AGRICULTURAL

MU Guide

PUBLISHED BY UNIVERSITY EXTENSION, UNIVERSITY OF MISSOURI-COLUMBIA

Atrazine: Best Management Practices and Alternatives in Missouri

Bill Johnson, Extension Weed Management Specialist
Fred Fishel, Coordinator of Pesticide Programs
Andy Kendig, Extension Weed Management Specialist

Atrazine is used on about 65 percent of all corn acreage and 69 percent of all grain sorghum acreage in the United States, and Missouri mirrors this level of use. It is estimated that the loss of atrazine would result in an annual cost of about $1 billion to U.S. farmers. This loss would come from reduced yields (up to 8%) and more expensive replacement products for weed control. With current products, the cost to replace atrazine would range from $12 to $18 per acre. This does not include the cost of additional soil erosion where tillage will be used to replace atrazine.

Atrazine provides residual broad-spectrum weed control and can be used with both conventional and conservation tillage. Atrazine also has a higher margin of crop safety than many of its possible replacements.

Public concern over the widespread use of atrazine centers on its detection in both surface and groundwater. Drinking water supplies in nine watersheds in northern Missouri contain atrazine levels higher than 3 parts per billion, the maximum contaminant level mandated by the U.S. Environmental Protection Agency. Thus, the future of atrazine in these areas is uncertain, and more restrictions may be required to bring the water supplies back into compliance. This publication provides guidelines for (1) reducing offsite movement of atrazine, and (2) using other products to control weeds. The alternative products are listed to provide growers with weed control tools if they either decide voluntarily not to use atrazine or are required to use other products because of additional restrictions by regulatory agencies.

Reducing offsite movement

Although atrazine contamination of the groundwater is a serious issue, it appears to be a localized problem that develops as a result of the interaction of several site-specific conditions. Atrazine in surface runoff is of more widespread concern. The unpredictable nature of runoff and the seasonal peak concentration of atrazine in streams and rivers draining agricultural areas imply the need to minimize loss at the source.

Control runoff

Herbicide loss in runoff depends on the intensity and duration of the rainfall, the time between herbicide application and the rain, the concentration of the herbicide in the upper half inch of soil, properties of the herbicide, tillage practice, soil type and the slope of the treated fields. Most studies show that runoff losses are less than 5 percent of the amount applied and that the greatest losses (up to 7%) occur when intense rainfall follows immediately after application.

Best management practices that encourage infiltration of surface water into the soil will be most effective in reducing atrazine losses in runoff. Research shows that light incorporation, or tillage, increases infiltration and can reduce offsite movement of atrazine. This is because atrazine moves primarily through solution in runoff water (the water phase) rather than attachment to soil particles (the sediment phase). Incorporation of herbicides by working them into the soil can decrease the amount of active ingredient in runoff; however, soil erosion losses will be greater on erodible lands and the net effect on the environment could be worse than herbicide runoff.

In no-till fields, we recommend the following:

- Either tank mix atrazine with another soil-applied herbicide to reduce the amount of atrazine applied or use other, non-atrazine herbicides.
- Don't till your no-till acres and destroy soil structure and other benefits gained by long-term no-till management.

On conventionally tilled acres, incorporation of atrazine and atrazine tank- and pre-mixes can reduce the amount of herbicide that leaves the field.

Use the proper amount of herbicide

The best way to minimize surface and groundwater contamination is to follow label directions exactly. If you do not follow these directions, your treatment may not be effective, you increase the chance of contaminating water and you may be violating the law. Proper timing and placement of all pesticides are important.

- Avoid temptations to use more herbicide than the label directs. Overdosing will not do a better job of controlling pests and will increase both the cost of control and the chance that the material may contaminate water.
- Calibrate equipment carefully and measure concentrates accurately before adding them to the tank.

Ensure proper disposal

Improper disposal of empty containers, rinse water or unused chemicals can cause localized groundwater problems.

- Dispose of all wastes in accordance with local, state and federal laws.
- Triple rinse or pressure rinse your containers and pour the rinse water into the spray tank.
- Dispose of leftover product in your spray tank in a manner consistent with the product label.
- Avoid leftover product when possible by mixing only the quantity you need.
- Do not drain rinse water from equipment near or into ditches, ponds, lakes or other water sources. Rinse waters containing pesticides are classified as hazardous wastes according to federal and state laws.

Observe buffer zones

Buffer zones provide a measure of protection against runoff and spills of agricultural chemicals during mixing and application.

Wells and sinkholes. Mix atrazine and fill and rinse your sprayer at least 50 feet from any well or sinkhole. Do not apply atrazine within 50 feet of any well or sinkhole.

Streams and rivers. Do not mix or load atrazine within 50 feet of any stream or river. Establish a 66-foot application buffer from points where field surface water enters an intermittent or perennial stream or river. If the field is highly erodible as determined by the Natural Resources Conservation Service (NRCS), plant a 66-foot buffer to your crop or seed with grass or other suitable crop or vegetation.

Lakes and reservoirs. Do not apply atrazine around a natural or impounded lake or reservoir within 200 feet of the water's edge. Do not mix or load atrazine within 50 feet of any lake or reservoir.

Farm ponds. Farm ponds are excluded from the setback or buffer requirements if they meet all of the following criteria: (1) the farm pond is located wholly on the farmer's property, (2) it is not used for human drinking water, and (3) its discharge is not conveyed directly to a stream or river through a clearly traceable, concentrated watercourse.

Prevent back siphoning

To prevent back siphoning, keep the end of the fill hose above the water level in the spray tank at all times. Use an anti-backflow device when drawing mix water from a well or pond. These anti-backflow devices can be purchased from irrigation or sprayer equipment suppliers.

Best Management Practices in Brief

- Leave crop residue on the field to reduce runoff; no-till agriculture can reduce pesticide runoff over conventional tillage. Terraces and contour farming prevent soil, nutrients and pesticides from leaving the field.
- Delay herbicide application if heavy rain is forecast. Also follow timely irrigation techniques. Pesticides are most susceptible to runoff during the first several hours after application.
- Match application rates to field characteristics. Carefully consider soil type, erosion characteristics, organic matter and weed problems when you are determining the proper rate for each field. Soil type and other factors vary from field to field, so application rates will vary.
- Avoid overspray and drift. Wind speed, temperature, and humidity all affect spray movement. You can reduce drift by lowering the height of the spray boom, reducing application pressure, adding drift control agents, and using nozzles that produce larger droplets.
- Evaluate each field to determine which fields are highly erodible or contain wells, sinkholes or points where surface water runs off into intermittent or perennial streams, rivers, lakes or reservoirs. Stake out or flag these areas so anyone applying atrazine can easily see them.
- Work with your dealer or applicator and evaluate your fields before planting season. Your local water utility or various Missouri regulatory agencies may impose additional safeguards beyond those required by the label.
- For further information, contact the Department of Natural Resources Technical Assistance Program, 1-800-361-4827, or your local University Extension Center.

Atrazine management

The total amount of atrazine applied to a field may not exceed 2.5 pounds of active ingredient (lb a.i.) per acre per year. This restriction includes all atrazine applied both before and after crops emerge.

Preemergence applications

Broadcast spray application rates for atrazine before crops emerge depend on the amount of plant residue covering your field at planting and on the erodibility of your soil as defined by NRCS.

Highly erodible soils.

- If 30 percent or more of the soil is covered with plant residue at planting, apply no more than 2.0 lb a.i. per acre.
- If less than 30 percent of the soil is covered with plant residue at planting, apply no more than 1.6 lb a.i. per acre.

Soils not classified as highly erodible.

- Apply no more than 2.0 lb a.i. per acre.

Postemergence applications

When appropriate, make postemergence applications of herbicides in narrow bands directly over the rows rather than cover the entire space between rows. In addition, consider delaying a herbicide application if heavy rains are forecast for the next few days. Research has shown that heavy rains shortly after application can cause significant loss of the herbicide in runoff. Follow these application guidelines:

- If no atrazine was applied before crop emergence, use no more than 2.0 lb a.i. per acre.
- If a preemergence application was made in the same calendar year, the combined preemergence and postemergence applications may not exceed 2.5 lb a.i. per acre.

Alternatives to atrazine

There are several chemical alternatives to atrazine or other triazines. Tables 1–4 list the current alternative treatments and their approximate cost per acre. The tables show specific alternatives to atrazine; these are not intended as alternatives to a total weed control program. Consult MU publication MP 575 *Weed Control in Missouri Field Crops*, your extension specialist or herbicide dealer to plan your weed control program.

For postemergence weed control in fields with conventional or reduced tillage, 2,4-D is an extremely competitive product in terms of price per acre, but be cautious of drift to nontarget vegetation (Table 4) especially with ester formulations. Mixtures of 2,4-D and Banvel have been extremely consistent in field corn over the years (Figure 1) and competitive on a per acre basis (Table 4). Proper herbicide combinations can increase your chances of successful weed

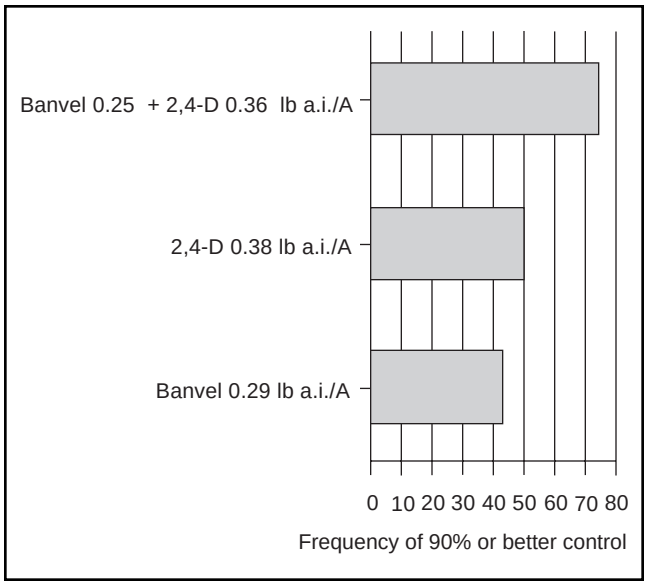

Figure 1. Control of broadleaf weeds with Banvel and 2,4-D.

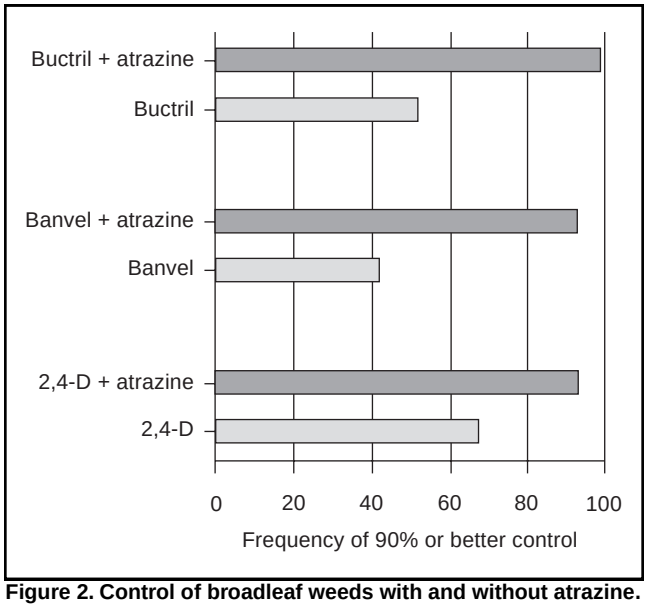

Figure 2. Control of broadleaf weeds with and without atrazine.

control. Figure 2, based on results from a Pesticide Impact Assessment Study published by the University of Illinois, outlines the success rates of various tank mixes. Mixing atrazine with Buctril or Banvel is likely to yield better weed control than use of either of those products alone. Excellent results have also been obtained when atrazine is combined with 2,4-D. If you still desire to use atrazine postemergence but would like to reduce the rate of application, consult MU publication MP 575 *Weed Control Guide for Missouri Field Crops* for the performance of several tank mixes.

No-till crop production

If you eliminate tillage before planting, you must control undesirable vegetation with herbicides at or before planting. Eliminating or reducing tillage puts a greater reliance on chemical weed control. Greater

emphasis may be placed on pre-plant or post-plant soil-applied herbicides that are not incorporated into the soil or on foliar-applied herbicides. Generally speaking, Roundup provides better control of large weeds, and Gramoxone provides better control of small weeds (Tables 1 and 2). Banvel and 2,4-D are superior if leguminous cover crops or annual broadleaf weeds are the dominant species present.

Where primary tillage is minimized, soil residual herbicides may reduce the need for a burndown herbicide. However, early pre-plant applications made more than 15 days before planting may require additional preemergence or postemergence herbicides for satisfactory weed control after planting.

Soybean stubble is often ideal for no-till production. Burndown plus preemergence or postemergence herbicides can often provide adequate control. Consult Tables 1, 2 and 3 for burndown and preemergence alternatives to atrazine.

No-till crop production does not necessarily reduce atrazine runoff unless water infiltration is increased. In no-till production, some large-seeded broadleaf weeds such as cocklebur will be less problematic, but perennial weeds and small-seeded weeds such as pigweeds become more of a problem.

Conventional-till crop production

In conventional tillage, consider using Broadstrike Plus as an alternative to atrazine as a pre-plant incorporated or preemergence treatment (Table 3). Use this product as a supplement to your pre-plant incorporated or preemergence grass control herbicide. There are several postemergence products to substitute for, or tank mix with, atrazine (Table 4). Consult MP 575, the herbicide label or your dealer for herbicide application rates. Typically the rate of application for atrazine in tank mixes is 1 lb a.i. per acre at a cost of $3 to $4 per acre. This makes it possible to supplement the postemergence weed control at very little cost. The labeled atrazine tank mix partners in field corn are Accent, Banvel/Clarity, Basagran, Bladex, Buctril, Prowl, Pursuit (on IT/IR [imidazolinone-tolerant or -resistant] corn), and Tough. The labeled atrazine tank mix partners in grain sorghum are Basagran and Buctril.

Table 1. Weed response to burndown herbicides.

Weed	**Atrazine** 2 lb a.i./A + crop oil	**Roundup** 1 qt/A + ammonium sulfate	**Gramoxone** 1.5 pt/A + nonionic surfactant	**Banvel** 1 pt + **2,4-D** 2 pt/A
Annual bluegrass	10	10	9	0
Downey brome/cheat	7	9	8	0
Carolina foxtail/little barley	10	9	9	0
Small flowered bittercress & sibara	8	8	9	9
Smallflower buttercup	10	9	9	0
Chickweed	10	10	10	–
Dandelion	4	5	4	8
Cutleaf eveningprimrose	7	6	8	–
Rough (daisy) fleabane	7	5	5	–
Carolina geranium	–	8	9	–
Henbit	–	9	9	–
Horseweed (marestail)	9	9	6	8
Mousetail	9	10	9	10
Wild mustard	10	9	8	9
Field pennycress	8	9	8	9
Prickly lettuce	9	8	7	9
Virginia pepperweed	8	10	8	9
Shepherd's-purse	10	10	10	9
Purslane speedwell	10	9	5	9
Crabgrass	7	9	8	0
Giant foxtail	7	8	7	0
Common lambsquarters	10	9	8	9
Common ragweed	9	9	8	10
Giant ragweed	9	8	7	9
Annual smartweed	10	8	7	8
Grain sorghum	Yes	Yes	Yes	Yes
Cost per acre ($)	7.50	11.00	7.28	13.44

Weed control: 8 to 10 = Good, 6 to 7 = Fair (partial control or suppression), Less than 6 = Poor, – = No data available
Note: This table presents burndown information only. It does not reflect residual weed control.

Integrated Pest Management

Integrated pest management programs combine chemical use with many other production practices to manage pests in ways that are both economically and environmentally sound. These programs include such practices as crop rotation to avoid the buildup of pest populations and to maintain or improve soil conditions, the use of alternative pest-control products and pest-resistant varieties, and careful pest monitoring to ensure that chemical methods are used only when needed.

Scout your fields early and often and select the herbicide based on the weeds present. Proper management of your fields is essential. Atrazine is useful as a stand-alone product and as a tank mix partner. But unless we practice good land stewardship, we may lose this important product.

Table 2. Cover crop and sod response to burndown herbicides.

Weed	**Atrazine** 2 lb a.i./A + crop oil	**Roundup*** + ammonium sulfate	**Gramoxone** 1.5 pt/A + nonionic surfactant	**Banvel** 1 pt + **2,4-D** 2 pt/A
Annual rye	6	9	7	0
Winter wheat	6	9	6	0
Alfalfa	4	4	4	8
Crimson clover	3	3	9	8
Red clover	5	6	4	9
Hairy vetch	7	6	8	9
Fescue	2	6	5	0
Orchardgrass	4	6	3	0
Timothy	2	8	5	0
Grain sorghum	Yes	Yes	Yes	No
Cost per acre ($)	7.50	5.50 per pint	7.28	13.44

Weed control: 8 to 10 = Good, 6 to 7 = Fair (partial control or suppression), Less than 6 = Poor, – = No data available

Note: A fall application of Banvel, Gramoxone or Roundup followed by a sequential herbicide application in the spring will provide better established sod control than single herbicide applications.

*The recommended application rate for Roundup in the spring is 2 to 3 pt/A for cover crops, and 2 to 3 qt/A for established sods.

Table 3. Broadleaf weed response to preemergence herbicides.

Weed	**Atrazine** 2 lb a.i./A	**Broadstrike Plus** 0.2–0.3 lb/A
Eastern black nightshade	9	8
Cocklebur	9	7
Jimsonweed	10	8
Common lambsquarters	9	9
Entire and ivyleaf morningglory	9	5
Pitted morningglory	10	–
Redroot and smooth pigweed	10	9
Prickly sida	9	7
Common ragweed	9	8
Giant ragweed (horseweed)	8	6
Annual smartweed spp.	9	8
Sunflower	7	9
Velvetleaf	8	8
Common and tall waterhemp	10	–
Grain sorghum	Yes	No
Cost per acre ($)	6.50	17.45

Weed control: 8 to 10 = Good, 6 to 7 = Fair (partial control or suppression), Less than 6 = Poor, – = No data available

Table 4. Broadleaf response to postemergence herbicides.

Weed	**Atrazine** 2 lb a.i./A + crop oil	**Banvel** 1 pt/A	**Beacon** 0.76 oz/A + nonionic surfactant	**Basagran** 2 pt/A + crop oil	**Buctril** 1.5 pt/A	**Resolve*** 5.3 oz/A + nonionic surfactant + 28%N	**Exceed** 1 oz/A + crop oil	**Permit** 1 oz/A + crop oil	**Scorpion III** 0.25 lb/A + nonionic surfactant	**2,4-D** 1 pt	**2,4-D** 1 pt **+ Banvel** 0.5 pt/A
Eastern black nightshade	9	9	7	2	9	8	8	7	8	7	9
Cocklebur	9	9	6	9	9	9	9	9	9	9	9
Jimsonweed	10	9	8	9	10	8	8	6	8	8	9
Common lambsquarters	10	9	5	6	9	8	8	6	8	9	9
Entire & ivyleaf morningglory	9	9	–	5	8	8	7	6	8	9	9
Pitted morningglory	9	10	–	7	8	–	–	–	–	10	10
Redroot & smooth pigweed	10	9	8	4	7	9	9	8	9	9	9
Prickly sida	9	8	–	8	4	7	6	7	7	8	9
Common ragweed	9	10	8	8	9	9	9	9	9	9	10
Giant ragweed	8	9	8	8	7	8	8	8	8	8	9
Annual smartweed	9	9	8	9	9	9	9	8	9	7	9
Sunflower	9	9	8	8	8	9	9	9	9	9	9
Velvetleaf	9	8	6	8	8	8	9	9	8	8	9
Waterhemp	10	8	8	3	6	8	5	8	–	8	9
Grain sorghum	Yes	Yes	No	Yes	Yes	No	No	Yes	No	Yes	No
Cost per acre ($)	7.50	10.20	19.56	16.26	10.41	16.50	11.30	13.85	9.00	1.62	6.72

Weed control: 8 to 10 = Good, 6 to 7 = Fair (partial control or suppression), Less than 6 = Poor, – = No data available

* Resolve is for use only on IT/IR [imidazolinone-tolerant and -resistant] corn.

No endorsement of any trade name is implied, nor is discrimination against similar products intended.

Herbicide prices are approximate retail costs in January 1996. Retail prices will vary depending on volume purchased, current price structure, and other factors. Retail prices from your dealer may be higher or lower than the approximate retail prices listed in this publication. Contact your local chemical supplier regarding current retail prices.

University Extension
UNIVERSITY OF MISSOURI
COLUMBIA

■ Issued in furtherance of Cooperative Extension Work Acts of May 8 and June 30, 1914, in cooperation with the United States Department of Agriculture. Ronald J. Turner, Director, Cooperative Extension, University of Missouri and Lincoln University, Columbia, MO 65211. ■ University Extension does not discriminate on the basis of race, color, national origin, sex, religion, age, disability or status as a Vietnam era veteran in employment or programs. ■ If you have special needs as addressed by the Americans with Disabilities Act and need this publication in an alternative format, write ADA Officer, Extension and Agricultural Information, 1-98 Agriculture Building, Columbia, MO 65211, or call (573) 882-8237. Reasonable efforts will be made to accommodate your special needs.