Considering Cover Crops?

Let this guide be your guide to cover crop success

Research Based Recommendations, Observations and Advice to Help Assure Success

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The observations and recommendations in this document are based on multi-year projects funded by the Illinois Nutrient Research & Education Council (NREC). The authors are the principal investigators and participants in the research. NREC continues to evaluate the establishment, management, economics and overall results of cover crops at multiple on-farm, field scale trials in corn-corn, corn-soy and corn-soy-wheat rotations.

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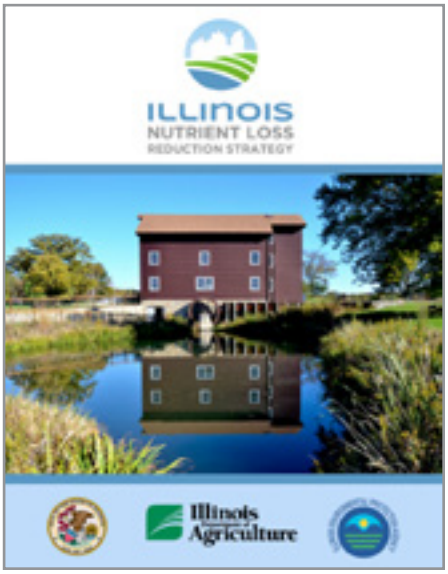
The Illinois Nutrient Research & Education Council (NREC) was created by state statute and is funded by a 75 cent per ton assessment on bulk fertilizer sold in Illinois. NREC supports nutrient research and education programs to ensure the discovery and adoption of practices that address environmental concerns, optimize nutrient use efficiency and ensure soil fertility. For more information on NREC go to ***www.illinoisnrec.org***

Why consider a cover crop?

The simple answer is that when properly managed, cover crops offer additional solutions to many of the agronomic challenges we face in our current production system. Cover crops can help reduce nutrient loss from tile drainage and overland runoff, reduce soil erosion, suppress weeds, increase water infiltration rates, contribute organic matter and provide grazing for livestock. Some of these benefits can be realized today and some over time.



Let's examine another obstacle impacting us all and where cover crops may fit in—the need to reduce nutrient losses. The Illinois Nutrient Loss Reduction Strategy (INLRS) calls for a 45% reduction in both nitrogen and phosphorus losses from current levels.

The Nutrient Research and Education Council (NREC) is looking for achievable AND profitable solutions to help Illinois' farmers meet the goals of the INLRS. Cover crops are one tool to integrate into our production system to help reduce nutrient losses. Research on managing cover crops on Illinois farms, as discussed in this guide, is demonstrating that they can reduce nutrient losses and also provide the benefits mentioned above.

Start small and establish a cover crop ahead of soybean

Started in 2014, continuing on-farm NREC research has demonstrated specific management practices that can make cover cropping successful on your operation. Most importantly, when cover crops precede a soybean crop, soybean yield has been maintained compared to replications with no cover crops. Therefore, we encourage you to first evaluate cover crops ahead of soybean before you consider using them ahead of corn.

This guide will take you through detailed, yet manageable steps to help ensure success when incorporating cover crops into your production system.

What type of cover crops work?

The Midwest Cover Crop Selector Tool at http://mccc.msu.edu/selector-tool/ is a nice resource that enables you to select a cover crop variety based on your state, county, planting date, soil characteristics and desired benefits. The simplest approach is to use a cover crop that winter kills, such as oats or an oat/radish mixture. But because these species die when temperatures reach the teens, many of their attributes are short lived, such as the ability to capture and hold nutrients into the following spring, when significant nutrient loss through field tiles can occur.

NREC recommends cereal rye – why?

For the purposes of this guide, we recommend using cereal rye (sometimes called winter rye but not to be confused with annual ryegrass). Cereal rye has been the focus of NREC research due to its ease of establishment, winter hardiness, and nutrient holding capacity in both fall and spring. It works well ahead of soybean. It is easy to terminate, helps reduce soil erosion, and suppresses weeds. Wheat or winter barley are also comparable options to consider. They produce less vegetative growth than cereal rye. While the focus of this guide is the management of cereal rye, the same principles can be utilized if you choose wheat or winter barley as your cover crop.

Important considerations when growing cereal rye ahead of soybean

Herbicides: Determine the field's corn herbicide program history to ensure that it is compatible with the seeding of cereal rye. We recommend you talk to your crop advisor and conduct an internet search of "herbicide rotation restrictions and cover crops" to learn more. Several common corn herbicides have a four month or less restriction, but some can exceed this. Dry summer conditions may also slow degradation of some residual herbicides and late applied post herbicides. If carryover concerns exist, hand seed and water a few square feet before your anticipated planting date and evaluate the growth.

Also, be mindful that you cannot make a fall herbicide application to control winter annuals if you want to establish a cover crop. Fortunately, a well-established stand of cereal rye can provide significant weed control, as shown in this photo taken in spring 2019. Read this Bulletin from Purdue for a good lesson on herbicide carry-over and cover crops: ag.purdue.edu/btny/weedscience/documents/covercropcarryover.pdf.

Photo taken Spring 2019 at the Douglas County NREC site. Burndown was delayed due to a wet spring. Butterweed population is greatly diminished by a fairly thin stand of cereal rye. Also noted was the lack of Horseweed (conyza canadensis) in the cereal rye versus the control.

Residue distribution at harvest: It's often said, *"A crop season starts with the residue coming out of the back of the combine."* Properly sized residue that is evenly spread across the full width of the area being harvested creates uniform field conditions. A mat of residue next to a strip of bare ground will make all aspects of management more difficult, whether it is establishing a cover crop, or managing the cash crop that follows.

Corn residue is evenly distributed over the field surface. This aids in even cover crop emergence and benefits other field operations, such as strip-till.

Planting date: You can plant cereal rye from early September through the first week of November. Typical corn harvest dates are quite compatible with this schedule. Unincorporated surface applications of seed should cease by the later part of October.

Planting Methods. You can use several techniques to successfully establish cereal rye. Planting and incorporation methods generally produce more uniform and predictable stands compared to aerial or surface applications. Let's review the most common planting options:

PRE-HARVEST SEEDING

Aerial seeding: Skilled pilots can uniformly broadcast cereal rye into standing corn. However, where needed, we advise you to establish up to a 100-foot buffer on the end rows or field boundaries to avoid off-target seed application. This will keep seed from falling into fields or areas where you (or your neighbor) don't want it. Seed germination from aerial applications is more consistent when these conditions are present:

1. Wait until corn dry-down has started and sunlight penetration on the soil surface reaches 50%.
2. Fly on seed when the soil is damp, and a substantial rain is likely in the near future. *"If it's dry, don't fly. If it's wet, you bet."*

Aerial Seeding of oats and radish into standing soybean prior to maturity.

High clearance applicator: You can apply cover crops into standing corn with a high clearance applicator equipped with a cover crop seeder. This method has proven very effective at several NREC research sites. Again, an open canopy from the crop drying down along with moist soil will create a better environment for stand establishment. Minimal corn will be damaged during the operation and usually only when the applicator turns. A grower's tolerance to seeing a bit of knocked down corn will vary.

High clearance sprayer with air seeder attachment. Drop tubes place the seed under the upper canopy. This works for both 30" corn and soybean rows with very little crop damage.

HARVEST SEEDING

Air seeder: A newer cover crop establishment method that shows promise is to mount an air seeder on your corn head or combine. Seed is dispersed while corn is being harvested, saving time and money. Eric Miller, an NREC farmer cooperator says, *"Our thought was, we have a machine that goes over every corn acre already. Let's utilize that asset. Plus, we're usually harvesting corn from mid-September through mid-October. That's a perfect time to establish our cereal rye cover crop."*

Here's how it works: Cereal rye is blown from the seed hopper through individual hoses mounted under each row snout, and scattered before crop residue is sized and deposited by the corn head. In-cab controls automatically adjust seeding rates based on ground speed, and start/stop the flow of seed when the corn head is lowered/raised. We recommend a seeding rate of 40 lbs./acre. Commercially available hoppers have capacities to hold up to 80 acres worth of seed. A seed tender is used for filling.

In addition to the air seeder attached to the corn head, a stalk devastator attachment is shown. The cover photo on this guide was seeded using this method.

POST-HARVEST SEEDING

Surface application with fertilizer: If you uniformly fertilize the field (no variable rate), cereal rye can be blended with the dry fertilizer. An air-flow machine is preferable to a spinner-spreader, but not required. You may need to consider making a light tillage pass, as surface residue can interfere with seed-to-soil contact, but success has also been achieved without this step. **Be Mindful** – complete cleanout of cover crop seed from a fertilizer applicator is necessary to prevent subsequent fertilizer applications elsewhere from unintentionally spreading cover crop seed.

Drill/planter: A no-till drill will generally produce a uniform, quick emerging stand. Research has also shown that 15" planters with row cleaners and the correct seed disc/plate perform very well. A corn head that sized stalks will help with material flow during these operations. A vertical tillage pass and then drill/planter pass can also be effective. Labor and machine costs need to be considered when using these methods.

A concept unique to drills or planters is they allow for precision cover crop planting. This method helps manage cover crop residue by creating defined paths for spring planting of your cash crop. The pictures below from Southern Illinois show cover crops seeded by adapting a drill to coordinate with 30" row spacings (left), and an operator who utilized a 15" row width planter that seeded the cereal rye, followed by a strip-till bar (right). These techniques require tractors with RTK guidance.

Vertical tillage tool with attached seeder: This is a similar concept to the combine/air seeder combination. A seed hopper with distribution tubing is mounted onto a vertical tillage tool. As you travel across the field, seeds are distributed and incorporated into the residue and soil.

Cereal Rye Seeding Rates ahead of Soybean*	
Drilled Seeding Rate:	40-60 lb./acre
Broadcast Seeding Rate with shallow incorporation:	40-70 lb./acre
Aerial Seeding Rate:	60-100 lb./acre
Seed Count:	18,000 seeds/lb.

Aerial application: This method of seeding can still be considered. To increase the level of success, a light vertical tillage pass should also be considered because the surface corn residue can interfere with seed-to-soil contact. Again, any aerial application should cease by the last several days of October, and should include a buffer around field edges or other boundaries to avoid seeding off-target areas. Aerially seeding will need moisture to germinate and become established.

Seeding rate: We encourage starting with the lower end of recommended seeding rates, especially for drilled/planted and harvest seeding methods. Also, earlier planting dates require less seed, as plants have additional time to allow for fall growth and tillering. The phrase *"one day of growth in September is equal to three days in October"* comes to mind. As you become more comfortable with cover crops, you can adjust your seeding rates based on your own experiences. Use the table above as a guide to determine the appropriate cereal rye seeding rate based upon your choice of seeding method.

**These rates are based on high-quality seed with germination rates of 85–98%. Based on fall growth and tillering, earlier planted rye (September) can use lower seeding rates than rye planted later in the fall (November). Seed cost and quality can vary significantly. Obtain quotes in the summer from 2-4 reputable suppliers. Seed is available in 50 lb. bags and mini-bulks.*

Reference: http://mccc.msu.edu/wp-content/uploads/2019/05/MCCC-105-IL-post-corn.pdf

TERMINATION OPTIONS & SOYBEAN PLANTING

Timing: Most growers will want to terminate cereal rye before planting soybean. Termination should occur a minimum of two weeks before anticipated soybean planting date. Err on the side of terminating early vs. too late. It is easier to manage (plant into) cereal rye if you terminate it when the plant is 6-10 inches in height, before the "boot" (stem elongation) stage. Be aware that with adequate moisture and warm conditions, cereal rye can double in size in 10 days.

Terminating with herbicide: A full label rate of glyphosate applied to actively growing cereal rye provides excellent control. An application made in March should not contain any additional herbicide active ingredients. If you intend to plant soybean within 2-3 weeks of termination, you can include a residual soybean herbicide with the glyphosate. Always consult your crop advisor to develop a complete, season-long herbicide program.

Planting into a standing cover crop: In the spring of 2019, when continuous rain kept many from being able to terminate cereal rye at the desired growth stage, some planted directly into the standing cover crop. We did this successfully at the Piatt County research farm. Others have decided to make this their standard practice in order to achieve maximum nutrient sequestration and weed control. Here are our suggestions and observations regarding planting into a standing cover crop:

Photo taken at Champaign County NREC site on March 19, 2017 when first termination occurred at 800 GDD.

Planting green into cereal rye with fall strips. This was the 3rd termination on April 14, 2017 in a corn/corn study at the Champaign County NREC site.

1. Apply a herbicide to kill the cereal rye a day or two before or after planting. This allows the cereal rye to remain upright and firmly attached to the soil to facilitate planting. If the cereal rye is killed several days before planting occurs, lodging can be an issue and may lead to a troublesome thatch that you must deal with.
2. Use a planter or drill with sharp disc openers to slice or slide through the plant material.
3. If you use a lower cereal rye planting rate, this will mean less vegetation to work through.
4. Scouting for pests, mainly army worms and slugs, is absolutely necessary.

Planting soybean in Spring 2019 at the Piatt County NREC site. The cereal rye received a herbicide application two days prior.

Terminating with Crimper: The use of a crimper is an alternative, non-chemical option to terminate cereal rye. To be effective, the cereal rye needs to be in the reproductive stage; this is because a roller "crimps" each elongated stem in several places. The flattened rye then creates a mulch on top of the soil. When crimping just ahead of planting soybean, the drill or planter pass should travel in the same direction as the crimper, with a compatible machine width. Available crimper sizes range from 10' to 40'. Crimping can also occur anytime immediately after planting through the V1 growth stage. A bulletin by Iowa State University is a helpful resource for management of this practice: https://crops.extension.iastate.edu/cropnews/2016/10/cereal-rye-suitability-roller-crimping-and-no-till-applications

Crimping cereal rye. Attachments are also available for the planter to perform this operation at planting time.

Remember: The establishment of your soybean crop always takes priority over attempting to reach a specific cereal rye growth stage before terminating the cover crop.

Management of armyworms, slugs or other pests: Removing the "green bridge" as demonstrated in the photo below, is the simplest method of pest control. Pests in cover crops can move to the emerging cash crop if there hasn't been enough time for the cover crop to deteriorate after termination. But if termination occurs a minimum of two weeks prior to soybean planting, the source of food and habitat for pests will diminish.

Voles can appear in cover crop and no-till environments. They eat all vegetation around their colony (generally 10-20 feet in diameter areas).

A resource from the University of Tennessee on controlling voles in no-till soybean is available here: https://extension.tennessee.edu/publications/Documents/PB1667.pdf

Cover crop roots impeding field tiles: This is extremely rare, and in nearly all cases that have been investigated, the issues thought to be attributed to the cover crop are actually related to on-going issues with the tile itself—it is either improperly installed, the grade is not correct or there are improper tile connections. However, if you experience any issues please contact Dr. Shalamar Armstrong, an author of this publication, to discuss the situation.

In this photo at the Douglas County NREC site, we terminated cereal rye at planting and planted corn into the strips made the previous fall.

TILLAGE CONSIDERATIONS FOR ESTABLISHING SOYBEAN FOLLOWING CEREAL RYE

How you manage your corn stalks in the fall, how you plant cereal rye and how you address soil preparation plays a VITAL role in determining the best soybean planting method.

There are several scenarios that work well and are described in this section. If you are trying one of these practices for the first time, pay attention to planter settings to achieve appropriate performance for the respective field conditions. Increased residue can influence planting depth and the closing of the seed slot.

Untouched corn stalks: In this scenario, plan to no-till soybean in the spring. Use well maintained drills and planters with sharp disc openers. Avoid no-till coulters if they pin residue in the seed slot or throw soil out of the furrow.

Row cleaners improve the seed zone, and those that float are preferred over fixed models. The goal is to push aside debris, not soil. This simple setup results in corn residue and cereal rye being pushed aside or penetrated.

Use closing wheels to firm soil around the seed. If they can also somewhat crumble the seed trench sidewall, that is a bonus. Normal seeding rates apply if equipment is performing well and soil conditions are fit.

Vertical tilled corn stalks: Again, most planters equipped with row cleaners, or no-till/minimum till drills can handle this planting environment. One vertical tillage pass is generally adequate, usually being made in the fall. If you determine that a fall and spring pass is beneficial, that is at your discretion.

Fall strip-tilled corn stalks: Simply plant soybean into the strips in the spring. Strip-till should be performed only on level, non-highly erodible fields. If your operation fits this description and you plant soybeans in 20” or greater row width, we highly recommend you evaluate strip-till. Our experience has been that this method of crop establishment provides benefits not just for a system that includes cover crops, but for overall residue and soil management.

Soybeans no-till planted into corn stalks.

Fall vertical tillage on corn stalks helps to incorporate cover crop seeding via fertilizer spreading, and removes winter annual seedlings.

The photo shows fall strips made in corn stalks..

Strip freshening: We continue to evaluate the use of strip fresheners. This tool features 30” spaced row units that incorporate a row cleaner, three low disturbance coulters, and a finishing basket to create shallow tilled strips approximately 10” wide. A freshener bar can be utilized in the fall, spring or both as a stand-alone tool. This bar can also be used in the spring on level fields that were strip-tilled the prior fall. Other row widths are also available.

Reduced tillage options: After soybean harvest, continue your rotation to corn, but consider reduced tillage options. Reduced tillage options discussed in this guide are also VERY compatible with corn production.

Fall tillage and incorporation of fragile soybean residue leaves a landscape vulnerable to soil erosion. Since phosphorus moves with soil, erosion is a conduit for nutrient loss. If we are going to maintain topsoil and reduce phosphorus losses to help meet the goals of the Illinois Nutrient Loss Reduction Strategy, we need to reduce tillage.

If your field has level to slightly undulating topography, and ideally soybean residue was spread evenly behind the combine, strip-till is again a great option. Where topography is more rolling, evaluate the use of no-till.

Several strip-till bar manufacturers offer machines with a multitude of options, sizes and configurations to accommodate your needs. There is base equipment that just builds strips, to complete set-ups that also perform deep placement of N, P and K. You can also consider hiring a custom operator if one is available in your area.

Ammonia toolbars for strip-tillage: If you want to evaluate strip-till on a trial basis, our advice is to start small, just like the philosophy with trying cover crops.

One option is making strips in the fall with an ammonia toolbar, whether you apply nitrogen or not. No additional fall tillage following soybean is needed. Note: Any dry fertilizer or lime applications should occur before the strips are made. Tractors pulling the ammonia toolbar and performing the spring planting pass should be RTK autosteer equipped. The level of repeatable accuracy will allow the planter to stay on the strip, which is priority #1. If winter annuals concern you, a cover crop or fall herbicide application may be warranted, but be sure to consult with a trusted crop advisor.

Strip freshener used on fall anhydrous ammonia applicator strips prior to spring corn planting. This was the only tillage pass and needs precision guidance such as RTK.

Fall anhydrous ammonia application using guidance to provide strips for planting in the spring. In the spring, use of a strip freshener with RTK guidance is recommended.

In the spring, you can plant directly into the strips, as they have mellowed over the winter. They can also be “scratched” lightly if you have access to a strip freshener, to create a more finished seedbed. Often this is not needed. A row cleaner on your planter that is set to remove any residue or clods, without throwing soil to the side, is helpful.

OTHER IMPORTANT CONSIDERATIONS

Economics of cover crops: New data provided by the Illinois Corn Growers Precision Conservation Management Program (PCM) provides information on investment and returns resulting from incorporating cover crops into soybean and corn production systems in Central Illinois from 2015-2018.

The PCM program found that the most profitable cover crop adopters, at least in the short term, are those who minimize seed and seeding costs for their cover crop applications. To view a table that shows costs and return on investment, access the PCM data analysis here: https://ilcorn.org/file/318/Cover%20Crop%20Fact%20Sheet-1.pdf

In the long term, farmers utilizing cover crops often report substantially greater profits (relative to non-cover cropped fields) resulting from increased cash crop yields. Their claim is fields become better able to withstand severe drought and storm events. As soil function and health improve, water infiltration and nutrient cycling improve. PCM continues to gather data on an annual basis and these concepts will continue to be documented and verified.

Moving to a "systems" approach: We've observed that the most successful experience with cover crops coincides with strip-till and no-till systems. It is important for everyone to realize that including cover crops in a conventional corn-soybean enterprise takes a "systems" approach to achieve real benefits. When cover crops have failed, it is often due to them being managed only as an additional input, rather than as part of a new production system. Modified production techniques for cash crops, as well as management of cover crops, are concepts that need to be embraced to assure success. We hope this guide makes that clear and understandable.

Cover crops ahead of corn: NREC research has revealed that nitrate losses in the fall and early spring from harvested soybean fields can be as problematic as nutrient losses from fertilized corn fields.

While this guide focuses on achieving success with cover crops ahead of soybean, NREC is also investigating how to successfully manage cover crops ahead of corn. The *"Illinois Cover Crop Recipe"* document is a beginner's guide for managing cover crops ahead of corn, starting with oats and radish. This document also contains tillage and fertility recommendations when considering cover crops ahead of corn and is available here: http://mccc.msu.edu/wp-content/uploads/2019/05/MCCC-106-IL-post-soybean.pdf

Fall Strips being made into a cereal rye cover crop at the Douglas County NREC site. P & K was broadcast early in the fall and the nitrogen was applied the following spring at planting and with a V3 side dress.

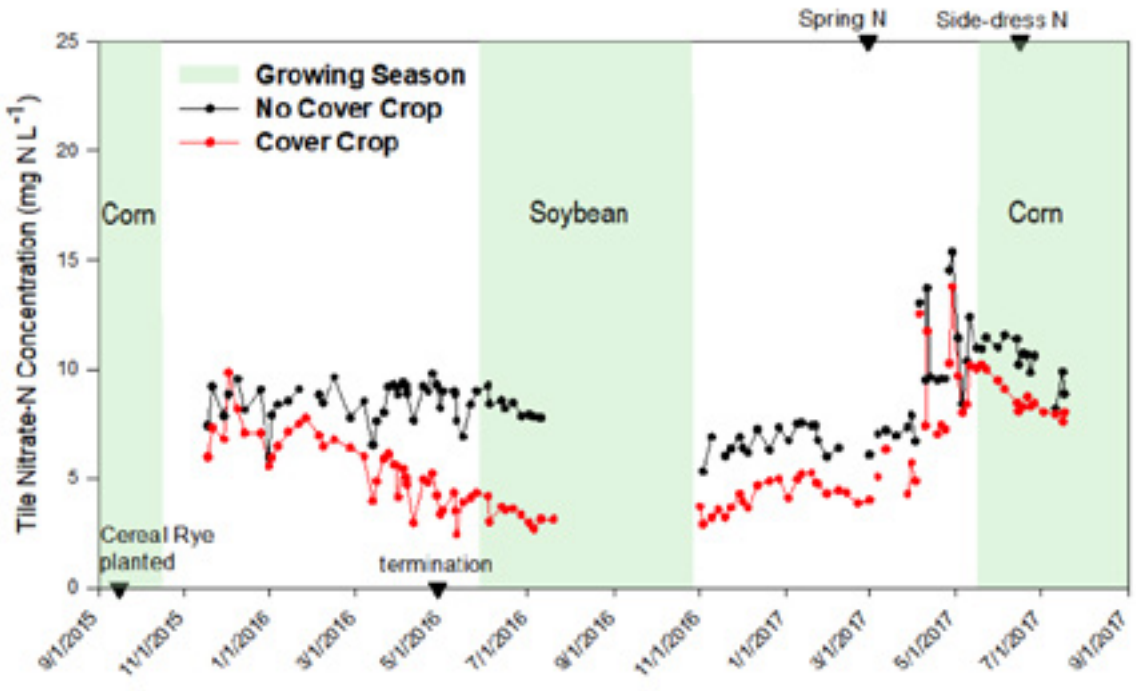
Do cover crops really reduce nutrient losses?

We know, and have proven, that water quality is impacted by nutrient loss. Nitrogen loss in our corn-soybean crop production system occurs via tile drainage. It's a "leaky" system. We also know that tile drainage helps improve crop yields by reducing the prevalence of saturated soils that impede plant development and nutrient uptake. Ultimately, the INLRS challenges us to balance the benefits of tile drainage with the need to reduce nutrient losses.

The graph in this section demonstrates the effect of a cereal rye cover crop in reducing tile nitrate concentrations. The federal drinking water standard for nitrate is 10 ppm on the left axis. Each dot on the graph represents the average of three plots (4 acres each) from our replicated tile drainage study in Douglas County.

All plots received the same amount of fertilizer N during the corn phase of a corn/soybean rotation (80 lbs. of N/acre as a pre-plant application of anhydrous ammonia and 80 lbs. of N/acre as a side-dress application of UAN). Cereal rye was aerially seeded into standing corn on September 16, 2015 and terminated with glyphosate on April 29, 2016. Above ground cereal rye biomass was 1.25 tons/acre; containing 32 lbs. of N/acre. The cereal rye cover crop reduced tile nitrate loads by 9 lbs./acre, a load reduction of more than 40% (22 lbs./acre from no-cover tiles vs. 13 lbs./acre from cover crop tiles). While 9 lbs./acre is a seemingly minor amount compared to total applied nitrogen, notice the much reduced concentration in parts per million.

This dataset also shows the beneficial carryover effect of the cover crop on tile nitrate concentrations through the next tile drainage season. A full year after the cereal rye was terminated, and a soybean crop was raised, tile N loads remained below those plots that had no cover crop.



Summary

One of the greatest challenges facing Midwest corn and soybean growers is the public (and governmental) expectation that we will measurably reduce nutrient losses to the environment. The benchmarks for reducing nutrient losses are established, and by 2025, the Illinois Nutrient Loss Reduction Strategy (INLRS) calls for a 15% reduction in nitrogen and a 25% reduction in phosphorus losses. Ultimately, USEPA and the INLRS call for a 45% reduction of both to meet the goals of the Gulf Hypoxia Action Plan. This is a huge challenge.

NREC was established to discover and encourage the adoption of practical, economically feasible and ultimately profitable methods to meet the environmental challenges facing Illinois agriculture. Nutrient management will get us part of the way, but ultimately an overall change in our cropping system will need to occur.

Using a cereal rye cover crop has proven to meet NREC objectives on several tile-drained farms in central Illinois that have previously been managed in a conventional corn/soybean rotation system. Cover crops work best in a production system that utilizes strip-till or no-till; reduced tillage also helps to reduce nutrient losses by reducing soil erosion during heavy rain events, and also enables the placement of nutrients into the strip — another method to reduce nutrient loss. This system is working, and we hope that you realize the benefits and will give it a try. Start small, get comfortable with it, ask for help (we are here for you) and you will achieve success. No one in agriculture wants to be regulated, therefore voluntary adoption of proven practices to reduce nutrient losses is paramount.

Let this guide be your guide to cover crop success.

This guide can be downloaded at http://illinoisnrec.org/ or email Julie Armstrong, NREC Executive Director at julie.armstrong@illinoisnrec.org to order printed copies.

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