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Developing a sound, early season weed management strategy in corn

Weed management

The term weed management is often used incorrectly. Many believe this term to mean total control of all weeds within a field. More correctly, weed management is the manipulation of the weed and/or its environment to facilitate a desired outcome, which would be a maximum economic yield. Total weed control is not necessary to accomplish this goal. In corn, controlling weeds from the 3rd to the 10th leaf stage is most critical. Weed control during this time will have the greatest effect on yield while control before or after should not significantly affect yield. Understanding this allows producers to choose a method that best suits their purposes.

Preemergence

Controlling weeds before crop emergence is a sound strategy. Reducing the amount of weed (Continued on page 23)

Herbicide options increase for Roundup Ready soybeans

In March Zeneca and Monsanto reached an agreement that will affect many Nebraska producers this year. This agreement will pave the way for use of Touchdown over Roundup Ready soybeans, although currently Touchdown does not have a label for this application. Until recently, producers were not allowed to use Touchdown over Roundup Ready soybeans. Touchdown (sulfosate) is the Roundup (glyphosate) equivalent produced by Zeneca and has nearly identical plant activity. Both chemicals share the same site of action and will have primarily the same efficacy on various weed species.

Touchdown is sold in a 5 lb/gal formulation and is applied at roughly 80% of the Roundup Ultra rate which is sold in a 4 lb/gal formulation. Like Roundup, Touchdown is a non-selective, non-residual, foliar-applied herbicide with no soil activity. Touchdown has to be applied to Roundup Ready crops, as does Roundup Ultra. Many other brands of glyphosate will be available from various companies in the future.

Jeff Rawlinson, Extension Technologist, Weed Science
Several Extension educators and specialists witnessed excessive blowing soil in an area of central Nebraska this week. Traffic along Interstate 80 drove with their headlights on and slowed to 40 mph Tuesday due to reduced visibility from the dark ground cloud of soil.

Some producers were reported to be using emergency tillage to stop the erosion. The use of fall tillage which destroyed residue and left fields bare was cited as a major factor in the erosion.

Paul Hay, Extension educator in Gage County, noted: Man destroys the soil structure and the residue cover with tillage, then blames Mother Nature for the wind erosion and takes pride in using emergency tillage to salvage the situation. Stop the cycle of erosion and save your soil.

Noel Mues, Extension educator in Furnas County: Weather has been cooperative for field work activities and corn producers are becoming anxious, especially with temperatures in the 60s and 70s. Several producers are preparing to seed alfalfa. We made it through the army cutworm invasion, but many producers had to use insecticides on alfalfa and winter wheat. Winter wheat is in excellent condition and is responding to fertilizer applications, early March snow, and recent rainfall of about 1/2 inch. More moisture is needed for continued growth and development. Weather has been great for calving and other livestock operations.

Dick Ronnenkamp, Extension educator in Boone-Nance counties: Some recent snow has helped with surface soil moisture here. Even with the moisture, high winds are moving soil. Many fields will be subject to wind erosion this spring. Pastures and alfalfa fields are starting to green up. Many fields are ready to plant when the soil temperature warms enough.

Steve Pritchard, Extension educator in Platte County: Producers are taking to the fields this week. Many producers are cutting stalks, disking corn fields and applying anhydrous ammonia. A few oat fields were drilled this week.

Ralph Anderson, Extension educator in Buffalo County: Spring fieldwork has been going rapidly and many producers are just waiting for soil temperatures to warm so that they can start planting.

We continue to hear about army cutworms, but many producers are waiting to see if they are causing significant plant damage before they treat. When we compare the price of hay against the price of chemicals, many are willing to sacrifice a little yield. Wheat is in a similar situation, plus much of our wheat wintered well and may outgrow the cutworms.

Our topsoils are plenty dry and strong winds continue to pull out moisture. We have not had a really good rain since last fall. The situation is not critical, but will become critical if we don’t get moisture by mid April.

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Acid surface soils can cause nitrogen-deficient alfalfa seedlings

During the past few years, "freedom to farm" has permitted the planting of many new fields to alfalfa where alfalfa had not been grown for many years. Seedlings emerged, but they grew slowly and often looked yellow.

Most of these fields had an acid surface layer of soil, caused by years of tillage and fertilizing with nitrogen. This acid layer usually was only a few inches deep, but it was severe enough to prevent nodules from forming on the alfalfa roots. Alfalfa seedlings were unable to produce their own nitrogen and became nitrogen deficient and unthrifty.

Nodule formation on alfalfa roots declines as the pH drops below 6.5, and nodules don't form at all where the pH is 5.0 or lower.

Conventional soil tests that collect 8-inch deep cores are unable to identify surface acidity. Most subsoils in Nebraska are calcareous (pH>7.0). When the soil from an 8-inch core is mixed, the acid surface layer gets blended with soil deeper in the profile. If this deeper soil has a pH near 7.0 or above, the pH of the blend could be 6.2 or higher, suggesting that alfalfa will grow satisfactorily without amendments to alter soil pH. Roots of young seedlings, however, only experience the more acid conditions of the surface soil, inhibiting seedling growth.

Solutions

To avoid this problem, gather two types of soil samples — one at a normal eight-inch depth and another couple inches deep. Then have the lab analyze the normal sample with the usual tests for phosphorus, potassium, soil and buffer pH, organic matter and so forth. Test the shallow sample only for soil pH.

If the pH of the shallow sample is below 6.0, poor nodulation and slow seedling development is likely. The pH of this surface soil should be raised.

Lime

The preferred way to raise this pH is with lime. Normally, the recommended amount of lime is determined using the buffer pH. But seeding alfalfa into acid surface soils has two other factors affecting this recommendation — neutralization time and pH gradient in the soil. If the pH of the normal sample is above 6.2 and no more than a half point higher than the surface sample, growers have been successful using only about half the usually recommended amount. This assumes the subsoil will be close to a neutral pH of 7.0 and not need amending. Otherwise, use the full recommendation.

Unfortunately, it takes time for lime to neutralize pH. Regular ag lime, especially at half-rates, will not change pH as rapidly as desired if applied only weeks before seeding alfalfa. Thus, this is one situation where more rapidly active lime sources, like pelleted lime and liquified lime, might hasten changes in soil pH and more rapidly permit nodule formation on alfalfa roots.

Tillage

Another way to minimize surface lime acidity is deep tillage that mixes deep, calcareous soil with the acid surface soil. Only use this method if pH of the 8-inch sample is above 6.2; more acid soils need lime even when blended.

Nitrogen fertilizer

Neither lime nor tillage are good options on already established alfalfa. If seedlings show nitrogen

(Continued on page 26)
**Broadleaf weed response to selected herbicides in corn**

Plant response may be altered by growing conditions, genetic variation in crops and weeds, soil type, pH, organic matter and application rates. Ratings may vary from season to season and geographical areas within the state.

**Weed response ratings:** Ratings are for light to moderate weed populations, favorable conditions and weed growth stage as specified on the product label. High weed populations, adverse conditions, or large weeds will reduce control. 10—(96-100%), 9—(90-95%), 8—(85-89%), 7—(60-69%), 6—(70-79%), 5—(60-69%), 4—less than 60%, 1—0%.

### Soil applied herbicides

| Herbicide | AAtrex/Atrazine | Axiom | Axiom + Atrazine | Balance | Balance + Atrazine | Balance + Bicep II | Bicep II Magnum | DoublePlay | Dual II Magnum | Dual II Magnum + Bladex | Eradicane | Eradicane + Atrazine | Eradicane + Bladex | Extrazine II/Cypro AT | Frontier | Fultime | Guardsman/LeadOff | Harness | Harness Xtra | Hornet | Lariat/Bullet or Micro Tech + Atrazine | Micro Tech | Micro Tech or Dual + (Atrazine+ Bladex) or Extrazine II | Micro Tech + Bladex | OpTill | Prowl + Atrazine | Prowl + Bladex | Python | Surpass | Surpass 100 | Topnotch |
|-----------|-----------------|-------|------------------|---------|-------------------|-------------------|-----------------|------------|---------------|----------------------|-----------|-------------------|-----------------|----------------------|---------|--------|-----------------|--------|-------------|--------|---------------------|---------|---------------------|...............|--------|--------------|-----------|-------|--------|--------|---------|
| Plant     | 9 8 10 10 1     | 10 10| 1 9 9            | 9 7 7 7| 10 10 1 1       | 9 7 7 7           | 9 7 7 7         | 2 6-24     | 2 6-24        | 2 6-24               | 2 6-24    | 2 6-24            | 2 6-24          | 2 6-24               | 2 6-24  | 2 6-24 | 6-24            | 2 6-24 | 2 6-24      | 2 6-24 | 2 6-24               | 2 6-24 | 2 6-24               | 2 6-24        | 2 6-24 | 2 6-24      | 2 6-24 | 2 6-24 | 2 6-24 | 2 6-24 | 2 6-24 |

*Crop varieties vary in their response to herbicides. Crop safety ratings less than 3 indicate that crop yield should not be affected by direct injury.

*The recrop interval varies with herbicide rate, soil texture, pH, organic matter, rainfall or irrigation, and rotational crop.

* Ratings include a PRE grass herbicide.

*For use in a resistant/tolerant hybrid only.
Grass weed response to selected herbicides

Plant response may be altered by growing conditions, genetic variation in crops and weeds, soil type, pH, organic matter and application rates. Ratings may vary from season to season and geographical areas within the state.

Weed response ratings: Ratings are for light to moderate weed populations, favorable conditions and weed growth stage as specified on the product label. High weed populations, adverse conditions, or large weeds will reduce control.

<table>
<thead>
<tr>
<th>Weed Response</th>
<th>Barnyardgrass</th>
<th>Crabgrass</th>
<th>Fall Panicum</th>
<th>Foxtail</th>
<th>Sandbur</th>
<th>Shattercane/Sorghum</th>
<th>Shattercane, ALS-resistant</th>
<th>Crop Safety</th>
<th>Recrop Interval, in Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>10—(96-100%), 9—(90-95%), 8—(85-89%), 7—(80-84%), 6—(70-79%), 5—(60-69%), 4-2—less than 60%, 1—0%</td>
<td>5 1 1 1 6-24</td>
<td>4 2 7 5 1 1 1 6-24</td>
<td>9 9 9 9 7 6 6 2 0-4</td>
<td>9 9 9 9 7 6 6 2 6-24</td>
<td>7 7 8 5 5 5 2 6</td>
<td>9 9 9 9 6 6 4 4 2 6-24</td>
<td>7 6 6 8 5 4 4 2 2 6-24</td>
<td>8 9 8 9 5 5 5 2 6-24</td>
<td>9 9 9 9 6 4 4 2 6-24</td>
</tr>
</tbody>
</table>

Research update: How row spacing affects corn yields

Narrow row corn outyielded wide row corn at all populations and at the optimum nitrogen rate in two of three years of University field trials in northeast Nebraska. Interest in narrow row corn production is increasing regionally, and this research was designed to test it under Nebraska conditions.

Narrow row corn production can increase the corn plant’s use of light, moisture and nutrients. In addition, earlier canopy closure will provide for improved weed control. Converting to this system, however, will necessitate modifying planters and combines or buying new ones, an expensive venture. Any change in production practices should be based on an expectation of comparable increased profits.

Procedures

Research to determine to optimum population and nitrogen levels for 20- and 30-inch irrigated corn was conducted at the Haskell Agricultural Laboratory at Concord from 1996 through 1998. A 12-row planter, narrow row head combine, and lateral move irrigation system were used. Mark Langrud, a UNL graduate student, conducted the research while pursuing his Master’s degree and Charles Shapiro, UNL soil scientist, supervised it.

A split-split plot arrangement of treatments in three replications was used to compare 25,000, 30,000 and 35,000 plant populations in 20-inch and 30-inch rows with 0, 75, 150 and 225 lbs nitrogen per acre. A John Deere Max-Emerge eight-row planter was used for the 30-inch rows and a 12-row John Deere 7300 vacuum system was used for the 20-inch rows. The experiment was planted May 30, 1996, May 9, 1997,

(Continued on page 26)
Narrow row corn (Continued from page 25)

and May 5, 1998 with Pioneer 3394. Plots were 10 feet wide and 40 feet long. Nitrogen was applied as 34-0-0 on June 11, 1996, June 10, 1997 and May 19, 1998. The experiment was hand harvested by taking 40 feet of row, shelling and taking a moisture sample. All yields were adjusted to 15.5% moisture.

The research was conducted on a mix of two soils: Alcester silt loam (Cumulic haplustoll, fine-silty, mixed, mesic) and Kennebec silt loam (Cumulic haplustoll, fine-silty, mixed, mesic). Initial soil tests indicated that the experimental site had a pH of 6.7, organic matter of 2.5%, soil texture of silty clay loam, Bray #1 phosphorus 35 ppm, potassium 381 ppm and DTPA zinc 0.7 ppm. Soil nitrate varied each year. Nitrogen recommendations for 150-bushel per acre yield goal were based on soil nitrate were 80, 145, and 75 lbs nitrogen per acre in 1996, 1997 and 1998.

Results

Plant populations at harvest were lower than planted populations and target populations. Average harvest populations were 24,200, 26,900, and 31,000 compared to a target population of 25,000, 30,000 and 35,000, respectively. Populations varied from year to year. In 1997 populations averaged 24,000 compared to 29,000 and 30,000 in 1995 and 1996, respectively. The lower populations in 1997 were due to a long, cool May that reduced plant stands.

Narrow rows increased yield in 1996 and 1997 by nine bushels per acre. In 1998 there were no significant differences due to row spacing, but the yields were 164 and 168 bushels per acre for the narrow and wide rows, respectively. This is surprising since the narrow rows were expected to be more responsive in higher yielding years. Average yields were 30 to 40 bushels greater in 1998 than in the previous years.

Nitrogen rate increased yields in all years and in both row spacings. Statistical analysis showed no effect of row spacing on response to nitrogen. In 1996 the response to nitrogen was linear and did not reach a plateau. In 1997 yields were maximized in both row spacings at 150 pounds per acre. In 1998 yield was maximized at 75 lbs nitrogen per acre for the wide rows and 150 lbs per acre for the narrow rows. Over the three years there was a five-bushel advantage for the narrow rows compared to the wide rows.

Summary

Narrow rows tended to increase yields at all populations and at the optimum nitrogen rate. The three-year average increased yields by five bushels over all populations and nitrogen rates. Because desired populations were not achieved each year, no specific recommendations are made on population; however, the differences in yield for the populations we achieved were not great and indicate other factors may be more important than plant population once populations reach the 25,000 range.

Average yields were not affected by population. Our results indicated that the optimum row spacing

Effect of row spacing and year on yield (bu/acre).

<table>
<thead>
<tr>
<th></th>
<th>1996</th>
<th>1997</th>
<th>1998</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-inch</td>
<td>143</td>
<td>125</td>
<td>164</td>
<td>144</td>
</tr>
<tr>
<td>30-inch</td>
<td>134</td>
<td>116</td>
<td>168</td>
<td>139</td>
</tr>
</tbody>
</table>

Effect of rowspacing and nitrogen rate on yield (bu/acre).

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>75</th>
<th>150</th>
<th>225</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-inch</td>
<td>127</td>
<td>145</td>
<td>152</td>
<td>150</td>
</tr>
<tr>
<td>30-inch</td>
<td>119</td>
<td>142</td>
<td>148</td>
<td>146</td>
</tr>
</tbody>
</table>

and population were 20-inch rows planted at 25,000 plants per acre. The optimum nitrogen rates were not affected by population or row spacing and should be calculated based on expected yield goals.

Charles Shapiro
Extension Soils Specialist
Haskell Ag Laboratory, Concord

Acid top soil
(Continued from page 23)

deficiency, 50 lbs of nitrogen per acre usually will improve growth sufficiently to enable roots to penetrate into the deeper profile. Since the pH of this soil is likely to be closer to 7.0, some nodules will form and provide nitrogen to the plants. Total production probably will not reach its potential because nitrogen fixation is not as high from deep nodules as from nodules formed near the soil surface, but the stand will survive and produce "average" yields.

Inoculation

Also be sure to inoculate alfalfa seeds sown into soil that has not grown alfalfa recently. Use inoculum specific for alfalfa; fresh, pre-inoculated seed is best but adding inoculum at the planter box also is effective.

Bruce Anderson
Extension Forage Specialist

Calendar

Fertilize alfalfa. When: now.

Sample soil for nitrogen. When: now.

Fields with a manure history should be sampled in early April if you’re planning to use preplant nitrogen. Sample fields in late May or early June if you’re planning to side dress nitrogen. Samples can be sent to the University of Nebraska Soils Laboratory or to a private lab. Allow four to five days.
Below normal precipitation predicted through August; central Nebraska to be hardest hit

The latest long range forecasts give little hope for a return to normal or above normal precipitation in the immediate future for much of the High Plains. This is likely due to the extended effects of La Nina.

There is growing uncertainty whether the current La Nina will dissipate this summer or continue into next year. Closer to home, central, north-central, and south-central Nebraska are most likely to receive below normal precipitation through late July. The predictions indicate that the western and eastern thirds of the state will have a tendency toward below normal precipitation.

With corn planting three to four weeks away, precipitation will be a premium. Short range models indicate a fairly strong storm system will develop over the Central Plains this weekend. Eastern Nebraska should have the best chance of receiving significant precipitation. Dry conditions are expected through most of next week.

April and May represent two critical months for recharging soil profiles. Based on the 30-year normals, eastern Nebraska average daily precipitation is 0.10 inches during April and increases to 0.15 inches during May. Western Nebraska precipitation is slightly lower, averaging 0.08 inches in April and 0.12 inches in May.

Field observations and reports indicate that soil profiles are very dry across the western two-thirds of the state. Since the latter half of last years’ growing season was drier than normal, most of the recharge moisture is probably in the top three feet of the soil profile. If normal to above normal precipitation fails to materialize through the first month of the 1999 production season, deep profile moisture may be inadequate to sustain crop growth if an extended dry period develops this summer.

Producers may want to determine how much moisture is in their soil profiles before further planning of their cropping/planting/tillage strategies. They could submit a soil core to a lab for moisture analysis. You can get a rough estimate of available soil moisture by knowing how much precipitation has fallen in your given area since the end of last years crop growth.

The High Plains Climate Center conducted a soil moisture monitoring study during the late 1980s through the mid 1990s. Results indicated that between 60-70% of the precipitation that fell from the end of the prior years’ growing season to the beginning of the current years’ growing season was captured in the soil profile. Simply stated, if 10 inches of precipitation fell during this period, 6-7 inches would be captured in the soil profile.

The only problem with this method is knowing how much moisture was in the profile at the end of last year’s growing season. If precipitation during the last two months of the growing season was less than 50% of normal, moisture reserves were probably depleted to less than 25% of their carrying capacity. If precipitation was above normal, soil profiles may have actually increased during the period.

On average western Nebraska receives 13-15 inches of precipitation during the growing season, while central Nebraska receives 15-17 inches of precipitation. If 80% of the precipitation is effective (not lost to runoff), that means that 12 inches of moisture would be available for crop growth based on receiving 15 inches of rain during the growing season. Adding the estimated soil moisture and effective rainfall will give an estimate of the moisture available for plant growth if normal rainfall occurs during the growing season.

If you know the water required to produce average yields, simply subtract the available moisture from this total to get your irrigation requirement. This total will need to be adjusted upward since some irrigation will be lost to evaporation. Also realize that these calculations assume normal precipitation. If below normal precipitation is forecast for the growing season, irrigation demands will need to be adjusted further upward.

Al Dutcher
State Climatologist
Agricultural Meteorology

Seasonal crop water use in Nebraska when water is not limiting.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Western</th>
<th>Central</th>
<th>Eastern</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>inches/year</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td>23-26</td>
<td>24-27</td>
<td>25-28</td>
</tr>
<tr>
<td>Soybean</td>
<td>20-22</td>
<td>21-23</td>
<td>22-25</td>
</tr>
<tr>
<td>Sorghum</td>
<td>18-20</td>
<td>19-22</td>
<td>20-23</td>
</tr>
<tr>
<td>Winter wheat</td>
<td>16-18</td>
<td>16-18</td>
<td>16-18</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>31-33</td>
<td>32-35</td>
<td>34-36</td>
</tr>
<tr>
<td>Dry edible beans</td>
<td>15-16</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>
New herbicides, new labels

Several herbicide products were announced in 1998 for release in 1999 and other products scheduled for use in 1998 were labeled late and will be used for the first time in 1999. Many specific changes occur in herbicide labels throughout the year and will not be completely covered here. Refer to the 1999 Herbicide Use Guide, published by the University of Nebraska, for general information and the product label for more specific information.

Jeff Rawlinson, Extension Assistant Weed Science

**Action** (Label pending), Novartis
Mode of action: Cell membrane disruptor
*Fluthiacet methyl*
POST in corn and soybean
Application rate and timing: 1.5 oz/A, corn – 2-3 leaf to 48"; soybean – 1st trifoliate to full flower.
Controls broadleaf weeds on contact with excellent velvetleaf control
Positioned for tank mixing with other broadleaf herbicides that are weak on velvetleaf.

**Aim** (Labeled), FMC
Mode of action: Cell membrane disruptor
*Carfentrazone*
EPOST in corn
Application rate and timing: 0.33 oz/A to 8 leaf collar
Controls broadleaf weeds on contact. Excellent control of nightshade, lambsquarters, and velvetleaf. Tank mixed with Atrazine or Banvel/Clarity for enhanced broadleaf control.

**Authority** (Labeled), DuPont
Mode of action: Cell membrane disruptor
*Sulfentrazone*
PRE in soybean
Application rate and timing: 4-5.3 oz/A
For selective control of broadleaf and grass weeds with increased control of black nightshade and pigweed. Crop tolerance is good with only occasional injury on low OM soils under excessively cold, wet or compacted conditions.

**Balance** (Labeled), Rhone-Poulenc
Mode of action: Pigment inhibitor
*Isoxaflutole*
EPP, PRE in corn
Rate 1-3 oz/A
Controls velvetleaf, pigweed, nightshade, common ragweed, lambsquarters, smartweed, marestail, kochia and several annual grasses.
Usually tank mixed with a chloroacetamide or atrazine to broaden control. Bleaches weeds white as they emerge. “Recharge” potential on weeds up to 2 inches after .5 inch rain.

**Bicep Magnum TR** (Labeled), Novartis
Mode of action: Shoot inhibitor + photosynthetic inhibitor + ALS inhibitor.
*S-Metolachlor + Atrazine + Flumetsulam*
EPP, PPSP, PPI, PRE, POST in corn
Rate: 1.6 – 2 qt/a
Bicep Magnum TR is Bicep Magnum with the active ingredient in Python, providing additional control of triazine-resistant weeds such as TR lambsquarters and pigweed.

**Celebrity** (Labeled), BASF
Mode of action: ALS inhibitor + Growth regulator
*Nicosulfuron + Dicamba*
POST in corn
Rate: 6.67 oz/a
Celebrity is a premix of Celebrity B (Banvel) and Celebrity G (Accent) for grass and broadleaf control in corn. One 6.67 oz treatment of Celebrity contains 6 oz of Banvel and 0.67 oz of Accent.

**Distinct** (Labeled), BASF
Mode of action: Auxin transport inhibitor + Growth regulator
*Diclofop + Dicamba*
POST in corn
Rate: 4-6 oz/A
Excellent activity on broadleaf weeds with limited grass activity.

**EPIC** (Labeled), Bayer + Rhone-Poulenc
Mode of action: Shoot inhibitor + pigment inhibitor
*Flufenacet + isoxaflutole*
PRE in corn
Controls many broadleaf and grass weeds with good residual control.
Epic is a premix of flufenacet (the grass compound of Axiom) and Balance.

**EXPERT 75 DF** (Projected label 1999), Novartis
Mode of action: amino acid synthesis inhibitor
*Oxasulfuron*
POST in soybeans
Application rate: 1.5 oz/A
Controls cocklebur, marestail, common ragweed, smartweed, velvetleaf, and morningglory.

**Field Master** (Labeled), Monsanto
Mode of action: ALS inhibitor + shoot inhibitor + photosynthesis inhibitor
*Glyphosate + acetochlor + atrazine*
EPP, PRE in corn
Rate: 3.5 – 5 qt/A
A premix of Roundup + Harness Xtra for burndown of annual weeds up to 6" with broad residual control.

**First Rate** (Labeled), Dow AgroServices
Mode of action: ALS inhibitor
*Chlorantranil methyl*
EPP, PPSP, PRE, POST in soybean
Rate: SOIL – 0.6-0.75 oz/A
POST – 0.3 oz/A
Controls cocklebur, velvetleaf, smartweed, common and giant ragweed, pigweed, lambsquarters, and morningglory with soil applications and all of the above except pigweed and lambsquarters with POST application.
Tracing adult corn rootworm resistance

Reports of decreased adult rootworm control with foliar insecticides (particularly those with methyl parathion [e.g., Penncap-M] and carbaryl [e.g., Sevin and SLAM] as active ingredients) in south central Nebraska led to a series of studies beginning in 1994 which have documented the presence of insecticide resistant western corn rootworms near York and Holdrege. UNL entomologists, in cooperation with USDA-ARS scientists from the Northern Grain Insects Laboratory in Brookings, S.D., have been researching the distribution of resistant beetles in Nebraska and the underlying mechanisms responsible for resistance, and are developing management recommendations for areas with resistant corn rootworms. In the last issue of Crop Watch, research results and recommendations on the larval resistance situation were described.

Adult resistance

A bioassay was developed for methyl parathion that quickly identifies whether a rootworm population is resistant or susceptible. A minimum of 50 beetles are collected in the field and returned to the laboratory. Beetles (10 per vial) are placed in vials coated on the inside with a known concentration of methyl parathion. After four hours the beetles are checked for mortality. The dose will kill a high proportion of the population if it is susceptible and a low proportion if the population is resistant. Field

New herbicides (Continued from page 28)

LeadOff (Labeled), DuPont
Mode of action: Shoot inhibitor + photosynthetic inhibitor
Dimethenamid + Atrazine
PPI, PPS, PRE in corn and sorghum
For broadleaf and grass weed control. LeadOff is a mixture of the active ingredient in Frontier and atrazine.

Liberty ATZ (Labeled), AgrEvo
Mode of action: Amino acid synthesis inhibitor + photosynthetic inhibitor
Glufosinate + Atrazine
POST in Liberty Link corn
For broad spectrum control of broadleaf and grass weeds. Liberty ATZ A premix of Liberty + Atrazine (3 lb/gal) may be applied following any corn PPI or PRE herbicide application.

NorthStar (Not Labeled), Novartis
Mode of action: ALS inhibitor + Growth regulator
Primisulfuron + Dicamba
Rate: 5 oz/A
POST in corn
A premix of Beacon + Banvel/Clarity for selective broadleaf and some grass control in corn

Paramount (Labeled), BASF
Mode of action: Growth regulator
Quinclorac
POST in sorghum
For grass and broadleaf weed control in sorghum
Paramount was granted a crisis exemption label in 1998 and shows real promise for POST control in sorghum.

Python (Labeled), DOW AgroSciences
Mode of action: ALS inhibitor + Growth regulator
Flumetsulam
PP, PRE in corn and soybean
Rate: 0.8 – 1.25 oz/A
Controls broadleaf weeds similar to Broadstrike. Python is the same active ingredient as Broadstrike but is offered alone. Python will require grass herbicide tank mix.

Rave (Labeled), Novartis
Mode of action: ALS inhibitor + Growth regulator
Triasulfuron + Dicamba
POST in small grains
Rave is a mixture of Amber and Banvel/Clarity for broadleaf control in small grains

Starane (Labeled), UAP
Mode of action: Growth regulator
Fluroxypyr
POST in wheat, barley, oats, fallow and non-cropland
Use rate: 0.66 – 1.33 pt/A
Starane has shown very good control of kochia (including ALS-resistant bio-types) with good crop tolerance. Labeling for tank mixes with grass herbicides is anticipated.

IMI Wheat
Wheat genetically engineered resistant to imidazolinone herbicides such as Raptor. Expected around 2000

Turbo Magnum (Not labeled), Novartis
S-metolachlor + Metribuzin
PRE in soybeans
Use Rate: 1.75 – 2 pt/A
Turbo Magnum uses the resolved isomer of metolachlor with .05 lb more Sencor for grass and broadleaf control in soybeans.
Adult corn rootworm resistance
(Continued from page 29)

reports of poor adult control with insecticides have correlated well with 50% or less mortality in this laboratory bioassay.

Using this procedure, annual surveys have been conducted since 1996 to better understand the distribution of insecticide resistant rootworms in Nebraska. Figure 1 shows results from the 1998 survey. The four ranges of percentages shown in the figure refer to percent mortality after four hours when exposed to a uniform dose of methyl parathion in the laboratory. The potential for poor adult control in the field when using products or tank mixes that contain methyl parathion is highest in areas marked with a star or solid square (= 0-50% kill in bioassay).

Populations of highly resistant (0-25% mortality) beetles were found in Phelps, Kearney, Adams, Franklin, and Gosper counties in the west and Hamilton, York and Polk counties in the east. Sites in between Holdrege and York with populations of susceptible (76-100% mortality) beetles were found in Adams, Buffalo, Hall, and Clay counties. Based on the presence of susceptible beetles in between the two resistant populations and laboratory studies on the resistance mechanisms, we conclude that these two areas of resistance have developed independently. Since 1996, the proportion of methyl parathion tolerant beetles has increased in many locations and the geographic distribution of resistant populations has expanded, as documented by annual bioassay surveys and poor product performance in the field.

Management recommendations

People in the areas with documented resistance to insecticides by adult rootworms should consider the following options:

Crop rotation is highly effective in controlling rootworms in Nebraska and has the added benefit of not increasing the selection for insecticide resistance.
- Base the decision to use insecticides on the level of rootworms present in individual fields, based on adult scouting and economic thresholds. (See Western Corn Rootworm Soil Insecticide Treatment Decisions Based on Beetle Numbers, NebGuide G778)
  Where economic thresholds are exceeded:
  - Other foliar insecticides may be used in place of Penncap-M to avoid the adult resistance problem, however most options are more expensive than Penncap-M, do not provide the degree of residual activity, and may not control the same spectrum of pests.
  - Increasing gallonage of spray applications may provide better control with existing insecticides by providing better coverage of insecticides within the canopy. Labels for Penncap-M and Warrior recommend a minimum of 1 and 2 gallons spray volume per acre, respectively.
  - Avoid spraying too early for adult beetle control. Males begin to emerge before females and females require lay eggs about two weeks after emergence.
  - Soil insecticides are another chemical control option. Resistant rootworm larvae do not respond similarly to all organophosphate insecticides. Based on 1997 research at Holdrege, planting time applications of Lorsban, Counter and Aztec provided adequate levels of root protection against a moderate-heavy rootworm population at a location known to have adult resistance to methyl parathion and carbaryl
    - If using soil insecticides, do not use less than labelled rates for rootworm control.
  - Whether you use adult control or soil insecticides, do not use the same insecticide in a field over several years

People farming outside the resistance area should consider the following practices to decrease the potential for insecticide resistance in the future:
- Rotate some of your corn acres.
- Whether you use adult control or soil insecticides, do not repeatedly use the same insecticide in a field over several years.
- Base the decision to use insecticides on the level of rootworms present in individual fields, based on adult scouting and economic thresholds. (See Western Corn Rootworm Soil Insecticide Treatment Decisions Based on Beetle Numbers, NebGuide G778).

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