What can I do to slow the development and (or) negate the negative impacts of enhanced atrazine degradation?

If growers are having difficulty controlling weeds with pre-emergence atrazine applications, and resistant weed biotypes are not present, the field may be exhibiting enhanced atrazine degradation. Growers should consider the following recommendations to improve weed control.

- Be familiar with other *s*-triazine herbicides that are frequently applied in corn and cotton production systems that **cross-adapted bacteria** can **biodegrade**. In corn be aware of simazine, e.g., Princep®, and ametryn, e.g., Evik 80W®. In cotton be conscious of prometryn, e.g., Caparol®.
- Avoid production systems with two or more consecutive years of soil applied *s*-triazine use.
- Use atrazine in conjunction with alternative residual herbicides, and if needed, follow with an appropriate post-emergence herbicide application.
- Research has demonstrated that post-emergence atrazine applications can be effectively used for two or more consecutive years in adapted soils; however, expect limited residual weed control with the herbicide.
- State Corn and Extension Weed Science Specialists should be consulted regarding viable alternative residual herbicides and application restrictions on specific corn varieties.

Disclaimer: Mention of trade or commercial names is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U. S. Department of Agriculture.

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Useful Definitions

Biodegradation is the breakdown of complex organic chemicals by microorganisms.

Atrazine-adapted bacteria can rapidly biodegrade the herbicide.

Cross-adapted bacteria can rapidly biodegrade more than one *s*-triazine herbicide.

***S*-triazine-history soils** have received repeated applications of atrazine and (or) other *s*-triazine herbicides.

Non-history soils have no history of atrazine and (or) other s-triazine herbicide use.

Adapted soils contain atrazine-adapted and (or) cross-adapted bacteria and exhibit enhanced degradation.

Non-adapted soils do not exhibit enhanced degradation and typically do not have a recent atrazine and (or) *s*-triazine use history.

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Enhanced Atrazine Degradation and Implications for Weed Control in Corn

Agricultural Research Service
Southern Weed Science Research Unit
FACT SHEET 2008-01

What is enhanced atrazine degradation, and why should I be concerned?

The photograph on the cover of this pamphlet is an example of reduced residual weed control in a Colorado corn field arising from **enhanced atrazine degradation**. **Enhanced atrazine degradation** is the phenomenon whereby the herbicide is rapidly **biodegraded** by a population of soil bacteria that has developed the ability to use the pesticide as a nutrient source because of previous exposure to it or other *s*-triazine herbicides.

The agronomic significance of enhanced atrazine degradation is decreased herbicide persistence which may result in reduced residual weed control. For example, the average half-life for atrazine in **non-adapted soil** is 60 days. Conversely, the average atrazine half-life in adapted soil is 6 days.[1] This 10-fold difference in atrazine persistence between **adapted** and **non-adapted soil** can adversely affect residual weed control.

The effectiveness of a residual herbicide is primarily a function of two parameters: 1) the herbicide concentration required to control a weed species, and 2) the herbicide's persistence in soil. For example, if an atrazine concentration of 0.4 mg/kg soil is required to control a given weed, then we can expect 80 days of residual weed control in a **non-adapted soil** as compared to 8 days in an **adapted soil** (Figure 1).

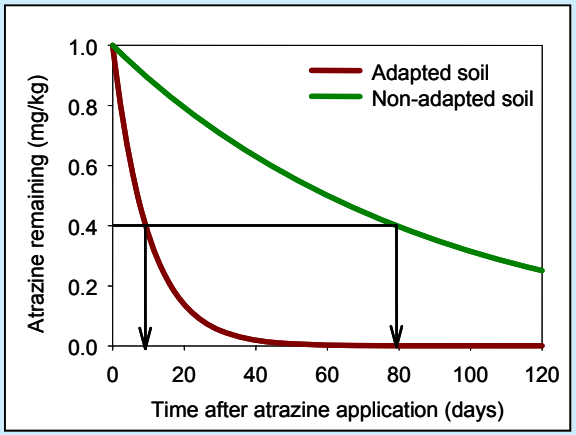

Figure 1. Residual weed control with atrazine in adapted and non-adapted soils.

How wide spread is the problem, and has reduced residual weed control been confirmed with atrazine in adapted soils?

Enhanced atrazine degradation has been confirmed in agricultural soils throughout North America and Europe. **Adapted soils** have been identified in various U.S. states where atrazine and (or) other *s*-triazine herbicides have been used extensively: California, Colorado, Hawaii, Illinois, Louisiana, Mississippi, Tennessee, and Texas.[1-3] To date, reduced residual weed control with atrazine has only been confirmed under greenhouse conditions in Mississippi (Figure 2) and under field conditions in Colorado (Figure 3) and Mississippi.[4-6]

Figure 2. Greenhouse response of pitted morningglory to atrazine applied pre-emergent at 0.0, 1.6, and 1.6 lbs ai/acre in non-treated, **adapted** and **non-adapted** Mississippi soils, respectively. Photograph taken 21 days after application.

How quickly can enhanced atrazine degradation develop?

Enhanced degradation can develop following one atrazine application.[7] However, the probability of encountering reduced residual weed control with atrazine increases if the herbicide is applied annually for three or more consecutive years (Figure 3).[5]

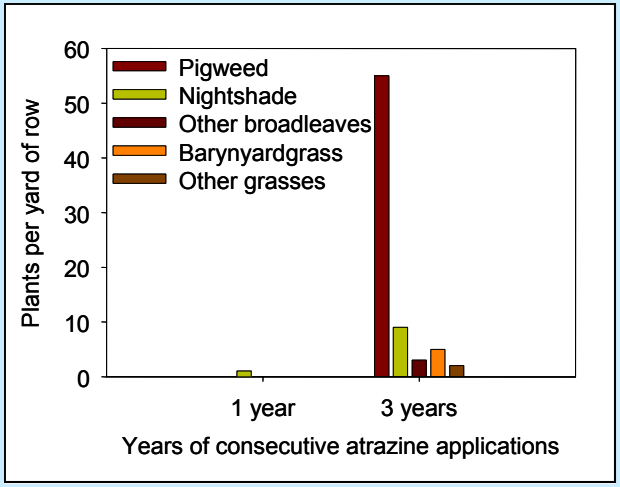

Figure 3. Weed control in Colorado no-tillage corn fields as a function of consecutive years of atrazine use.

Is there evidence for cross-adaptation among *s*-triazine herbicides?

Yes. Genetic analysis of bacteria isolated from Mississippi and Colorado **adapted soils** indicate the potential for widespread **cross-adaptation** among various *s*-triazine herbicides.[1] Specifically, laboratory experiments have confirmed that soils exhibiting enhanced atrazine degradation are **cross-adapted** with the *s*-triazine herbicide simazine, and Mississippi field studies have confirmed decreased persistence and reduced residual weed control with simazine in **atrazine adapted soils**.[6]

Can atrazine's effectiveness as a residual herbicide be restored in soils where reduced residual weed control has been observed?

Probably. We are currently conducting research in Mississippi to address this question. Our research group should have a more definitive answer by 2010.