Soil pH effects on atrazine carryover damage to no-till soybean

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Objective & relevance to Missouri agriculture:
- Our objective is to evaluate soybean yield loss due to carryover of atrazine at different soil pH levels in a no-till soybean-corn rotation.
- Relevance to Missouri agriculture:
  - This experiment has already been funded by the Fertilizer & Ag Lime grants program through two 2-year cycles.
  - In the first harvest year (2000), we found substantial (about 5 bu/acre) yield reductions when atrazine had been applied to high-pH surface soils the previous year. Extrapolated over Missouri, this amounts to an annual loss of about $4 million. We also saw possible yield losses at low soil pH.
  - In 2002, we found a small yield reduction (about 1.5 bu/acre) when atrazine had been applied to low-pH surface soils in 2001.
  - Greater carryover damage in 2000 may be related to the dry conditions from summer 1999 to spring 2000. Many herbicides break down more slowly in dry soil.
  - We would like to continue this experiment through one more two-year cycle to get a better indication of the average size of the yield reduction and whether the problem is more common at high pH or at low pH.
  - Problems are most likely to occur in no-till cropping systems due to large swings in surface soil pH. No-till cropping is widely used in Missouri.
    - Lime applications lead to high pH in the surface soil, where atrazine is active.
    - Surface applications of N lead to low pH in the surface soil.
  - Many Missouri fields have spatial variability of soil pH of more than 2 pH units. Even when field-average pH is good, yield loss may occur in parts of the field. Variable-rate liming can correct this situation and may be justified.

Procedures:
- Small-plot experiment at Bradford Farm near Columbia
- No-till corn-soybean rotation
- We have already created a wide range of soil pH levels in the top inch of soil using surface applications of lime and iron sulfate.
- Herbicide programs for corn in 2003 will include:
  - Untreated check
  - Atrazine 1.25 lb a.i./acre preplant
  - Atrazine 2.5 lb a.i./acre preplant
  - Atrazine 1.25 lb a.i./acre preplant followed by 1.25 lb a.i./acre post
    - This is a new treatment in the study. Many producers use post applications of atrazine, which carry greater carryover risk than preplant applications.
- Roundup Ready corn will be used and Roundup will be used to control weeds so that only carryover damage is evaluated.
- Soybean will be planted in these plots in 2004. Yields will be measured and related
to treatment and soil pH values.

- In past years, soybean herbicides have had no effect on corn yield in the following year. We are discontinuing this part of the experiment, and changing the experiment to focus only on atrazine carryover to soybean. This will allow us to have eight replications in the experiment, which will increase the stability of our results.

**Current status and importance of pH-related atrazine carryover:**

- We are not aware of any published research on soil pH-related atrazine carryover.

- 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.

- In our previous research, we have found soil pH effects on soybean yield when atrazine was applied to corn the previous year (graph at right). Both regression lines are statistically significant. Soil pH range is lower for 2002 yields because it was measured in May 2001 after surface N application to corn and reflects the acidifying effect of the N fertilizer.

- An estimate of the economic impact of the yield loss seen in 2000 for Missouri:
  
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  (5 \text{ million total acres of soybean}) \times (50\% \text{ following corn}) \times (\text{Atrazine applied to } 80\% \text{ of corn acres}) \times (50\% \text{ no-till}) \times (15\% \text{ of no-till acres have pH above 6.5 in surface inch}) \times (5 \text{ bu/acre lost}) \times (\$5.50/\text{bu}) = 4.1 \text{ million/year lost income to Missouri soybean producers}
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- 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.

- Yield losses due to herbicide carryover may occur with no visible symptoms, or with minimal symptoms.

- In no-till production systems, the effects of lime applications, and often of acidifying N fertilizer applications, are concentrated in the top inch of soil. The result is that surface soil pH goes through much larger swings over time than it would with tillage.
Timetable:
- Possible additional soil pH treatments (lime & iron sulfate): February 2003
- Measure 1" soil pH, plant corn, apply herbicide treatments, apply N: April/May 2003
- Plant soybean: May 2004
- Harvest soybean, assess yield loss: October 2004
- Final results available: December 2004

Budget:
Salary and wages
- 33% of research specialist $10,000
- Fringe benefits 2,500
- Supplies 1,000
- Soil pH analyses 500
**Total per year** 14,000
2-year total 28,000