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Reducing Atrazine Runoff from Croplands

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Atrazine is one of the most widely used herbicides in Texas crop production. Its popularity can be attributed to its effectiveness, residual weed control, and low treatment costs. Used mainly in corn and grain sorghum production, atrazine can also be found in "weed-and-feed" combination lawn care products and other weed-management products used in the home landscape.

Atrazine is primarily used to control annual broadleaf weeds and some annual grasses. It is typically broadcast uniformly across the entire crop-production area to help ensure adequate coverage. Rainfall or irrigation moves the atrazine into the upper soil level, where weeds germinate and take up the herbicide through their roots. Weeds susceptible to atrazine are affected by the disruption of photosynthesis. They emerge but are unable to convert light to chemical energy required for food production and eventually die by starvation.

Because atrazine is so widely used and because it is broadcast across thousands of acres of corn and grain sorghum, concerns about the presence of atrazine in surface water runoff have grown across Texas. Atrazine is moderately soluble and thus can move in surface water from the intended target to unintended areas, such as streams, rivers or lakes. The herbicide can also be adsorbed onto soil surfaces and move via sediment in runoff water, eventually being deposited onto areas not targeted for its application. Losses of atrazine in surface runoff have raised concerns, primarily in the Central Texas blacklands, where atrazine has been detected in water bodies that provide public drinking water and in the drinking water itself.

Big Creek Lake, which supplies water for the city of Cooper and surrounding communities, has been affected by atrazine runoff.

These detections have led to discussions about how to reduce the amount of atrazine that is running off agricultural lands. A complete ban on the use of atrazine in corn and grain sorghum production systems has been proposed. However, it is estimated that such a ban would increase weed-control costs in Texas by approximately $45 million annually. The cost of using atrazine alternatives would be higher, and revenue would be lost because of reduced crop yields.

Rather than ban the product, research has been conducted to determine whether alternative atrazine application strategies can reduce runoff while maintaining acceptable weed control and crop yields.

Application Strategies

The application methods studied were 1) the traditional broadcast method (BROAD), 2) preplant incorporation (PPI), and 3) banding (BAND).

In BROAD, atrazine is applied to the entire soil surface across the field. After application, the herbicide is incorporated into the soil by rainfall or irrigation.

In the PPI method, atrazine is mechanically mixed into the soil after it is broadcast. A farm implement such as a rotary hoe, spring-tooth hare, or disk is used to mix the herbicide into the soil. This action mixes the atrazine into the 2 to 3 inches of soil below the surface, thus reducing the risk that the herbicide will be lost in surface runoff.

The BAND application of atrazine places the product only in the area where the crop is planted. In most cases, using this application method reduces the total amount of material applied to the field by 50 to 66 percent as compared to the BROAD method. Untreated areas between crop rows then require an early-season mechanical cultivation to reduce weeds between rows. This application strategy reduces the total amount of herbicide introduced into the environment.

Methods Used to Study Application Strategies

To thoroughly evaluate the three application strategies, a demonstration site was established on the Stiles Farm near Thrall, Texas. Each of the three application strategies was studied for effectiveness in reducing losses of atrazine in surface runoff. In addition, the PPI and BAND application methods were compared to the BROAD method for percentages of pigweed control and corn yield.

The treatments were applied to four 38-inch rows in 50-foot-long plots and replicated four times. A berm was placed along each side and both ends of each plot to prevent storm-generated water from leaving the original plots. Water was collected from the first runoff event of the season by using a combination of automatic stormwater runoff and passive water samplers placed at the lower end of each plot. Average slope of the plots was 3 to 5 percent.

Corn test plots at the Stiles Farm were treated with atrazine using the BROAD, PPI, and BAND methods.

The Texas AgriLife Research Pesticide Fate Research Laboratory in College Station collected the runoff from each plot, analyzed it for concentration of atrazine in µg/L (micrograms per liter, or parts per billion), and averaged the concentration for each treatment. Weed control ratings and crop yield were also taken and averaged for each application treatment. Data was collected in 2004, 2005 and 2006. Because of environmental conditions associated with drought, extraction failures in the laboratory, and other problems encountered in the field, no data is presented for the 2005 production year. Yield variations between 2004 and 2006 reflect dry conditions experienced during the middle and late growing season in 2004. Table 1 shows the averages for each treatment.

Findings of the Study

As shown in Table 1, the PPI and BAND application techniques reduced concentrations of atrazine in surface runoff in both years of the study. When compared to the BROAD treatment, the PPI treatment reduced atrazine losses by approximately 90

Table 1: Atrazine runoff, weed control, and yield of three application strategies.

Application method	Average atrazine lost (µg/L)		Average percent of pigweed control		Average yield (bushels/acre)	
	2004	2006	2004	2006	2004	2006
BROAD	155.7	234.1	94.6	87.5	35.0	94.8
PPI	16.2	79.1	88.4	75.3	30.0	97.4
BAND	20.1	102.9	84.0	57.6	67.0	89.0

percent in 2004 and more than 65 percent in 2006. The BAND treatment showed an approximately 87 percent reduction in atrazine lost in surface runoff for 2004 and a 56 percent reduction in 2006, when compared to the BROAD treatment.

Average pigweed control in each of the seasons was better when using the traditional BROAD application method. Both the PPI and BAND treatments had weed control in the 80 percent range for 2004, but weed control decreased during 2006 for both application methods.

Although there were differences in pigweed control between the BROAD and the PPI and BAND application methods, corn yield reduction differences between treatment plots were not as large. The BAND treatment plot outyielded the other two treatment plots in 2004, and the PPI treatment plot outyielded all treatments in 2006. No real trends were established in determining which application method would contribute to the highest crop yields. However, the results of this demonstration show that the PPI and BAND treatments, which are designed to reduce losses of atrazine in surface runoff, can produce yields comparable to or better than the BROAD application treatment.

By employing the PPI and/or BAND treatments, a corn or grain sorghum producer can reduce the risk of atrazine contaminating the surface waters of Texas, while maintaining acceptable yields. Therefore, producers in areas where atrazine contamination is a risk should consider using the PPI or BAND treatment as part of their natural resource protection plan.

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For Further Information

Atrazine Management and Water Quality (Missouri Manual 167), Missouri University Extension.

Reducing Herbicides in Surface Water: Best Management Practices (L-5205), Texas AgriLife Extension Service.

Some Facts About Atrazine (L-5204), Texas AgriLife Extension Service.

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