management practices (BMPs) have reduced the amount of atrazine detected in Kansas waters. However, continued efforts are needed to keep atrazine in farm fields, especially in light of regulatory changes proposed by the EPA.

Definitions

Adsorption: A chemical's tendency to bind or stick to soil particles, primarily clay and organic matter.

Infiltration rate: The speed that water moves into the soil.

Metabolites: The molecules formed as herbicide is broken down in the environment.

Persistence: How long it takes for herbicide to degrade in the environment.

Water solubility: How much of a chemical can be dissolved in water, usually at room temperature.

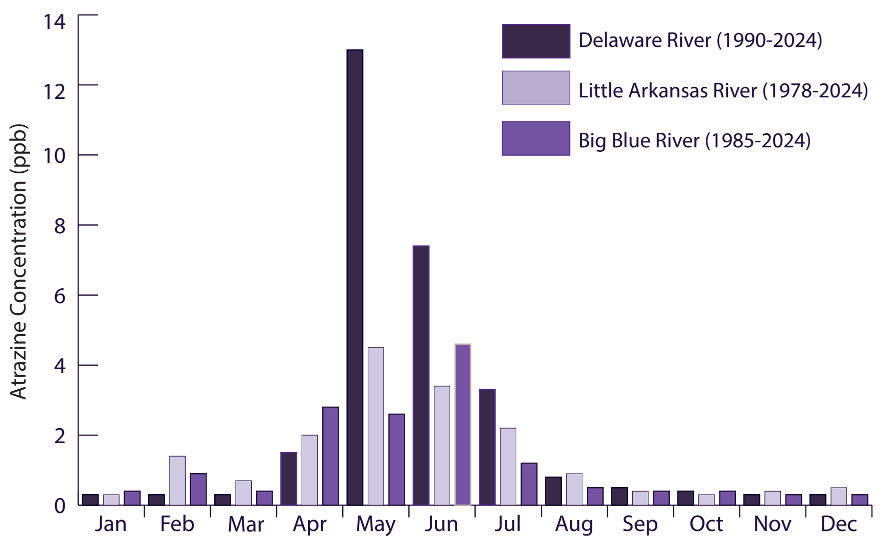

Figure 1. Atrazine concentrations in water samples collected monthly from the Big Blue River, Little Arkansas River, and Delaware River over time. Data provided by KDHE.

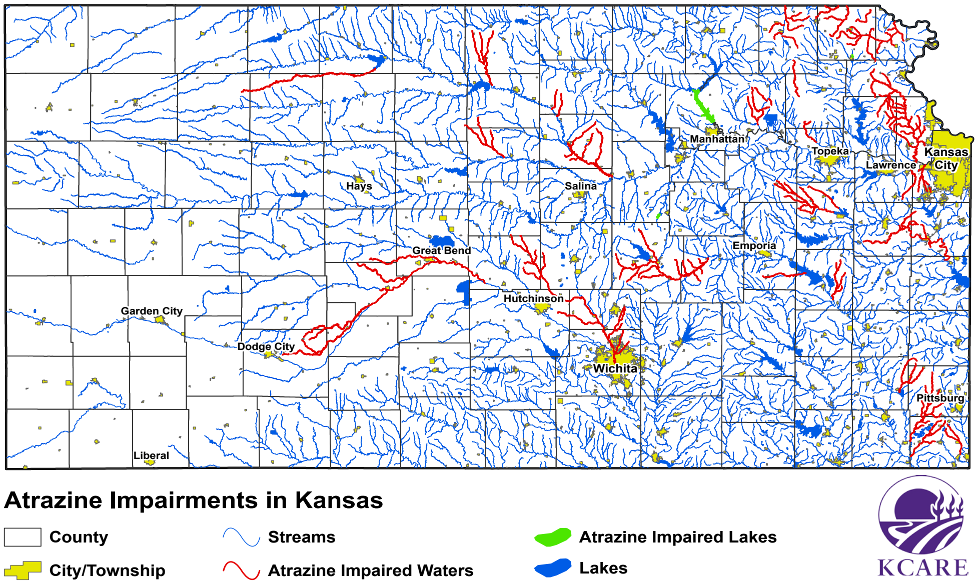

Figure 2. Kansas surface waters with atrazine impairments. Data provided by KHDE.

How atrazine is lost from crop fields

Atrazine is susceptible to losses in runoff from crop fields due to its long persistence in the soil, low adsorption to soil particles, and water solubility. Slower degradation provides longer weed control, but also greater opportunity for losses in runoff. Weak adsorption means atrazine generally leaves the field in runoff water and not with the eroding soil particles, unlike more tightly adsorbed herbicides, such as glyphosate, that leave the field with eroding soil particles. Even though atrazine has relatively low solubility compared to herbicides such as dicamba, the water solubility of atrazine is sufficient to cause losses in runoff.

Soil and site characteristics

Soil and site characteristics are important factors when determining whether atrazine runoff will be a problem. Characteristics associated with a faster infiltration rate are associated with lower runoff potential because water moves into the soil faster. A soil with a high clay content at the surface will have a greater runoff potential due to a slower infiltration rate. Similarly, a site with steeper slopes will have a lower infiltration rate due to faster runoff. A soil's hydrologic group, as determined by the Natural Resources Conservation Service (NRCS), indicates the amount of runoff to be expected from a soil when saturated and is a predictor of a soil's potential to transport pesticides in surface runoff.

Tillage practices

Reducing tillage generally reduces total runoff from a field and reduces the loss of adsorbed atrazine. However, total atrazine losses may or may not be reduced. If atrazine is surface-applied to soils with high clay content, with an impermeable layer such as a claypan near the surface, or to saturated soils, atrazine losses are likely to increase in no tillage fields due to greater runoff volume. In conventional- or minimum-tillage fields, incorporating atrazine reduces the amount exposed to runoff losses.

Rainfall

The wetter the soil surface when atrazine is applied, the sooner runoff begins during a rain, and the greater the potential for atrazine runoff. If the soil surface is dry at the start of a rainfall event, more water and atrazine infiltration will occur initially, and less atrazine will be available for runoff. Rainfall that soaks into the soil before runoff will move some of the atrazine below the mixing zone, reducing the amount of atrazine subject to runoff losses. About two-thirds of the total atrazine runoff occurs with the first major storm/runoff event following atrazine application during spring and early summer, when soil moisture levels are high. The longer the interval between application time and the first runoff event, the less atrazine runoff is expected. As rainfall intensity increases, the water runoff rate increases, and so does the potential for atrazine loss. A gentle rain will move some of the atrazine below the soil surface and reduce the amount of atrazine available for runoff.

Best management practices for atrazine

The most effective way to minimize atrazine runoff into surface water is to implement BMPs. The atrazine BMPs listed are designed to:

- Reduce the amount of atrazine on the soil surface at any one time, especially during periods of high rainfall events in late spring and early summer;
- Reduce the effect of the first runoff event on atrazine loss; and
- Provide a mechanism for deposition of the atrazine to prevent it from leaving the field.

Changes in EPA regulations may result in different, additional, or more restrictive management practices.

Recommended atrazine best management practices

Practices indicated with an * are listed on the EPA's Runoff Mitigation Menu finalized in 2024 and may be necessary to attain the runoff mitigation points required by future herbicide labels. See *https://www.epa.gov/pesticides/mitigation-menu* for more detailed information.

Use proper atrazine rates, mixing, loading, and disposal practices

Follow all label requirements when using atrazine and other pesticides. The application rate should be determined by label recommendations based on water-quality concerns, weed infestations, soil type, etc. Using above-labeled atrazine rates is unlawful and may lead to increased atrazine runoff, crop damage, and carryover concerns. All application equipment should be calibrated regularly to maintain the accuracy of the application. All pesticides should be stored in appropriate facilities.

Use care when mixing and loading spray tanks with atrazine and other herbicides. Mix and load away from wells and surface water. Loading from a nurse tank is preferable to loading directly from a well. If loading from a well, a backflow device should be used to prevent back-siphoning into the well. Follow product label recommendations on rinsing and disposing of the herbicide container. Water from rinsing a sprayer should be applied back onto a site labeled for use and not drained near wells, ponds, lakes, or streams.

Reduce atrazine application rates*

There is a direct relationship between the atrazine application rate and the runoff amount. The lower the rate applied, the less the potential for atrazine runoff. Applying lower rates of atrazine in multiple passes reduces the amount of atrazine available for runoff at any one time.

Soil-applied atrazine should be used in combination with other products and is often applied with a Group 15 herbicide such as S-metolachlor (Dual Magnum, others), acetochlor (Harness, others), dimethenamid-P (Outlook), or pyroxasulfone (Zidua).

Using postemergence applications results in less atrazine runoff than typical preemergence soil-applied atrazine applications. The growing crop reduces atrazine runoff potential by intercepting some of the atrazine and reducing the runoff. When using postemergence products with grain sorghum, which is planted later than corn, postemergence applications can be delayed until late June or early July, when the soil surface can be expected to be drier. However, weather conditions, such as wind or rain, may delay postemergence applications, reducing weed control.

In addition, using banded or targeted herbicide applications* (e.g., See & Spray) that reduce the proportion of the field treated with atrazine reduces the total amount of atrazine present in the field while maintaining the labeled application rate on the areas treated.

Use integrated pest management strategies

Integrated pest management strategies combine prevention, suppression, and monitoring with cultural, mechanical, and chemical practices to promote the responsible use of herbicides. Crop rotation, variety/hybrid selection, narrow-row spacing, increased seeding rate, optimal planting dates, crop scouting, tillage, and cover crops* can reduce weed infestations, improve the crop's ability to compete with weeds, and reduce the need for herbicides. However, herbicide rates should not be reduced below the product's labeled rated use rates.

Use conservation practices and structures in and adjacent to the field

Conservation practices and structures that slow or reduce water runoff and soil erosion from a field reduce atrazine runoff.

Reduced and no-tillage*

Adopting reduced and no-tillage systems reduces runoff losses of atrazine. Sediment-bound atrazine loss from a field can be greatly reduced, though this is a small portion of the total atrazine in the field. Conversely, atrazine runoff is lower in reduced-tillage systems when atrazine is incorporated*, especially before a rainfall.

Contour farming*

Field and planting operations performed at a perpendicular orientation to the slope of the land result in decreased sheet and rill erosion by creating furrows or small dams perpendicular to the slope. Reduced erosion leads to reduced losses of soil-adsorbed atrazine. Contour farming also increases the time between the onset of rainfall and the initiation of runoff, allowing some of the atrazine to be moved below the mixing zone and reducing atrazine runoff.

Gradient terraces

Gradient terraces are designed to reduce the slope length, erosion, and soil content in runoff water. These terraces divert runoff to a suitable outlet, such as a grassed waterway*. Gradient terraces reduce soil erosion and subsequent soil-bound atrazine. They also may result in a slight reduction in water and associated atrazine runoff from the field by increasing infiltration in the terrace channel. The atrazine concentration contained in the runoff water can be further reduced in the grassed waterway.

Grassed waterways*

Grassed waterways direct surface water through vegetated channels planted to perennial grass and into a stable outlet. Grassed waterways slow the flow of water, which increases infiltration and reduces erosion.

Vegetative filter strips* or riparian buffer areas*

Vegetative filter strips are areas of permanent grass adjacent to the field. Riparian areas are similar but are used when the field is adjacent to any surface water. These buffers effectively slow runoff and collect soil particles from erosion. Vegetative and riparian buffers may reduce the amount of water runoff by increasing infiltration of runoff water within the buffer. To the extent that water infiltrates into the buffer strip soils, atrazine loss will be reduced. Vegetated areas are most effective at reducing water and atrazine runoff when the water flows evenly across the filter. If water infiltration in the buffer area does not occur, atrazine runoff will not be reduced as the vegetation will not adsorb atrazine.

Water and sediment-control basins*

Water and sediment-control basins slow down and store water, trapping soil particles from erosion. Basins are especially effective at reducing soil-bound atrazine losses and can be effective at reducing atrazine losses in runoff water. Basins are most effective when they store water until soil infiltration or evaporation occurs. However, in many basins, an outlet, similar to a tile outlet terrace system, releases water. With a release outlet, the basin is not effective in preventing atrazine movement into streams.

Summary

Atrazine is used widely in Kansas for weed control in corn and grain sorghum. The presence of atrazine in surface waters poses a risk to human health and environmental quality. There are concerns about the levels of atrazine in surface waters. The highest levels of atrazine in surface water occur in the spring and summer months following herbicide applications that occur at or near the time of runoff-producing rains. The movement of atrazine from crop fields is determined by soil and site characteristics, tillage practices, application timing and methods, and rainfall characteristics. Farmers are encouraged to adopt the combination of BMPs that are the most economical and the most effective in reducing atrazine runoff in their fields. Atrazine BMPs are designed to: (1) reduce the amount of atrazine in the field; (2) reduce the amount of atrazine lost in the runoff; and (3) provide a mechanism for deposition of the atrazine before it leaves the field and reaches surface water.

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Kansas State University Agricultural Experiment Station and Cooperative Extension Service

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MF3714 August 2025