



UNIVERSITY OF MINNESOTA

EXTENSION

Focus on Ag

April 2009

1

Vol. 3 No. 1



Dear Ag Producer,

Thanks to all who returned the survey mailed in early March! I appreciate your feedback and will work hard to incorporate your suggestions. If your survey is still lying around, it's not too late to return it.

The on-line interactive map for acetochlor (ex. Harness®) applications is now available. It can be used to quickly identify areas on a field-by-field basis within Dakota County where applications of this herbicide may be restricted by the label. You'll find all of the details inside.

A summary of the 2008 nitrogen management studies is included in this edition. The studies were originally designed to evaluate the 2006 University of Minnesota nitrogen rate recommendations under local conditions. The database used to develop the new guidelines is thin on irrigated coarse-textured soils, so the work in Dakota County continues to be significant. In addition to nitrogen application rates, our studies were expanded to evaluate sensor technology. Two tools, the SPAD meter and Greenseeker™, have been developed to help determine nitrogen needs during the growing season. Since irrigation equipment allows for "spoon-feeding" of nitrogen to the crop when it can most utilize it, the use of sensors may have a place in increasing efficiencies in irrigated corn. Thanks to local support, this study will be repeated at two locations this year (south of Hastings and Ravenna Township).

Finally, you'll find a summary of the University of Minnesota Weed Science Team's 2008 weed control evaluations for corn and soybeans. Last summer, the weed scientists received several reports of poor glyphosate performance around the state, so you'll find a discussion of possible causes and tips for increasing performance consistency.

Have a good, safe spring! If you have any questions or comments, please don't hesitate to contact me.

Sincerely,

Phyllis Bongard
Agriculture Production/Water Quality

For more information...

Phyllis Bongard
Agriculture Production/
Water Quality
Dakota County Extension &
Conservation Center
4100 220th St. W, Suite 101
Farmington, MN 55024

651-480-7757

phyllis.bongard@co.dakota.
mn.us or
bonga028@umn.edu

Interactive Map for Acetochlor (Harness®) Applications

April 2009

2

Vol. 3 No. 1

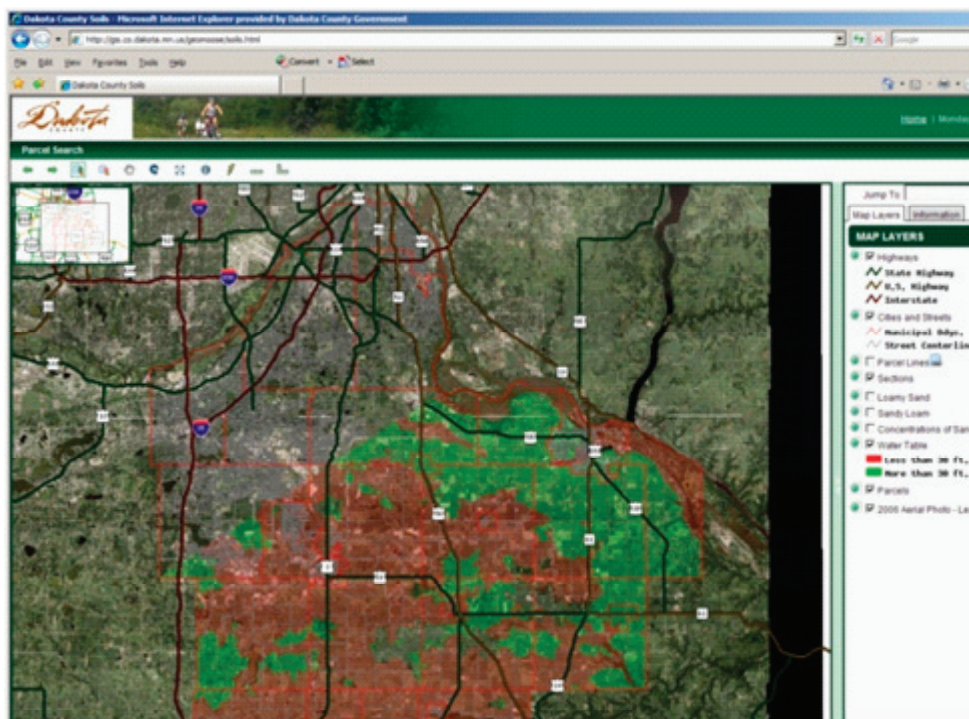
An on-line mapping tool is now available to quickly and easily identify fields within Dakota County where application restrictions for herbicides containing acetochlor (ex. Harness®) may apply. The label restrictions are based on soil texture, organic matter content and depth to groundwater. Specifically, herbicides containing acetochlor cannot be applied to sands with less than 3 percent organic matter (O.M.), loamy sands with less than 2 percent O.M. or sandy loams with less than 1 percent O.M. where the depth to groundwater is 30 feet or less.

The interactive map (shown below with the depth to groundwater layer) can be used to easily identify both soil texture and depth to groundwater on a field by field basis throughout Dakota County. Soil organic matter content, the final piece of information needed to make a decision, can be obtained through a soil test. The map offers both an overview and a step-by-step decision guide to look at fields where acetochlor application restrictions may apply.

The **overview of potential acetochlor restrictions** combines areas of coarse-textured soils where the depth to groundwater is less

than 30 feet. Since the overview doesn't differentiate between loamy sands and sandy loams, applicators should go through the more complete **Three Step Guide** if a field is included in one of these potentially restricted areas. When following this guide, users look at soil texture layers and depth to groundwater in a step-by-step manner on the website:

- Step 1. Does the field contain a loamy sand (yellow) or sandy loam (orange) soil?
 - a. If yes, go to Step 2.
 - b. If no, acetochlor may be applied.
- Step 2. Is the depth to groundwater less than 30 feet (click on water table)?
 - a. If yes (area is red), go to Step 3.
 - b. If no (area is green), acetochlor may be applied.
- Step 3. According to field soil tests, is the soil organic matter content less than 2.0% for a loamy sand, or less than 1.0% for a sandy loam?
 - a. If yes, acetochlor may not be applied according to label restriction.
 - b. If no, acetochlor may be applied.



The interactive acetochlor map can be accessed through the Dakota County agriculture program pages (www.dakotacounty.us and search "acetochlor" or "agriculture") and is a collaborative project between University of Minnesota Extension – Dakota County, Dakota County Office of GIS, and Water Resources Department.

Nitrogen Management Studies in Irrigated Corn – 2008

With the help and support of local farmers and the Vermillion River Watershed Joint Powers Organization, the fertilizer nitrogen (N) rate studies were expanded to evaluate new technologies that help determine nitrogen needs of irrigated corn during the growing season. Two sites were established in 2008: One was located just south of Hastings on a loamy sand where corn was the previous crop. The second site was located in Hampton township near Cannon Falls on a silty clay loam soil where the previous crop was sweet corn.

Nitrogen rates and basal stalk nitrate concentrations

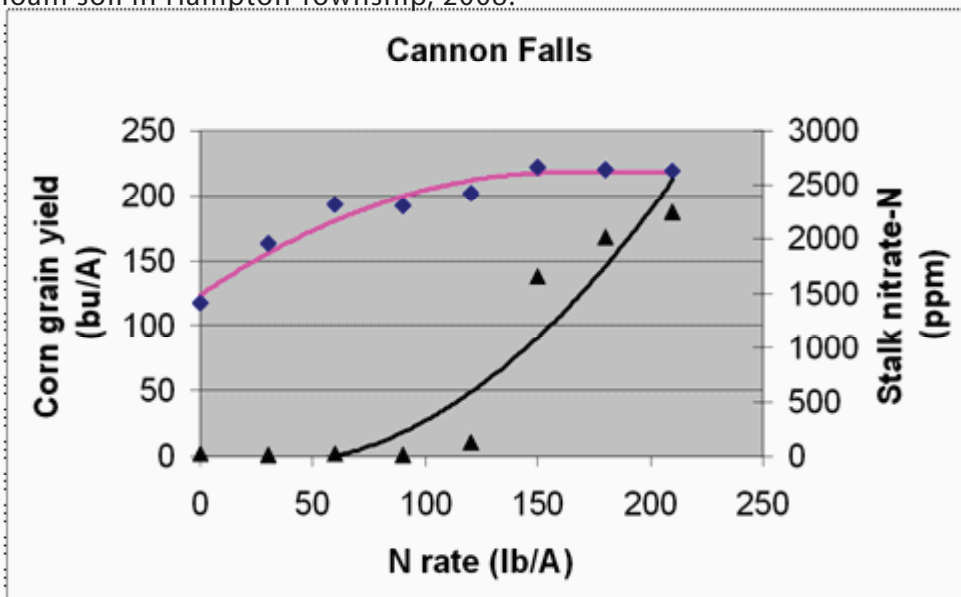
The studies continue to include an evaluation of nitrogen rates (0, 30, 60, 90, 120, 150, 180, and 210 pounds N per acre). In these treatments, urea was split-applied with the first application just after planting (5/13) and the second application one month later when the corn was 6-12 inches tall (6/13).

Corn yields (pink lines) and basal stalk nitrate-N concentrations (black lines) for both sites can be seen in Figures 1 and 2. At the Hampton

township site near Cannon Falls, the agronomic optimum N rate (AONR) of 162 pounds N per acre yielded 218 bushels per acre. Nitrogen rates above 162 pounds per acre did not result in additional yield at this site. Economic optimum N rates (EONR) take fertilizer N costs and corn price into account to calculate the most cost effective N rate. Subsequently, EONRs will be less than the nitrogen rates required to maximize yield (AONR). In these studies we used an EONR ratio of 0.15 (N cost per pound/corn price). The nitrogen rate that optimized return at this site was 141 pounds N per acre. It yielded 217 bushels per acre and fell within the new University of Minnesota guidelines.

Basal stalk nitrate-N concentration samples are taken close to harvest, so they serve as a post mortem report. Iowa State University suggests that levels between 700 and 2000 ppm indicate that nitrogen had been applied at an optimum rate. Levels above 2000 ppm would indicate that N had been applied in excess. At the Hampton township (Cannon Falls) site, the stalk nitrate concentration at the EONR (141 lb N/A) was just under 1000 ppm, well within the suggested optimum range.

Figure 1. Corn yields (pink) and basal stalk nitrate-N concentrations (black) at varying rates of nitrogen fertilizer on an irrigated silty clay loam soil in Hampton Township, 2008.

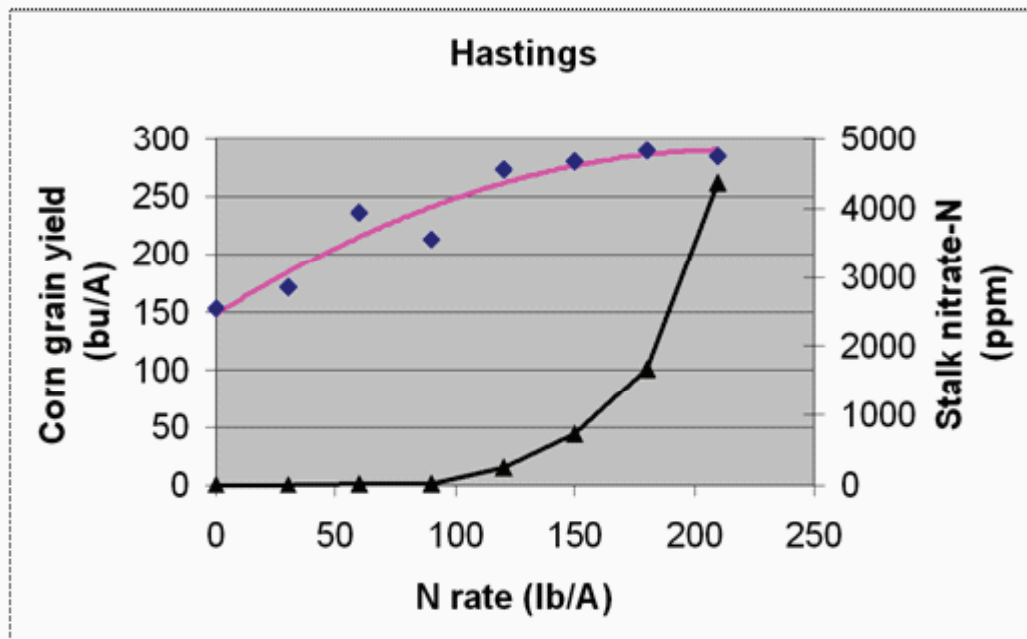


Yields were considerably higher at the Hastings site (Figure 2). The EONR of 193 pounds per acre yielded 289 bushels per acre. In addition, starter fertilizer and nitrate from the irrigation water brought the total N application to 230 pounds, a rate well above the current recommendations, but one that achieved exceptional yield. Since 2006, the majority of the N rate studies in irrigated corn on sandy soils (Dakota County and Becker, MN) support the new University guidelines. However, two sites this year, including this one, required more nitrogen than what is currently recommended. What was different this

year? Since the majority of sites support the recommendations, no changes are being made at this time. However, these studies will be repeated and the guidelines for irrigated coarse-textured soils will continue to be evaluated.

At Hastings, the average stalk nitrate-N concentration in the 180 pound N rate plots (slightly under EONR) was just under 2000 ppm, still within the optimum range. However, the stalk concentration spiked quickly above this rate and reached levels in the excessive range in the 210 pound N rate plots.

Figure 2. Corn yields (pink) and basal stalk nitrate-N concentrations (black) at varying rates of nitrogen fertilizer on an irrigated sandy soil near Hastings, 2008.



In-season sensors

The studies were expanded in 2008 to evaluate new technologies that help determine the nitrogen needs of corn during the growing season:

- “Spoonfeeding” – While this treatment did not use a sensing tool, our objective was to compare a simple split application (90 + 90 lb/A) to a treatment that mimicked fertigation with several applications from planting to the V13 stage. A total of 180 pounds of N was split into 6 applications of 30 pounds per acre each.
- SPAD meter – The relative greenness of corn leaves in the SPAD treatment was compared to corn in a non-N limited plot (210 pounds N per acre). Readings were taken at four vegetative stages and N applied to the SPAD plots when the readings were less than 95% of the 210 pound N per acre plots (Table 1).
- Greenseeker™ - This tool senses how much light is absorbed by the corn. The information is related to the crop’s biomass and can be used to calculate growth rates and N needs. Similar to the SPAD plots, readings were taken at four vegetative stages and N was applied when indicated by the reading.

2008 Roundup Ready Corn Weed Control Evaluations

| | Herbicide | Rate | Number of locations | | | | | | | | | | | | Yield | Cost | Returns | |
|---------------------|---|--|---------------------|-----|----------------|-----|---------------|-----|------------------|-----|----------------|-------|----------------------|-----|-------|------|---------|-------------|
| | | | Giant foxtail | | Common ragweed | | Giant ragweed | | Common cocklebur | | Tall waterhemp | | Common lambsquarters | | | | | Velvet-leaf |
| | | | 4 | 1 | 2 | 2 | 1 | 1 | 3 | 3 | 4 | 4 | 2 | 2 | 1 | 6 | | |
| | | product/A | % control | | | | | | | | | | | | bu/A | \$/A | \$/A | |
| Preemergence | | | | | | | | | | | | | | | | | | |
| 1 | Corvus | 5.6 oz | 81 | 75 | 97 | 41 | 72 | 77 | 84 | 99 | 138 | n/a | n/a | | | | | |
| 2 | Dual II Magnum / Hallex GT+ atrazine + NIS + AMS | 1 pt / 3.6 pt + 16 oz + 0.25% + 3 qt | 97 | 90 | 97 | 72 | 75 | 96 | 99 | 163 | 61.97 | 547 | | | | | | |
| 3 | Preemergence/POST II (V2 corn) | | | | | | | | | | | | | | | | | |
| | Balance Flexx / Laudis + MSO + 28% | 3 oz / 3 oz + 1% + 1.5 qt | 94 | 86 | 99 | 94 | 93 | 95 | 98 | 99 | 178 | n/a | n/a | | | | | |
| 4 | Harness / Ignite + AMS | 1.75 pt / 22 oz + 2 qt | 96 | 91 | 99 | 85 | 88 | 92 | 94 | 99 | 175 | 46.50 | 605 | | | | | |
| 5 | Harness / Laudis + MSO + 28% | 1.75 pt / 3 oz + 1% + 1.5 qt | 89 | 91 | 97 | 94 | 91 | 95 | 97 | 170 | 50.34 | 582 | | | | | | |
| 6 | Breakfree / Resolve Q + atrazine + Roundup PowerMax + AMS | 1 pt / 1.25 oz + 16 oz + 22 oz + 3qt | 94 | 88 | 95 | 90 | 90 | 94 | 99 | 172 | 54.57 | 589 | | | | | | |
| 7 | Harness / Roundup Weather Max + AMS | 1.25 pt / 22 oz + 3qt | 96 | 91 | 96 | 89 | 93 | 93 | 96 | 99 | 171 | 49.37 | 590 | | | | | |
| 8 | Lumax / Touchdown Total + AMS | 3 pt / 24 oz + 3 qt | 94 | 90 | 98 | 93 | 92 | 93 | 97 | 178 | 56.20 | 614 | | | | | | |
| 9 | SureStart / Durango + AMS | 1.75 pt / 24 oz + 3 qt | 95 | 90 | 99 | 93 | 98 | 93 | 97 | 177 | 47.27 | 619 | | | | | | |
| 10 | SureStart / Durango + AMS | 2 pt / 24 oz + 3 qt | 94 | 91 | 96 | 90 | 91 | 92 | 97 | 173 | 49.20 | 600 | | | | | | |
| 11 | SureStart + atrazine / Durango + AMS | 2 pt + 2 pt / 24 oz + 3 qt | 95 | 89 | 96 | 92 | 94 | 95 | 98 | 173 | 51.79 | 601 | | | | | | |
| 12 | Outlook / Roundup Weather Max + AMS | 12 oz / 22 oz + 3 qt | 94 | 90 | 96 | 87 | 98 | 92 | 94 | 173 | 51.13 | 598 | | | | | | |
| 13 | Outlook / Roundup Weather Max + Status + AMS | 12 oz / 22 oz + 2.5 oz + 3 qt | 94 | 90 | 97 | 91 | 90 | 91 | 96 | 172 | 54.47 | 586 | | | | | | |
| 14 | Harness / Impact + atrazine + MSO + 28% | 1.75 pt / 0.5 oz + 24 oz + 1% + 2.5% | 94 | 93 | 95 | 92 | 97 | 96 | 98 | 173 | 49.81 | 597 | | | | | | |
| 15 | Harness / Impact + atrazine + Roundup Weather Max + AMS | 1.25 pt / 0.5 oz + 16 oz + 22 oz + 3qt | 94 | 91 | 95 | 95 | 96 | 96 | 98 | 176 | 59.95 | 600 | | | | | | |
| | POST I (1" weeds) / POST IV (4"weeds) | | | | | | | | | | | | | | | | | |
| 16 | Roundup WeatherMax + AMS / Roundup WeatherMax + AMS | 22 oz + 3qt / 22 oz + 3qt | 99 | 94 | 99 | 98 | 99 | 99 | 97 | 177 | 50.60 | 616 | | | | | | |
| | POST I (V2 corn) | | | | | | | | | | | | | | | | | |
| 17 | SureStart + Durango + AMS | 1.75 pt + 24 oz + 3 qt | 93 | 89 | 88 | 67 | 91 | 95 | 96 | 165 | 40.27 | 580 | | | | | | |
| 18 | Hallex GT + atrazine + NIS + AMS | 3.6 pt + 16 oz + 0.25% + 3qt | 96 | 88 | 98 | 74 | 94 | 95 | 99 | 164 | 42.27 | 575 | | | | | | |
| | POST III (V3 corn) | | | | | | | | | | | | | | | | | |
| 19 | Require Q + atrazine + Roundup PowerMax + AMS | 4 oz + 16 oz + 22 oz + 3 qt | 95 | 87 | 99 | 96 | 95 | 91 | 99 | 173 | 42.09 | 605 | | | | | | |
| 20 | Resolve Q + Callisto + Roundup PowerMax + AMS | 1.25 oz + 1 oz + 16 oz + 3 qt | 94 | 85 | 93 | 91 | 98 | 89 | 97 | 172 | 39.80 | 602 | | | | | | |
| 21 | Steadfast Q + Impact + atrazine + MSO + AMS | 1.5 oz + 0.5 oz + 16 oz + 1% + 3 qt | 91 | 81 | 90 | 86 | 93 | 90 | 98 | 160 | n/a | n/a | | | | | | |
| 22 | Resolve Q + atrazine + Roundup PowerMax + AMS | 1.25 oz + 16 oz + 22 oz + 3 qt | 94 | 86 | 93 | 86 | 97 | 91 | 98 | 173 | 38.59 | 611 | | | | | | |
| | Checks | | | | | | | | | | | | | | | | | |
| 23 | Weedy Check | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 73 | 0.00 | 266 | |
| 24 | Weed-Free Check | - | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 177 | 0.00 | 668 | |
| | LSD (0.10) | | 2 | 4 | 4 | 6 | 13 | 3 | 2 | 10 | 38 | | | | | | | |

2008 Roundup Ready Soybean Weed Control Evaluations

Soybean price = \$9.00 / bu

| Herbicide | Rate | Number of locations | | | | | Velvetleaf | Redroot pigweed | Yield bu/A | Cost \$/A | Returns \$/A |
|--|---|---------------------|-----|-----|-----|-----|------------|-----------------|------------|-----------|--------------|
| | | 4 | 1 | 2 | 2 | 4 | | | | | |
| Preemergence / POST I (4-inch weeds) | | product/A | | | | | | | | | |
| 1 Boundary / Flexstar + Fusion + Harmony GT + MSO + 28% | 1.5 / 16 oz + 8 oz + 0.125 oz + 1% + 2.5% | 91 | 91 | 92 | 87 | 91 | 88 | 98 | 41.5 | 59.05 | 315 |
| Preemergence / POST II (6-inch weeds) | | % control | | | | | | | | | |
| 2 Authority First / Roundup Original Max + AMS | 3.2 oz / 22 oz + 3 qt | 96 | 91 | 99 | 99 | 99 | 95 | 99 | 45.1 | 56.89 | 359 |
| 3 Authority Assist / Roundup OriginalMax + AMS | 5 oz / 22 oz + 3 qt | 94 | 96 | 92 | 99 | 99 | 95 | 98 | 43.3 | 46.21 | 344 |
| 4 InRRo / Roundup Weather Max + AMS | 4 pt / 22 oz + 3 qt | 96 | 95 | 92 | 99 | 88 | 93 | 89 | 45.1 | 47.71 | 358 |
| 5 Gangster / Roundup Original Max + AMS | 2.4 oz / 22 oz + 3 qt | 96 | 94 | 99 | 99 | 98 | 96 | 97 | 45.1 | 49.70 | 357 |
| 6 Prefix / Touchdown Total + AMS | 2 pt / 24 oz + 3 qt | 98 | 95 | 91 | 99 | 94 | 92 | 87 | 44.8 | 46.09 | 357 |
| 7 Boundary / Touchdown Total + AMS | 1.5 pt / 24 oz + 3 qt | 96 | 97 | 97 | 99 | 91 | 92 | 93 | 43.9 | 48.37 | 347 |
| 8 Valor / Roundup Original Max + AMS | 2 oz / 22 oz + 3 qt | 94 | 96 | 96 | 99 | 96 | 94 | 89 | 46.2 | 44.90 | 371 |
| 9 Valor SX + Pytho / Roundup Original Max + AMS | 1.5 oz + 0.5 oz / 22 oz + 3 qt | 96 | 95 | 98 | 99 | 97 | 99 | 99 | 46.4 | 47.28 | 371 |
| 10 Valor SX + Sencor / Roundup Original Max + AMS | 1.75 oz + 4 oz / 22 oz + 3 qt | 94 | 93 | 96 | 98 | 95 | 97 | 97 | 46.6 | 47.72 | 371 |
| 11 Sonic / Durango + AMS | 4.5 oz / 24 oz + 3 qt | 97 | 95 | 99 | 99 | 99 | 97 | 99 | 47.0 | 49.80 | 373 |
| 12 Enlite / Roundup PowerMax + AMS | 2.8 oz / 22 oz + 3 qt | 96 | 96 | 97 | 98 | 98 | 95 | 99 | 46.8 | 47.79 | 373 |
| 13 Enlite / Roundup PowerMax + Harmony + AMS | 2.8 oz / 22 oz + 0.125 oz + 3 qt | 96 | 95 | 98 | 99 | 97 | 97 | 99 | 46.9 | 50.09 | 372 |
| POST I (4-inch weeds) / POST III (Canopy) | | | | | | | | | | | |
| 14 Roundup Weather Max + AMS / Roundup Weather Max + AMS | 22 oz + 3 qt / 22 oz + 3 qt | 99 | 98 | 99 | 99 | 99 | 98 | 99 | 44.5 | 50.60 | 349 |
| 15 Durango DMA + First Rate + AMS / Durango DMA + AMS | 24 oz + 3 qt / 24 oz + 3 qt | 99 | 98 | 99 | 99 | 99 | 98 | 99 | 44.8 | 51.82 | 351 |
| 16 Touchdown Total + AMS / Touchdown Total + AMS | 24 oz + 3 qt / 24 oz + 3 qt | 99 | 98 | 99 | 99 | 99 | 98 | 99 | 44.2 | 48.57 | 349 |
| POST II (6-inch weeds) | | | | | | | | | | | |
| 17 Classic + Roundup PowerMax + AMS | 0.33 oz + 22 oz + 3 qt | 95 | 96 | 90 | 97 | 94 | 91 | 91 | 41.9 | 33.36 | 344 |
| 18 Harmony GT + Roundup PowerMax + AMS | 0.5 oz + 22 oz + 3 qt | 94 | 94 | 92 | 99 | 91 | 92 | 79 | 41.1 | 38.78 | 331 |
| 19 Harmony GT + Classic + Roundup PowerMax + AMS | 0.5 oz + 0.33 oz + 22 oz + 3 qt | 95 | 97 | 93 | 99 | 90 | 93 | 96 | 41.1 | 43.35 | 332 |
| 20 Resource + Roundup Original Max + NIS + AMS | 2 oz + 22 oz + 0.25% + 3 qt | 92 | 94 | 74 | 97 | 88 | 80 | 81 | 39.7 | 32.27 | 325 |
| 21 Cadet + Roundup Original Max + NIS + AMS | 0.4 oz + 22 oz + 0.25% + 3 qt | 93 | 96 | 76 | 99 | 86 | 94 | 79 | 38.1 | 32.99 | 310 |
| 22 Roundup WeatherMax + AMS | 22 oz + 3 qt | 93 | 95 | 87 | 99 | 83 | 92 | 74 | 39.5 | 30.30 | 325 |
| Checks | | | | | | | | | | | |
| 23 Weedy Check | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8.7 | 0.00 | 85 |
| 24 Weed-Free Check | - | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 44.0 | 0.00 | 429 |
| | LSL (0.10) | 2 | 3 | 4 | 2 | 5 | 4 | 10 | 2.4 | | 22 |



Table 1. Time of nitrogen applications for sensor and comparable rate treatments for studies in Hampton Township and Hastings, 2008.

| | Time of nitrogen application | | | | | | Total N |
|------------------------------|------------------------------|-----------|----|----|-----|-----|---------|
| | Planting | Sidedress | V6 | V8 | V10 | V13 | |
| Hampton Twp. | pounds N per acre | | | | | | |
| "Spoonfeeding" 180 lb N/A | 30 | 30 | 30 | 30 | 30 | 30 | 180 |
| | 90 | 90 | | | | | 180 |
| SPAD meter 120 lb N/A | 30 | 30 | | 30 | | 30 | 120 |
| | 60 | 60 | | | | | 120 |
| Greenseeker 150 lb N/A | 30 | 30 | 30 | | 30 | 30 | 150 |
| | 75 | 75 | | | | | 150 |
| Hastings site | | | | | | | |
| "Spoonfeeding" 180 lb N/A | 30 | 30 | 30 | 30 | 30 | 30 | 180 |
| | 90 | 90 | | | | | 180 |
| SPAD meter 120 lb N/A | 30 | 30 | 30 | 30 | | | 120 |
| | 60 | 60 | | | | | 120 |
| Greenseeker 90 lb/ N/A | 30 | 30 | | | | 30 | 90 |
| | 45 | 45 | | | | | 90 |

Yields for the checks and all of the paired treatments listed in Table 1 can be seen in Figures 3 and 4:

- Spoonfeeding – There was no advantage at either site for the spoonfeeding treatment compared to the 180 pound N rate plots.
- SPAD meter – At both sites, SPAD readings called for a total of 120 pounds of N, but application times differed. At the Hastings site, where all of the applications were completed by V8, there was no advantage to the SPAD treatment over the 120 pound N rate plot. However, there seemed to be a slight advantage for the SPAD treatment at the Hampton site, where SPAD readings called for later applications at V8 and V13.
- Greenseeker™- Sensor readings resulted in very different application rates at the two sites. In Hampton township, readings called for a total of 150 pounds N per acre, while only 90 pounds N were applied at the Hastings site. There was no yield advantage in using the Greenseeker™ in Hampton township. In Hastings, however, the Greenseeker™ plots yielded 256 bushels per acre compared to 214 bushels in the 90 pound N per acre plots. Even so, yield and return over N costs for the Greenseeker™ treatment were significantly less than yield and return at the economic optimum N rate (256 vs 289 bu/A; \$979 vs. \$1060/A at \$4/bu, \$0.50/lb N).



Figure 3. Corn grain yields for sensor and comparable nitrogen rate treatments at the Hampton township site, 2008.

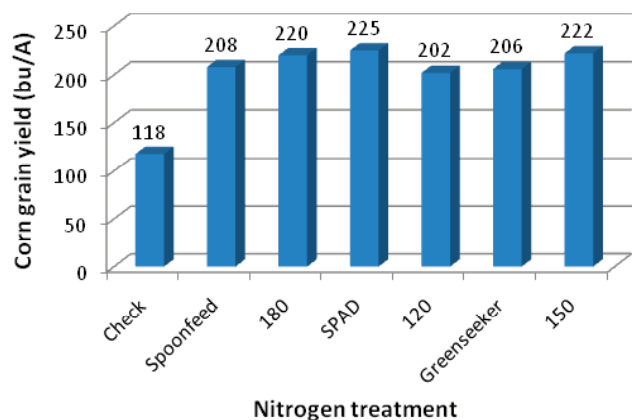
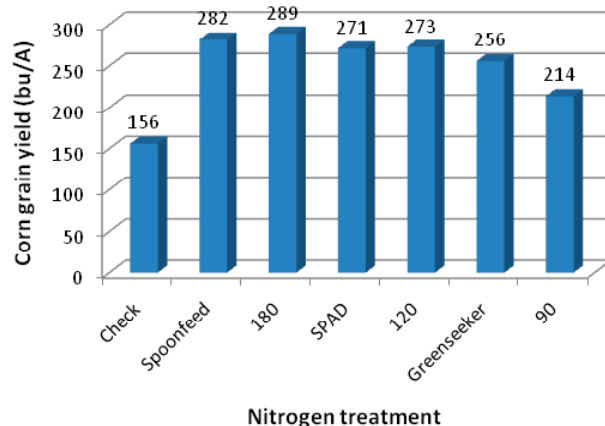


Figure 4. Corn grain yields for sensor and comparable nitrogen rate treatments near Hastings, 2008.



The use of sensor technology is still in its early stages in Minnesota. While results from this first year were somewhat inconsistent, they did show some potential for increasing efficiencies in irrigated corn. This study will be repeated at two locations in the County in 2009.

2008 University of Minnesota Weed Control Evaluations

The University of Minnesota Applied Weed Science research team evaluates both conventional and Roundup Ready® weed control systems in corn and soybeans each year. Weed control, crop injury potential, economic return and performance consistency were evaluated in 2008 at several locations. The newsletter insert includes averaged results for weed control, yield and economic return for several different application systems over the locations. Yields and returns that are highlighted in yellow are not statistically different from each other (returns based on \$3.74/ bu corn, \$9.00/bu soybeans, and takes into account herbicide, applicator and Roundup Ready® seed costs). Several different preemergence (PRE) and postemergence (POST) application combinations were included in the trial for both crops:

- Corn systems
 - PRE (only)
 - PRE + POST I (V2 corn)
 - PRE + POST II (V4 corn)
 - POST I (1" weeds) + POST IV (4" weeds)
 - POST I (V2 corn)
 - POST III (V3 corn)

- Soybean systems
 - PRE + POST I (4" weeds)
 - PRE + POST II (6" weeds)
 - POST I (4" weeds) + POST III (Canopy)
 - POST II (6" weeds)

In corn, the greatest economic returns occurred in the preemergence + post application systems at the V4 corn stage, the 2-pass Roundup treatment and the single-pass Roundup tank-mixes at the V3 corn stage. Previous research has suggested that the best use of glyphosate in corn is in a PRE + POST system or in a two-pass system. Since corn is more sensitive to early season weed pressure than soybeans, relying on a one-pass system may be risky if weather or workloads delay applications. In soybeans, the greatest returns were in the PRE + POST II system and the two-pass glyphosate system.

Glyphosate performance issues

While glyphosate is a powerful herbicide, there were several reports of poor performance around the state in 2008, especially in soybeans. According to the University's weed science team, the most frequently reported problems were with giant and common ragweed, tall waterhemp, common lambsquarters and barnyardgrass. The causes are hard to nail

down with certainty and may have been due to poor application techniques or timing, the environment, late weed flushes or herbicide resistance. If glyphosate applications tend to fail on the same weeds in the same area of a field for several years, glyphosate resistance may have developed. Giant and common ragweed and tall waterhemp have demonstrated resistance at 4X and even up to 8X glyphosate rates in parts of Minnesota. On the other hand, poor control of common lambsquarters and barnyardgrass is more likely due to poor timing or environmental causes.

Recommended practices for increasing glyphosate performance

The following practices are recommended to help increase glyphosate performance consistency, decrease the risks associated with poor timing and environmental issues, and to slow the selection of glyphosate resistant weeds:

- **Increase herbicide chemical diversity** in corn and soybeans. Rotating among herbicides with different modes of action will help delay the development of herbicide resistance in weeds. Consider adding a preemergence herbicide to your program or using different tank mix partners. To help identify herbicides with different modes of action, University of Wisconsin-Extension has published a Corn and Soybean Herbicide Chart that groups herbicides by their effect on plant growth (mode of action). The herbicide chart can be found at www.glyphosateweeds crops.org and is a great resource. I also have a few printed copies available at the Extension Office.
- **Increase use of residual herbicides.** There are several advantages to increasing the use of pre-emergence herbicides:
 - Adds flexibility for timing of postemergence applications
 - Improves control of weeds that are more difficult to control with glyphosate and with weeds that emerge over an extended period of time
 - Provides other modes of action to help reduce development of herbicide resistance

There are also risks with using preemergence herbicides:

- Requires rainfall for activation
 - Potential for crop injury when conditions are cold and wet
 - Potential for limits on crop rotation. The following examples are crop rotation intervals (CRI) for a few soybean herbicides:
 - Gangster®: 18-month CRI for potatoes and sweet corn
 - Sonic®/Authority First®: 18-month CRI for potatoes and sweet corn
 - FirstRate®: 18-month CRI for potatoes and sweet corn
 - Potential label limits for application on coarse-textured soils. In the 2008 University corn evaluations, a majority of the applications in the PRE + POST II (V4 corn) group included herbicides that have application restrictions on coarse-textured soils where the groundwater is shallow. These include Harness®, Breakfree® and SureStart® which contain aceto chlor and a related herbicide, Outlook®, which contains dimethenamid. For a more complete discussion on application restrictions for aceto chlor, please see the related article in this newsletter.
- **Consider alternating** Roundup Ready® crops with LibertyLink® technology or a conventional hybrid or variety. In contrast to glyphosate herbicides, Ignite®, a new formulation of glufosinate, and Liberty® are not readily translocated in the plant. As a result, they are only effective on small annual weeds (3" to 6" maximum height), so pre-emergence herbicides are highly recommended with any LibertyLink® soybeans.
 - **Scout fields** 10-14 days after the first glyphosate application to detect any weed escapes. If weeds survived, try to determine why. Consider poor weather, misapplication, poor timing or later weed flushes, then address the problem while there is still time.

The best weed control strategies will take into account weed species and density, weed emergence patterns, any "chronic" problem weeds, and crop rotation. While glyphosate herbicides continue to provide broad spectrum control with minimal crop injury, maintaining its effectiveness in the long run will require a diversified approach.

Additional Resources

Several related publications are available through the Dakota County Extension Office and online at www.soils.umn.edu/extension/extension_publications.php:

- FO-3790-C *Fertilizing Corn in Minnesota*. 2006. University of Minnesota Extension
Best Management Practices for Nitrogen Use on Coarse-textured Soils in Minnesota. 2008. University of Minnesota Extension. www.extension.umn.edu/distribution/cropsystems/DC8556.pdf.
Best Management Practices for Nitrogen Use in Southeastern Minnesota. 2008. University of Minnesota Extension. www.extension.umn.edu/distribution/cropsystems/DC8557.pdf.
Best Management Practices for Nitrogen Use in Minnesota. 2008. University of Minnesota Extension. www.extension.umn.edu/distribution/cropsystems/DC8560.pdf.
Corn Nitrogen Rate Calculator. Iowa State University. <http://extension.agron.iastate.edu/soil-fertility/nrate.aspx>

University of Minnesota Applied Weed Science Research website
(<http://appliedweeds.cfans.umn.edu>)

Glyphosate, Weeds and Crops website (www.glyphosateweeds crops.org) for publications:

- Corn and Soybean Herbicide Chart - Mode of Action
- Facts about Glyphosate Resistant Weeds
- Understanding Glyphosate to Increase Performance
- Biology and Management of Common Lambsquarters

The information given in this publication is for educational purposes only. Reference to commercial products or trade names is made with the understanding that no discrimination is intended and no endorsement by the University of Minnesota Extension is implied.