

No-till lime management and soil pH effects on herbicide carryover

Peter Scharf, Bill Johnson, and Jim Wait
Agronomy Department, University of Missouri

Objective:

Evaluate yield loss due to carryover of pH-sensitive herbicides at different surface soil pH levels in a no-till soybean-corn rotation.

Methods:

- The experiments were conducted at Bradford Farm east of Columbia.
- No-till soybean-corn rotation. Both crops are grown each year.
- Experimental treatments are five lime/acid treatments in combination with four herbicide treatments for each crop.
 - Lime/acid treatments are:
 - high rate lime (about 3 tons/acre)
 - low rate lime
 - no treatment
 - low rate acid (iron sulfate was used)
 - high rate acid (equivalent to high lime rate).
 - Lime and acid treatments were surface-applied.
 - Lime and acid treatments created a wide range of soil pH values in the surface inch. For example, soil salt pH (normal MU test) ranged from 4.4 to 7.1 in May 2001.
 - Herbicide treatments for each crop are shown in Table 1. These herbicides were chosen because their chemistry is pH-sensitive, with greater potential for carryover at high or low pH.
 - Increased potential for carryover at high pH: Atrazine, Peak, Classic
 - Increased potential for carryover at low pH: Atrazine, Pursuit, Scepter

Table 1. Herbicide Treatments applied in 1999 & 2001.

<u>Corn</u>		<u>Soybean</u>	
<u>Herbicide</u>	<u>Rate (lb/ac)</u>	<u>Herbicide</u>	<u>Rate (lb/ac)</u>
Atrazine	1.25	Pursuit	0.063
Atrazine	2.5	Scepter	0.125
Peak	0.018	Classic	0.04
Untreated		Untreated	

- This study has a two-year cycle. In the first year of the cycle, the herbicide treatments in Table 1 were applied to each crop. In the second year of the cycle, the rotation crop was grown and yields were analyzed to see whether they were affected by herbicide carryover from the previous year.
 - Herbicide treatments were applied in 1999 and 2001.
 - Yield effects of herbicide carryover were evaluated in 2000 and 2002.

- Soil pH also influences herbicide efficacy. We wanted to focus on pH effects on carryover, and eliminate differences in weed control between plots. We did this by growing Roundup Ready crops and controlling weeds in all plots with postemergence Roundup applications.

Results for soybean:

- Soybean yields were good in both harvest years. Average yield in 2000 was 58 bu/acre, and in 2002 was 49 bu/acre.
- In both 2000 and 2002, there was evidence of atrazine carryover effects on soybean yield.
 - In 2000, both atrazine treatments (1.25 lb/acre and 2.5 lb/acre) resulted in soybean yields that were sensitive to soil pH.
 - A curved line best described this relationship (Figure 1) with 95% confidence, while soybean yields in the control and Peak treatments were not influenced by soil pH.
 - Yields were most clearly reduced at high soil pH values, but they also appeared to be reduced at low soil pH.
 - There are reasons why atrazine carryover damage might be expected at either low or high soil pH values:
 - At low pH, atrazine is strongly adsorbed to soil particles, making it less available for breakdown.
 - At high pH, atrazine is extremely soluble in the soil solution, producing potentially toxic effects even when concentration in the soil as a whole is very low.
 - With the 2.5 lb/acre rate of atrazine, average soybean yield was 59 bu/acre from salt pH 5.7 to 6.5, and 54 bu/acre with pH above 6.5, a yield difference of 5 bu/acre.
 - Dry conditions from July 1999 to April 2000 may have favored herbicide carryover. Herbicide breakdown is usually slower under dry conditions.

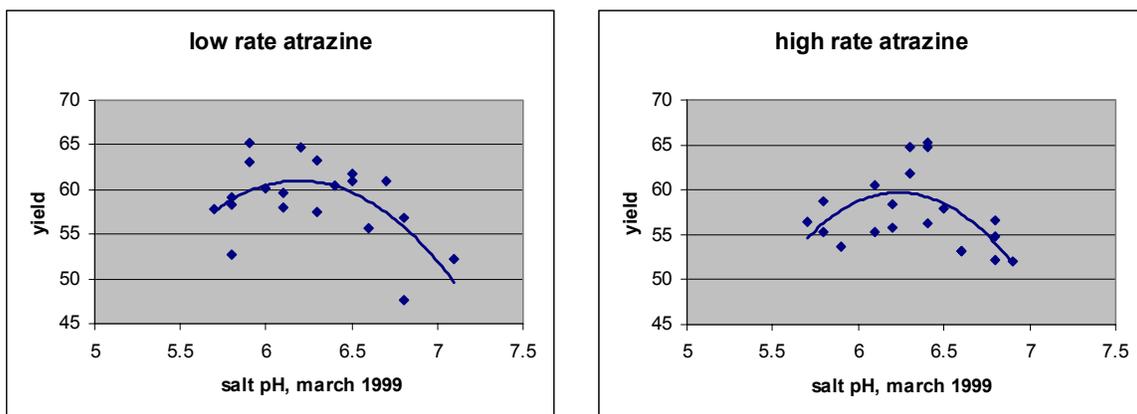


Figure 1. Soybean yield in 2000 was affected by soil pH in plots that had received atrazine (either 1.25 or 2.5 lb ai/acre) in 1999. For both atrazine treatments, yields were reduced at high soil pH and possibly also at low soil pH. The curved (quadratic) line best described the observed yields (95% confidence for both graphs). Soil pH measurements were taken in March 1999 (shortly before atrazine applications were made) in the top inch of soil, which is the main zone of atrazine activity.

- In 2002, soil pH affected soybean yield in plots that had received the 2.5 lb/acre rate of atrazine, but not with the 1.25 lb rate.
 - Lower yields were seen with low soil pH values, especially below salt pH of 5.2 (Figure 2), but the reduction was only about 1.5 bu/acre (95% confidence). There was also some indication of yield reduction at low pH in 2000.
 - Unlike 2000, we did not see any yield reduction at high soil pH in 2002.
- Peak treatments did not result in pH-sensitive carryover damage. However, soybean yields in 2000 were reduced by 3 bu/acre when Peak had been applied the previous year, regardless of soil pH. No yield reduction was seen in 2002, in fact, plots receiving Peak in 2001 yielded 1 bu/acre more than control plots.
- Overall, herbicide carryover had much greater impact on soybean yield in 2000 than in 2002. This is probably related to the dry weather from July 1999 to April 2000, which created a poor environment for herbicide breakdown.

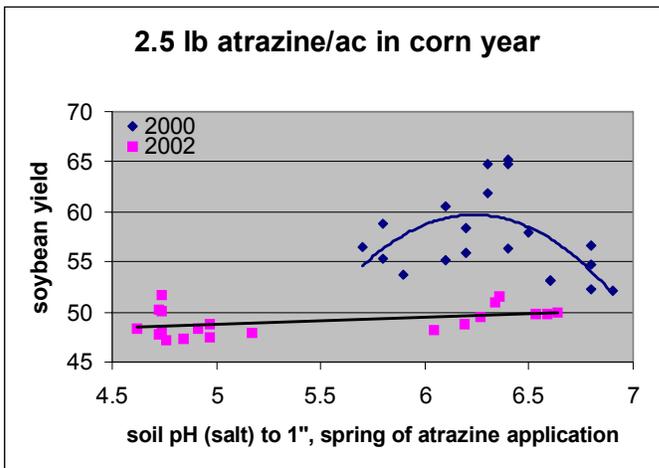


Figure 2. Soil pH effects on soybean yields compared for 2000 and 2002 in plots that had received 2.5 lb atrazine/acre the previous year. In 2000, yield was reduced at high soil pH (54 bu/acre above pH 6.5, 59 bu/acre below) and perhaps also at low pH, while in 2002 yields were reduced only at low pH and the yield reduction was smaller (1.5 bu/acre). Both effects are statistically significant with 95% confidence.

Results for corn:

- Corn yields were not as good as soybean yields, but were representative of many Missouri cornfields. In 2000, average corn yield was 132 bu/acre. In 2002, yields were limited by drought stress and average yield was 101 bu/acre.
- We did not see any effect of Pursuit, Scepter, or Classic treatments from the previous year on corn yield in either 2000 or 2002.

Economic analysis:

Results from 2000 suggest a soybean yield loss of around 5 bu/acre following atrazine when soil salt pH is above 6.5 (approximate water pH of 7.0) in the top inch. An estimate of the economic impact of this yield loss for Missouri:

(5 million total acres of soybean) x (50% following corn) x (Atrazine applied to 80% of corn acres) x (50% no-till) x (15% of no-till acres have pH above 6.5 in surface inch) x (5 bu/acre lost) x (\$5.50/bu) = \$4.1 million/year lost income to Missouri soybean producers

The estimate of 15% of no-till acres with pH above 6.5 in surface inch is very rough. Most no-till ground that is limed probably falls into this category for a year, so if liming happens once every 6 or 7 years, about 15% of no-till fields will have high surface pH.

Economic loss based on 2002 results would be much smaller, possibly \$1.2 million/year (similar calculation but 1.5 bu/acre yield loss and estimating that 15% of no-till acres have low surface pH due to surface N applications).

Conclusions:

- Soybean yield was affected by carryover of herbicides (particularly atrazine) and soil pH in both 2000 and 2002, but effects were much greater in 2000. This was probably due to drought in 1999/2000, which favored herbicide carryover. Yield reductions due to atrazine were seen at both low and high soil pH.
- Corn yield was not affected by herbicide carryover or soil pH in either 2000 or 2002.
- The economic impact of pH-related herbicide carryover in Missouri is difficult to assess at this point. Results from 2000 suggest that it could be a multi-million dollar problem, but this year's results show that the impact can be much smaller.
- Avoiding over-liming may be important for soybean profitability when atrazine is used in a no-till soybean-corn rotation. Small, frequent lime applications may be appropriate. Variable-rate lime applications may also be justified.