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Pest&Crop newsletter

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In This Issue

Management Considerations for Tar Spot in Indiana

(Darcy Telenko)

In Indiana, tar spot has been an annual concern since 2018 when growers experienced 20-60 bu/A loss. This past season favorable weather conditions led to another severe epidemic where there are reports of fields experiencing 50% reduction in yields across the Midwest. Tar spot has continued to spread and has now been confirmed in 82 of 92 Indiana counties, 14 states, and Ontario Canada. As to say tar spot is a disease has become the number one topic in corn during our winter meetings.

Therefore, I am going to share some points on what we have learned and how to plan for this disease in 2022 and beyond.

My first question to a grower is how severe tar spot was on your farm in 2021? Did you find a few lesions (upper green leaf in Fig 1.) or was it severely blighted and covered with stromata (lower leaf in Fig 1)? In our research trials in central Indiana (West Lafayette), we saw limited tar spot impact. I can find the small black spots (stroma of the fungus), but it has yet to get above 1% severity. Gray leaf spot was our bigger concern. There were extremely dry/drought conditions across central Indiana in 2021 – where lack of water was a bigger concern than disease. If tar spot was not severe on your farm you won't get a return on investment (ROI) to manage it, but be aware, on the lookout, and prepared to make in-season decisions should the environment become favorable.

Figure 1. Severe tar spot causing blighting. Tar spot lesions (stromata) on corn leaves. (*Photo Credit: Darcy Telenko*)

If the farm saw severe tar spot, I suggest a few things for next year.

1. **Watch the tracking map to know when the disease is first active in Indiana**. I will worry about the disease staring early if we have a wet June and July like we did in 2021. Otherwise the disease won't appear to mid- to late- July. (https://corn.ipmpipe.org/tarspot/ or https://extension.purdue.edu/fieldcroppathology/)
2. **Download the Tarspotter app** to help with determining if the weather conditions are favorable for tar spot to develop in your fields. (https://ipcm.wisc.edu/apps/tarspotter/)
3. **Scout, scout, and continue to scout** your fields.
4. **Make informed fungicide decisions.** Only in 2021 did our research trials show a benefit of two application at V10/V14 with a follow up application 3 weeks later. We have seen severe disease every season in Porter County – yield impact will all depend on when the disease starts. In 2019 and 2020, we DID NOT see a benefit of a second fungicide application, that is why it is important to monitor and scout.
5. As for a fungicide timing window **VT-R2 has consistently provided good protection** with a single application program.
6. We need to make an informed decision on our fungicide use not only for ROI, but also for fungicide stewardship to make sure we aren't increasing risk for fungicide resistance to develop.
7. No, it will not be cost effective to apply fungicide every year. I suggest being flexible and it is important to understand how severe the disease was on your farm. Moisture plays a significant role in how fast tar spot develops.

A summary of what we have learned thus far.

Tar spot will continue to be an issue in Indiana

- Severity level will be a function of the hybrid, weather, and when epidemic initiates earlier vs. later in the season.
- The 2021 epidemic was problematic, because tar spot started in some fields before tasseling.
- Fungus driven by weather – a wet July in 2021 compared to 2019 and 2020.
- Varying levels of tar spot occur across region due to weather

The tar spot fungus can overwinter in the upper Midwest

- We now have high inoculum levels in many locations.
- Weather is key (water and irrigation management).
- Rotation may help a bit, not a sole solution.
- Tillage may help reduce or delay onset of disease (reducing residue).
- Tar spot inoculum (spores) can travel long distances.

Some hybrids are more resistant than others

- Strong hybrid resistance can be overcome by a favorable disease environment.

Fungicide application can reduce tar spot severity

- Product is important, use multiple modes of action (QoI + DMI or QoI + DMI + SDHI) (See resources for details on fungicide efficacy)

Timing very important

- Application needs to occur close to the onset of the epidemic
- Number of applications and optimal timing are going to vary by year.
- Tarspotter isn't perfect, but a valuable tool to help make the decision, and optimize, fungicide applications
- If just spraying once and not interested in prediction, VT-R2 has been most consistent timing in Indiana.

Understand your farm – what disease(s) are most of concern in each field.

What you can do?

1. Assess your risk – is the disease endemic in your area? Did you find it in your fields in 2021? If so, how severe did tar spot get at the end of the season?
2. Talk to your seed salesmen about hybrid resistance.
3. Scout and monitor your fields throughout the season.
4. Use these tools if you have fields at high risk and are going to apply fungicides.
    1. Fungicide efficacy tables and Extension research reports (see links below)
    2. Use the Tarspotter App to monitor for conducive weather conditions
    3. Follow the map to learn when tar spot is active new your county https://corn.ipmpipe.org/tarspot/
2. Leave check strips if you try a new management strategy.
3. Don't forget about the other diseases – new and established (gray leaf spot, southern rust, ear and stalk rots, etc.).

Resources:

Tar spot of corn: Impact and management options. PDF of Dr. Telenko's 2022 tar spot slide deck from winter meetings.

Purdue Field Crop Pathology Extension Website for in-season updates, the tar spot and southern rust maps and other resources.

Crop Protection Network: tar spot publications and web book.

Applied Research in Field Crop Pathology for Indiana – summaries of research trials in Indiana. (2021 data will be available Feb 1).

Tarspotter Apps

Which Residual Herbicide Should I Use for Waterhemp Control in Soybeans?

(Bill Johnson) & *(Marcelo Zimmer)*

One of the topics that we get many questions about is picking a residual herbicide for soybean production that helps with waterhemp control. This topic has even greater importance as we get closer to the 2022 growing season and the uncertainty about the supply of many of our commonly used postemergence herbicides, particularly glyphosate and glufosinate. When planning for this shortage, our most common message is to build your weed control program around a solid foundation of a residual herbicide, at a full labeled rate, so you can take some of the pressure off of your postemergence weed control tactics and reduce the reliance on glyphosate or glufosinate, particularly multiple treatments of these actives for protecting crop yields.

Since waterhemp continues to infest more acres in the eastern cornbelt, it has become more important to target this weed as a "driver weed" as we select soil residual herbicides for soybean. We have known for over 2 decades that there are a couple of active ingredients that have consistently provided good control of waterhemp, and have been positioned in the marketplace to go on those acres. These active ingredients include flumioxazin (Valor), sulfentrazone (Authority/Spartan), metribuzin (Sencor/Tricor), and the group 15 herbicides metolachlor (Dual), acetochlor (Warrant), pyroxasulfone (Zidua), and dimethenamid (Outlook). In addition, we know there are some other herbicides that have provided some control of waterhemp such as pendimethalin (Prowl), saflufenacil (Sharpen), fomesafen (one of the components in Prefix). However, with the proliferation of premixed herbicide products, and some of the confusing marketing campaigns that we see, it can be difficult to pick a residual herbicide that best fits each weed control scenario.

The purpose of this article is to share some of the results we have generated in our research program over the last several years regarding the efficacy of single active ingredient, and multiple active ingredient premix herbicide products for waterhemp control. To compile this data set, we went through all of our herbicide screening field trials and compiled the waterhemp control data. In each figure, you can see the waterhemp control provided by the specific herbicide and the number of observations that went into calculating the mean control for that herbicide. In some cases, we grouped a couple of herbicide rates together if they were reasonably close. Keep in mind we were not able to evaluate every single herbicide premix that might be available on the market. The criteria that we placed on including data in this set was at least four observations from a specific herbicide. Obviously, treatments with more data points included will provide a more reliable estimate of the treatment's efficacy over multiple environments, soil types, or years. The waterhemp population evaluated was resistant to ALS (Group 2) inhibitors and glyphosate (Group 9). The level of PPO herbicide resistance (Group 14) was somewhat variable but below 15%.

In Figure 1, we present data from single active ingredient treatments. The Pursuit treatment is included to provide readers with a baseline level of control with an ALS inhibitor compared to the other treatments on waterhemp that is ALS resistant. Sharpen herbicide at the 1 oz/A

rate typically provides good control for about 10-14 days, but then declines and waterhemp control by 28 days was less than 60%. Prowl and metribuzin herbicide provided control in the mid 70s. Metribuzin activity is very similar to what you would observe with Sharpen. Control is very good for about two to three weeks at the rates evaluated, then it starts to decline. Prowl, on the other hand, is much less water-soluble and the control values will hang around 70 to 80% for around four to six weeks. Control with Spartan, Valor, Outlook, Zidua, and Warrant was 90% or greater at 28 days after treatment.

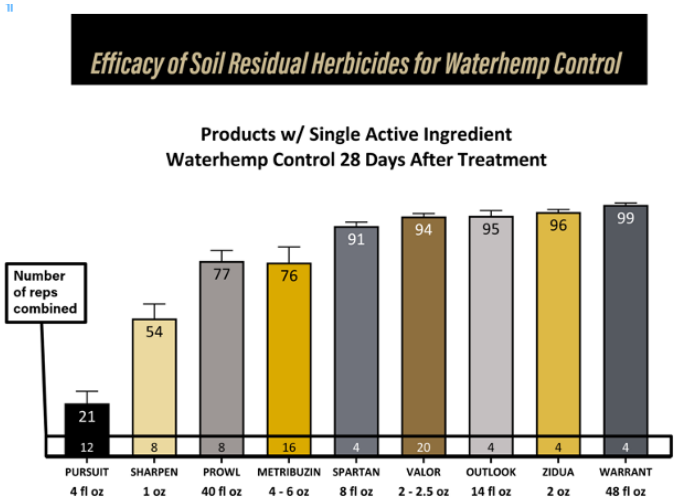

Figure 1. Waterhemp control with single active ingredient herbicides at 28 days after application.

In an effort to reduce some of the confusion around all of the herbicide premixes available, we broke up the data into smaller pieces by showing efficacy data for premixes containing flumioxazin (Valor), sulfentrazone (Authority/Spartan), metribuzin (Sencor/Tricor), and the group 15 herbicides in separate figures. As you view the figures for each of the active ingredients, we inserted the single product active ingredient rate in each premix in the bar for the specific treatment. This will help you sort out how much of each of these key actives are in the premixed product. To obtain the information on the other components in the premix, consult Table 1.

Table 1. Soybean herbicide premixes and equivalent reates of single active ingredient products.

Premix Product	Rate Of Premix Per Acre	Active Ingredients	Equivalent Rate of Single Active Ingredient Products
Anthem Maxx	4 oz.	Pyroxasulfone Fluthiacet	2.5 oz. of Zidua WG 0.55 fl. oz. Cadet
Authority Assist	10 oz.	Sulfentrazone Imazethapyr	8.33 fl. oz. Spartan 4F/ 3.35 fl. oz. Pursuit
Authority Elite	25 fl. oz.	Sulfentrazone S-metolachlor	4.38 fl. oz. Spartan 4F 1.3 pt. Dual II Magnum
Authority First	6.45 oz.	Sulfentrazone Cloransulam	8 fl. oz. Spartan 4F 0.6 oz. FirstRate
Authority MTZ	16 oz.	Sulfentrazone Metribuzin	5.75 oz. of Spartan 4F/ 5.75 oz. of Tricor DF
Authority Supreme	8 oz.	Sulfentrazone Pyroxasulfone	4.2 fl. oz. Spartan 4F 2.5 oz. of Zidua WG
Authority XL	8 oz.	Sulfentrazone Chlorimuron	10 fl. oz. Spartan 2.5 oz. of Classic
Boundary	32 fl. oz.	Metribuzin S-metolachlor	6.7 oz. Tricor DF 22.7 fl. oz. Dual II Magnum
Fierce	3 oz.	Flumioxazin Pyroxasulfone	2 oz. Valor SX 1.5 oz. Zidua WG
Fierce MTZ	16 oz.	Flumioxazin Pyroxasulfone Metribuzin	2 oz. Valor SX 1.5 oz. Zidua WG 4 oz. Tricor DF
Fierce XLT	4 oz.	Flumioxazin Pyroxasulfone Chlorimuron	2 oz. of Valor SX 1.5 oz. Zidua WG 1.07 oz. Classic
Prefix	32 fl. oz.	Fomesafen S-metolachlor	16 fl. oz. Flexstar 18 fl. oz. Dual II Magnum
Trivence	6 oz.	Chlorimuron Flumioxazin Metribuzin	0.94 oz. Classic 1.5 oz. Valor SX 3.5 oz. Tricor DF
Zidua PRO	6 oz.	Imazethapyr Saflufenacil Pyroxasulfone	4 fl. oz. of Pursuit 1 fl. oz of Sharpen 2 oz. Zidua WG

In Figure 2, we show the data for the flumioxazin (Valor) based premixes. Control is 94% or higher with Valor alone or any of the premixed products. The Trivence product contains metribuzin in addition to flumioxazin. The Fierce products also contain pyroxasulfone (Zidua). Therefore, all of these premixed products shown in Figure 2 contain at least two effective active ingredients with different modes of action for waterhemp control. Fierce MTZ premix contains three effective active ingredients with different modes of action for waterhemp control (flumioxazin, pyroxasulfone, and metribuzin).

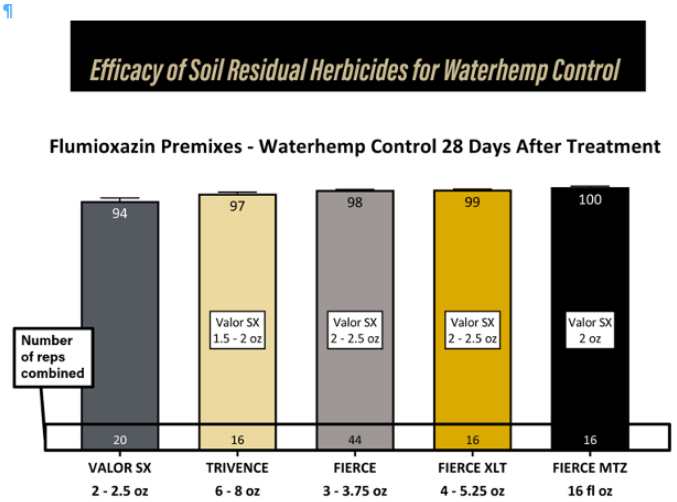

Figure 2. Waterhemp control with flumioxazin alone and premixed products at 28 days after application.

In Figure 3, we show the data for the sulfentrazone premixes. There are a LOT of Authority branded premixes to keep track of. The performance of these premixes has been very good with control values of 88% or higher. Ideally, you would pick one of these premixes that contains sulfentrazone (Spartan) plus a second active ingredient that is active on waterhemp. The premixes that DO NOT contain a second herbicide that works on waterhemp would be Authority XL (second active is chlorimuron), Authority First (second active is cloransulam), and Authority Assist (second active is imazethapyr). The other three Authority products contain a second active ingredient that works on waterhemp. Authority MTZ contains metribuzin, Authority Elite contains metolachlor, and Authority Supreme contains pyroxasulfone.

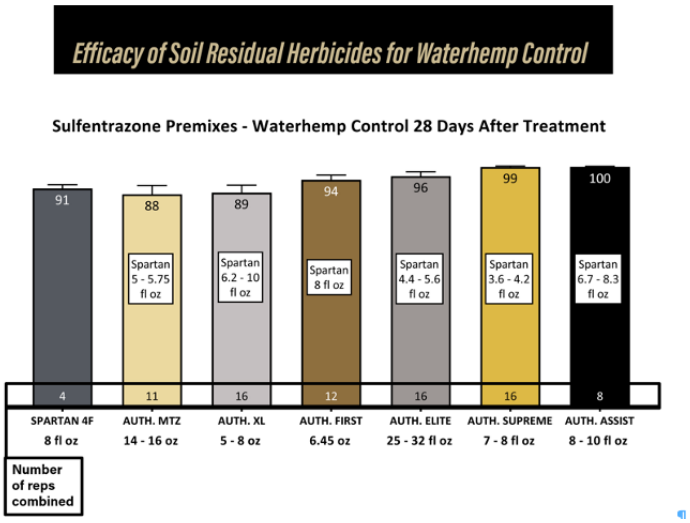

Figure 3. Waterhemp control with sulfentrazone alone and premixed products at 28 days after application.

In Figure 4, we show the data for metribuzin and a couple of metribuzin premixes. As mentioned above, metribuzin is very active on waterhemp for two to three weeks, then the control declines rapidly unless metribuzin rates are higher. At 28 days after treatment, 4 to 6 ounces of metribuzin alone provided control in the mid 70s. When combined with another herbicide that has activity on waterhemp as shown with all of the premixes, control is 88% or greater and probably reflects the control with the other active ingredient once we get to this 28-day rating. This is particularly evident with Trivence and Fierce MTZ since the metribuzin rates in these premixes are quite a bit lower than the Authority MTZ or Boundary products.

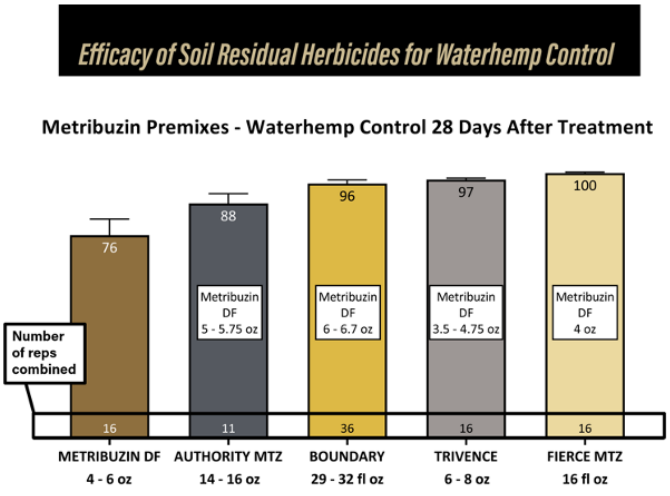

Figure 4. Waterhemp control with metribuzin alone and premixed products at 28 days after application.

In Figure 5, we show the data from herbicide premixes that contain Group 15 herbicides. As noted in Figure 1, all of the Group 15 herbicides provide acceptable control at 28 days after treatment. When combining a group 15 herbicide with a second mode of action that has activity on waterhemp, control is 93% or greater at 28 days after treatment. An important point though with the Group 15 herbicides is that they can be put on emerged soybeans. Group 14 herbicides like flumioxazin (Valor), sulfentrazone (Authority/Spartan), saflufenacil (Sharpen), and Group 5 herbicides like metribuzin, cannot be applied to emerged soybeans.

When planning a weed control program for soybeans, we recommend a broad-spectrum preemergence herbicide, followed by a postemergence herbicide program that contains a residual herbicide as well. Therefore, in most cases, it would be beneficial to use a Group 14 herbicide with metribuzin preemergence, and put on the Group 15 herbicide with your postemergence treatment. All of the group 15 herbicides alone, or the Prefix product, which contains metolachlor plus fomesafen, can be put on with the postemergence treatment. Many growers may avoid using group 14 herbicides at preemergence because of the potential for soybean injury. However, we strongly recommend using these active ingredients due to their high efficacy on waterhemp, long soil residual activity, and to reduce reliance on group 15 herbicides. To prevent PPO injury from occurring, always consult with your soybean seed dealer and purchase varieties that have a higher tolerance to the PPO herbicides. Also, target soybean planting dates when soil and weather conditions are fit (planting too early when soils are wet and cold increases the risk of herbicide injury and soybean seedling diseases).

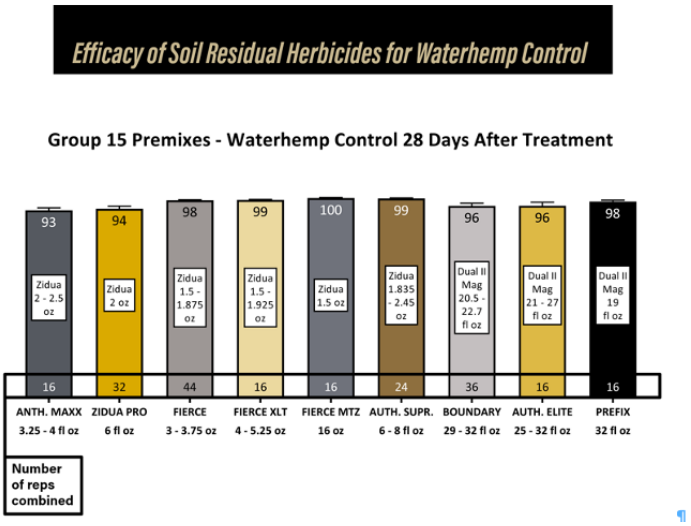

Figure 5. Waterhemp control with Group 15 premixed products at 28 days after application.

Hopefully, the presentation of data in this format allows you to gain a greater understanding of how to use these specific active ingredients in the premixes to effectively manage waterhemp. A key thing to keep in mind when buying these premixes is that in many cases they contain lower rates of specific active ingredients. If you're having a major battle with waterhemp a few key points to keep in mind include the following:

To get the longest residual control from soil-applied herbicide use in a premix, it's important to have a high enough rate of the specific active ingredients. You have the ability to take a specific premix and add a straight goods product to it to increase the length of residual control. So, here are our guidelines for the minimum amounts of the specific active ingredients needed for about 4-5 weeks of residual control of waterhemp.

1. Metribuzin (Sencor/Tricor) – use at least 5-6 ounces per acre equivalent of the 75 DF formulation.
2. Flumioxazin (Valor) – use at least 2 ounces of the Valor SX formulation.
3. Sulfentrazone (Authority/Spartan) – use at least 6 ounces of the Authority/ Spartan 4F formulation
4. Saflufenacil (Sharpen) – use of 1 ounce provides about two weeks of residual activity and that is the common rate used in the burndown treatment to help with foliar control of marestail, giant ragweed and a few other weeds that are emerged when

burndowns are made. To get more soil residual activity of saflufenacil, use the equivalent of 2 ounces of the Sharpen 2.85 SC formulation in whatever premix you are using. Pay attention to soybean preplant restrictions when using higher rates of saflufenacil.

5. Pyroxasulfone (Zidua) – use at least 2 ounces of the 4.17 SC formulation
6. Metolachlor (Dual/others) – use at least 20 ounces of the 7.64 EC or 7.8 E formulations
7. Acetochlor (Warrant) – use at least 20 ounces of the 3 lb formulation.
8. Dimethenamid (Outlook) – use at least 14 ounces of the 6 EC formulation.

Here are a couple of examples of taking a premixed product and boosting the efficacy on waterhemp.

- My retailer sold me on the idea of using Fierce at 3 ounces per acre. This rate of Fierce provides 1.5 ounces of Zidua per acre. Since my fields also contain a lot of foxtail and Zidua is good on grass weeds, I am going to purchase some straight goods Zidua 4.17 SC and add 0.5 ounces per acre to the Fierce I am using.
- I have fields with a lot of waterhemp, giant ragweed, lambsquarters, morningglories, and marestail. I was able to purchase Trivence and plan to apply it at 6 ounces per acre for my soil type. Trivence at 6 ounces per acre contains 3.5 ounces per acre of metribuzin and 1.5 ounces per acre of Valor. In this case, we need to decide on whether to add additional metribuzin or additional Valor. Given the weed spectrum, we are trying to control, I would add at least 0.5 ounces per acre of Valor to bring the Valor rate up to a minimum of 2 ounces per acre.

Hopefully, this article provided some assistance in understanding the activity of soil residual herbicides on waterhemp in the myriad of premix products available on the market. We would also add that our colleagues at the University of Wisconsin and the University of Kentucky have also produced some very good material on waterhemp control, and these documents can be accessed at the links below:

Residual Control of Waterhemp with Pre-emergence Herbicides in Soybean – University of Wisconsin

Multi-SOA Pre-emergence Herbicides for Palmer Amaranth and Waterhemp Control – University of Kentucky

Hemp Licensing In 2022

(Marguerite Bolt, mbolt@purdue.edu)

Those interested in growing, handling, or researching hemp in 2022 need to apply for a license through the Office of the Indiana State Chemist. The process of obtaining a license is the same as 2021. Both new and former license holders will need to get a federal FBI background check and upload the results into the OISC licensing software. Background checks must be completed within 60 days of hemp application submission. There are multiple videos available on the OISC hemp page in section 3 that guide applicants through the process. It is important to note that a federal background check can be obtained through the United States Postal Office in Indianapolis, by sending in a fingerprint card to FBI, or using an FBI channeler service.

This is a busy time of year for OISC, license applicants should review the materials in Section 3 before calling with questions.

For those interested in hemp licensing, an overview of the 2021 season, and hemp legislation, there is a webinar on February 3rd at 7:00pm. This is a great way to stay on top of changes taking place in the Indiana hemp industry and connect with other webinar attendees. This webinar is hosted through the Midwest Hemp Council, more information and registration can be found at this link.

Stay tuned for more virtual hemp events coming in the next several months.

Can New Microbes Lower Nitrogen Rates in Corn?

(Tony Vyn)

Recent high fertilizer prices have prompted huge farmer interest in the possibility of lowering nitrogen (N) rates with commercial microbial supplements that claim to fix N from the atmosphere. Environmental concerns about N losses in corn production only add to the impetus to apply less N per unit of yield.

In this presentation, Dr. Tony Vyn will highlight his team's experiences, and that of other universities in the Mid-West United States, from the results of recent public-institution trials with corn produced with commercial microbial products like Envitaä, PROVENâ and PROVENâ 40. In each case, the preliminary public institution trials were conducted with a full range of nitrogen (N) fertilizer rates. Public data on possible reductions from the economic N rate when farmers utilize microbial supplements are, unfortunately, limited. Nevertheless, Dr. Vyn addresses some of what is known from public replicated trials in Indiana and other Corn Belt states. He also provides perspectives on the daunting challenges in conducting field research to arrive at a reliable number for a N fertilizer rate reduction, if any, with N-fixing microbial supplements.

The title of his presentation is ***"Finding Proof for Recommending Less N with Microbial Supplements: Research Challenges in Corn"***. This talk was first presented at the Indiana Certified Crop Adviser Conference in mid-December, 2021, and then modified. However, even then, these tentative conclusions are based on a public-data set that is too small. New financial resources, and considerably more private-public cooperative research, are needed to expand research station and on-farm trials with present and evolving microbe strains that may help meet corn's N requirements with less N fertilizer per bushel.

Corn Response to Sulfur Fertilizer in Indiana – Research Update

(Jim Camberato), (Bob Nielsen), (Diana Salguero) & *(Dan Quinn)*

Summary

Sulfur (S) deficiency is becoming more common in Indiana crops because, in part, S deposition from coal-fired power plants has been reduced. Large plot strip trials were conducted at several locations from 2017-2021 to examine corn yield response to S applied as ammonium thiosulfate (ATS) in starter and/or sidedressed nitrogen (N) fertilizers. Grain yield was increased by sidedress S in 15 of 40 trials. In those 15 responsive trials, the average yield benefit to S fertilization ranged from 4 to 24 bu/acre, averaging 12 bu/acre. Application of S reduced yield in 3 of 40 trials. In 2 trials, 5 lb S/acre applied at sidedress reduced yield compared to no S applied or higher S rates. In another trial, 15 lb S/acre

reduced yield 2.3 bu/acre compared to no S applied. Sulfur in starter fertilizer as the only source of applied S and at rates of 5 lb S/acre or less, was only beneficial in 1 of 9 trials. Applying S in starter and sidedress was no better than applying S only in sidedress. A summary of our sulfur research can be viewed on YouTube at https://youtu.be/XFV6vUpgphI .

Figure 1. Sulfur deficiency symptoms in corn.

Sulfur Deficiency

Sulfur (S) deficiency has become more common in Indiana crops because S emissions from coal-fired power plants have decreased over the past few decades (Camberato and Casteel, 2017). Consequently, atmospheric S deposition to soils has also decreased.

Sulfur deficient corn plants exhibit a general yellow-green color from top to bottom of the plant, often also with visible leaf striping (Fig. 1). Other nutrient deficiencies can cause striping and can sometimes be confused with S deficiency (Camberato, 2013). Nitrogen deficiency on the other hand, will usually have green leaves emerging from the whorl while the lower leaves turn yellow from the tip through the mid-rib, then turn brown, and quickly wither away. Tissue S levels less than 0.15 – 0.18% and tissue sample N:S ratios greater than 15:1 – 20:1 are considered reasonably good indicators of S deficiency in corn.

Sulfur Response Trials

Starter fertilizer S

We conducted 9 field-scale trials exploring the impact of starter and/or sidedress S on corn yield in 2017 and 2018. To provide S we mixed ammonium thiosulfate (ATS) with urea ammonium nitrate (UAN-32% or 28%) or a mixture of UAN and ammonium polyphosphate (10-34-0) as a starter fertilizer in 2×2 placement and/or as ATS with UAN as a sidedress application. Rates of S ranged from 3-5 lb S/acre as starter and 12-25 lb S/acre as sidedress. Sidedress fertilizer was injected in the row middle to a depth of 2-4 inches at corn growth stages between V5 and V7 (all but one trial).

Starter fertilizer alone, compared to no S, had no effect on yield in 8 of 9 trials. Interestingly, three of those trials were actually S deficient and responded to higher rates of S at sidedress with yield increases from 15 to 20 bu/acre. Sidedress alone at 15-25 lbs S was as good or better than splitting S between starter (5 lbs S) and sidedress (remainder of S). In the one trial in which starter S increased yield, compared to no S applied, sidedressing an additional 10 or 20 lb S/acre did not increase yield any more than starter alone.

Grain yield response to S supplied in sidedress applications

To determine the effect of sidedress S on corn grain yield, 40 field-scale trials (including the 9 with starter S treatments) were conducted at several sites from 2017-2021 (Fig. 2). Multiple rates of sidedress S were utilized in 26 of the 40 trials, ranging from 5 to 30 lb S/acre and always including a 0 lb S/acre treatment. Fourteen trials only had 2 S rates, 0 and 15 lb S/acre (mostly in 2021). Sidedress S was applied as described in the previous section.

Sidedress S increased yield in 15 of 40 trials (Fig. 2), ranging from 4 to 24 bu/acre averaged over the entire experimental area. In 7 trials where corn responded to multiple rates of sidedress S, the lowest sidedress rate examined (ranging from 5 to 20 lb S/acre) was enough to maximize the yield response.

Even at sites that had large yield increases with S fertilization in some years, no response occurred in other years. Several sites were consistently unresponsive to S fertilization over several years of testing – Purdue research farms in Whitley, Jay, and Tippecanoe counties – even though responses to S were obtained at other sites near these farms.

Yield decreases with S fertilizer occurred in only 3 of 40 trials. In 2 trials, 5 lb S/acre applied at sidedress reduced yield compared to no S applied or higher S rates. In another trial, 15 lb S/acre reduced yield 2.3 bu/acre compared to no S applied.

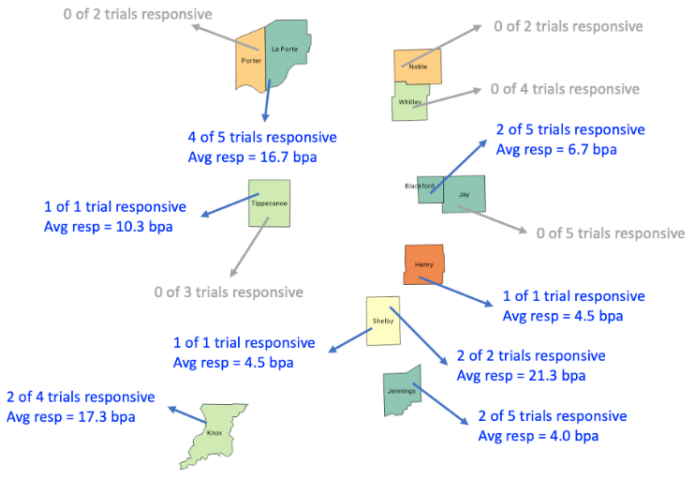

Figure 2. Effect of fertilizer S on corn grain yield in 40 field scale trials conducted throughout Indiana, 2017-2021. All the positive yield responses were sidedress S apart from 1 trial in Jennings County that was starter S (bpa = bushels per acre).

No soil properties (including extractable sulfate-S, organic matter, and texture) or pre-sidedress plant tissue %S or N:S ratio consistently separated responsive from non-responsive sites, although some sites affirmed previous research which suggested S deficiency would be more likely and more severe on sandy low organic matter (OM) soils. For example, the LaPorte site is composed of loamy sand and sandy loam soils and averaged 2% OM. At this site S fertilization increased corn yield in 4 of 5 years, averaging 16.7 bu/acre. Similarly, in another site

with substantial soil variability, S increased yield 10 bu/acre on a Whitaker silt loam (2.1% OM), while there was no response to applied S on a Bono silty clay (3.9% OM). However, the opposite occurred in a trial in Shelby County where the yield response to S was 35 bu/acre on soil mapped as Brookston silty clay loam (2.6% OM), while there was no response to S on soil mapped to the lighter-textured lower OM Crosby silt loam (1.9% OM). Other sites with clayey soils and high %OM have also had substantial responses to applied S – for example a Chalmers silty clay loam soil with 3.9% OM in Tippecanoe County. Work continues to identify soil, plant, and environmental measurements that improve our ability to predict corn yield response to S fertilization.

Although tissue sampling prior to sidedress did not identify sites requiring S fertilization, measuring earleaf tissue %S or the tissue N:S ratio in the earleaf at silking were useful in identifying S deficiency. Current guidelines for adequate S in the earleaf at silking suggest Figure 2. Effect of fertilizer S on corn grain yield in 40 field scale trials conducted throughout Indiana, 2017-2021. All the positive yield responses were sidedress S apart from 1 trial in Jennings County that was starter S (bpa = bushels per acre). 4 greater than 0.15% S is sufficient. Our work suggests the critical level for sufficiency may be higher, greater than 0.18% (Fig. 3). The N:S ratio of plant tissue concentrations is also used to assess S deficiency in corn. Sulfur and N are primary components of plant protein and typically occur in a ratio of about 15 parts N to 1 part S (15:1 N:S). Greater N:S values suggest S is deficient. Our results are consistent with this assessment, with most of the responsive locations having a N:S ratio of 16:1 or greater (Fig. 4).

Neither % or N:S are perfect at separating responsive and non-responsive sites, so if tissue levels are near or below these critical levels or S deficiency symptoms were noticed you should consider conducting simple S response trials on your farm next year. A simple protocol for conducting these trials can be downloaded at https://www.agry.purdue.edu/ext/corn/ofr/protocols.html. We would be eager and willing to partner with you in conducting these trials.

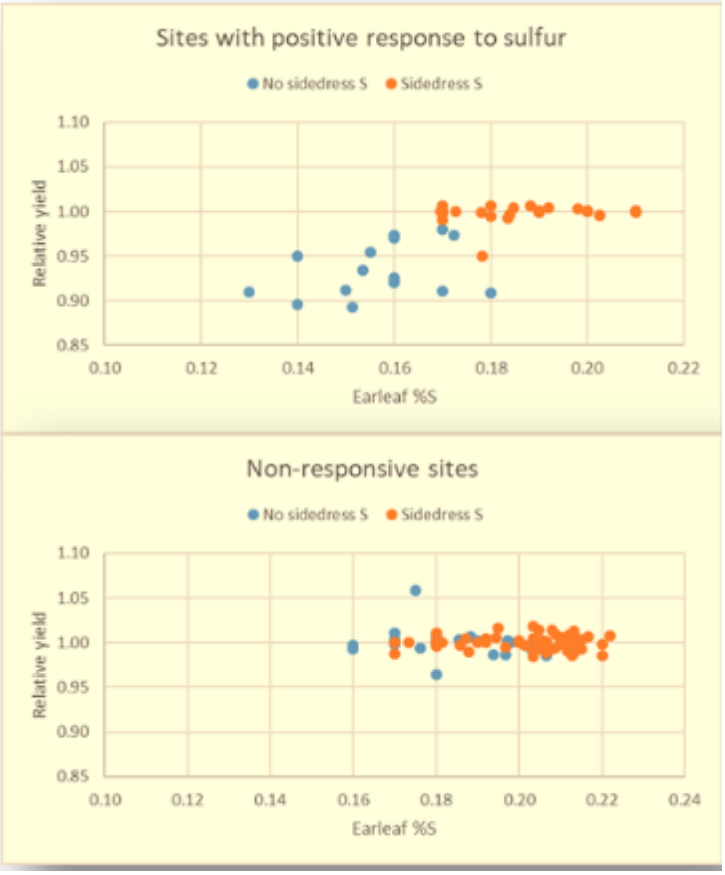

Figure 3. Earleaf tissue S concentrations at sites with positive responses (top) and non-responsive to S fertilization (Bottom). Blue symbols indicate treatments not receiving S fertilizer. Relative yield is yield of the no S treatment divided by yield obtained with S. Data are from 13 responsive and 21 non-responsive sites.

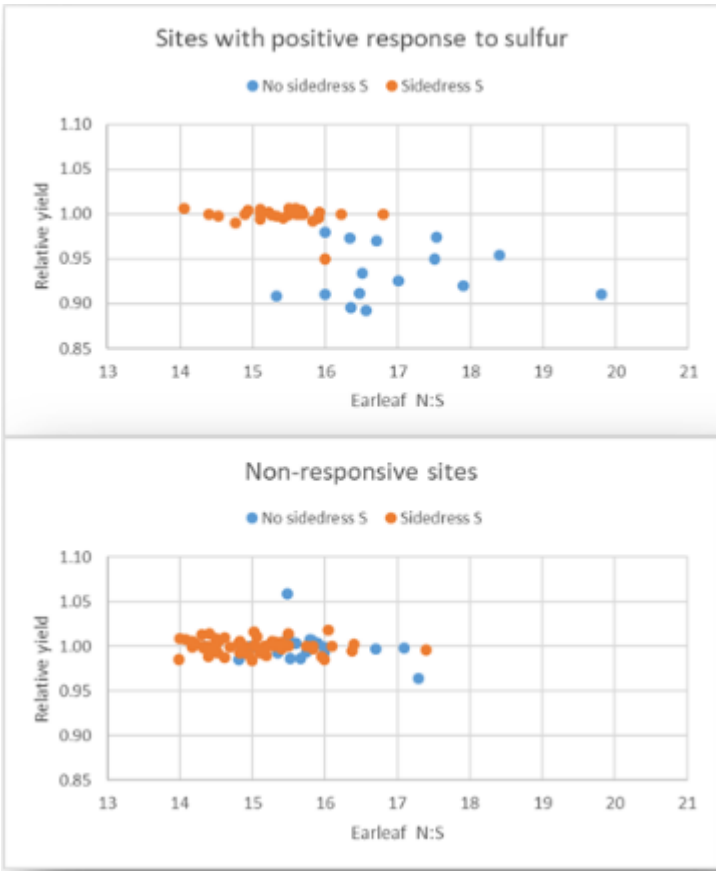

Figure 4. Earleaf tissue concentration N:S ratios at sites with positive responses

(top) and non-responsive to S fertilization (bottom). Blue symbols indicate treatments not receiving S fertilizer. Relative yield is yield of the no S treatment divided by yield obtained with S. Data are from 13 responsive and 21 non-responsive sites.

Sulfur fertilization decisions

Not every field of corn is deficient for sulfur and so we do not recommend that everyone routinely apply S fertilizer to every single field they farm. Unfortunately, based on the results of on-going research, there is yet no consistent soil or plant predictor that accurately tells us where and when S fertilization of corn will be needed.

Sulfate-S analysis from fall soil samples is not helpful and we have found that even soil samples taken between planting and sidedress time are not helpful in determining whether a field needs S fertilization. The reason for this is that soil sulfate-S is subject to leaching from excessive rainfall, like soil nitrate-N, and soil-test S does not adequately reflect the organic-S that may come available during the growing season.

Our research also suggests that tissue analyses of plant samples taken just before sidedressing are also not reliably predictive of S needs by the corn plant, WITH THIS CAVEAT – If plants are (1) showing S deficiency symptoms prior to sidedressing and (2) plant tissue analyses show that %S is very low (approaching 0.12%) and (3) the N:S ratio of the plant tissue concentrations is very wide (>24:1), then S fertilization is likely needed. We typically don't see these levels of %S and N:S at sidedress time in our research trials, but we encounter them occasionally when troubleshooting problem fields. Although it is possible the crop will grow out of such early season deficiency as soils warm, organic matter mineralization increases, and roots explore more soil, it is more likely that an application of 10-15 lb S/acre will be needed to provide non-limiting conditions. Furthermore, since our research indicates that [sidedress alone] is just as good or better at relieving S deficiency than [starter plus sidedress], delaying the decision to apply S based on symptoms and tissue analysis between planting and sidedress is a reasonable strategy.

Low rates of S as starter alone (<5 lb S/acre) have not increased corn yields in our trials. Higher starter rates might be beneficial but, unfortunately, we have not conducted field research with higher starter rates to answer that question. We caution against applying 10-15 lbs of S in the form of ATS in 2×2 or closer starter placements without on-farm testing of your own because ATS can result in plant toxicity.

The risk of soil sulfate-S loss increases the farther ahead of planting S fertilizer applications are made. Counting on plant available S from elemental S is risky since availability is reliant on warm soil temperatures. Plant availability of S applied as elemental S in fall and winter is no different than a spring application because conversion to sulfate won't occur till soils warm substantially. Even fertilizers claiming accelerated elemental S conversion to sulfate because of very small particle sizes include a sulfate component to provide plant available S soon after application.

What is the minimum effective rate of S to apply? Our research suggests that 10-15 lbs S/acre, applied just before planting but no later than sidedressing, will be adequate in most S-deficient situations. Broadcast applications of sulfate-S at/or shortly after early season plant sampling should be similarly effective as knife/coulter sidedress S applications.

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Optimum Plant Populations for Corn in Indiana

(Bob Nielsen), (Dan Quinn) & (Jim Camberato)

Seed corn represents one of the most expensive variable input costs for Indiana corn growers (Langemeier et al., 2021) and so choosing the most economical seeding rate is important for maximizing dollar return to seed at harvest time. Choosing the most economical seeding rate involves balancing the cost of the seed corn and the price you expect to receive for the harvested grain when you sell it. Just as importantly, the most economical seeding rate depends on the yield response of corn to final PLANT POPULATION.

Jim and Bob conducted nearly 100 field scale trials around Indiana from 2008 through 2019 to document the yield response of corn to PLANT POPULATION. The complete summary of that research is available online (Nielsen et al., 2019).

Figure 1 below was derived from that summary and illustrates (1) the average yield response of corn (in terms of percent yield) to final PLANT POPULATION and (2) the average dollar return to seed for 83 trials that represented a range of growing conditions that we characterized as "normal" for Indiana. In particular, none of those 83 trials experienced severe drought conditions. Yield levels among those 83 trials ranged from about 150 to 250 bushels per acre and across the entire set of trials, the average yield level was 194 bushels per acre.

Based on the yield response curve (blue data points), we can determine that maximum (100%) corn yield occurred at a final PLANT POPULATION of about 32,000 PLANTS per acre. However, note how "shallow" or nearly "flat" the yield response curve is for those 83 trials. That "flatness" reflects the tolerance of today's hybrids to higher populations, much more so than hybrids of "yesteryear". Note also how tolerant today's hybrids are to lower populations. The tolerance to both low and high populations results in the shallow response curve. In fact, our data suggest that potential yield at final PLANT POPULATIONS ranging from about 28,000 to 35,000 PLANTS per acre at harvest varies by only +/- 1 bushel per acre at yield levels around 200 bushels per acre!

The dollars and cents upshot of such a shallow yield response curve is that when the POPULATION is near the optimum to start with, "squeezing" one more bushel per acre by increasing seeding rate requires more seed than you can afford. In Fig. 1, the curve

representing dollar return to seed (red data points) illustrates that point. The average ECONOMIC PLANT POPULATION for our 83 trials was closer to 27,000 PLANTS per acre, or about 5,000 fewer PLANTS per acre than the AGRONOMIC OPTIMUM POPULATION that maximizes grain yield.

Obviously, the ECONOMIC OPTIMUM POPULATION is influenced by market corn price and seed corn cost. Table 1, also available in our complete online summary, provides estimates of ECONOMIC PLANT POPULATIONS for a range of seed corn costs and market grain prices.

Seeding Rate versus Plant Population?

The astute reader will have noticed our use of the capitalized term "PLANT POPULATION". The reason for that is corn responds to the actual plant population in the field, not simply the seeding rate because percent stand success is rarely 100%. In our own field trials, percent surviving stand averaged 95%. For other folks, that number may be 90% or 98% or 85%.

Assuming you know your typical percent stand from past field scouting, then you can calculate the seeding rate that targets a desired economic optimum plant population by simply dividing the target PLANT POPULATION by the percent stand. For example, if you are aiming for a final stand of 30,000 PLANTS per acre and your average percent stand success is 95%, then the seeding rate to achieve that target would be 30,000 divided by 0.95, which would equal a seeding rate of about 31,600 SEEDS per acre.

Impact on Variable Rate Decisions?

The "flat" grain yield response of corn to plant population should give you pause for thought relative to variable seeding rate decisions. Our data (Fig. 1) tells us that maximum grain yield occurs within a WIDE range of plant populations, from about 28,000 to 35,000 plants per acre, for most productive, non-droughty soils throughout the state. Interestingly, most variable rate "prescriptions" that farmers have shared with us also fall within the range of about 28,000 to 35,000 plants per acre. Most of these farmers tell us they are "pleased" with the results and believe that VR seeding helped them improve yields and/or profit. When pressed, many admit they do not actually have any valid comparisons with uniform seeding rates.

In field trials where we have looked at yield response to a range of plant populations in different "management zones" (soil types, elevation, etc.), we rarely see any difference in optimum final plant populations. The exception is when there are areas in a field subject to severe drought stress. The optimum PLANT POPULATION for drought prone areas of fields is obviously lower than for areas with adequate soil moisture. Data from 14 of our field trials that suffered severe drought stress suggests that the optimum population for droughty fields or areas within fields is 5,000 to 10,000 fewer PLANTS per acre than for less droughty areas.

Hybrid Response to Plant Population?

We have rarely observed any CONSISTENT and REPEATABLE differences among hybrids in their yield responses to PLANT POPULATION. However, since seed corn prices can vary among hybrids, the ECONOMIC OPTIMUM PLANT POPULATION may vary among hybrids and can be visualized with the data in Table 1. If one hybrid costs $175 per bag and another costs $350 per bag, then their respective ECONOMIC OPTIMUM PLANT POPULATIONS would be 28,645 and 25,501 PLANTS per acre, respectively (using a $5 market price for grain).

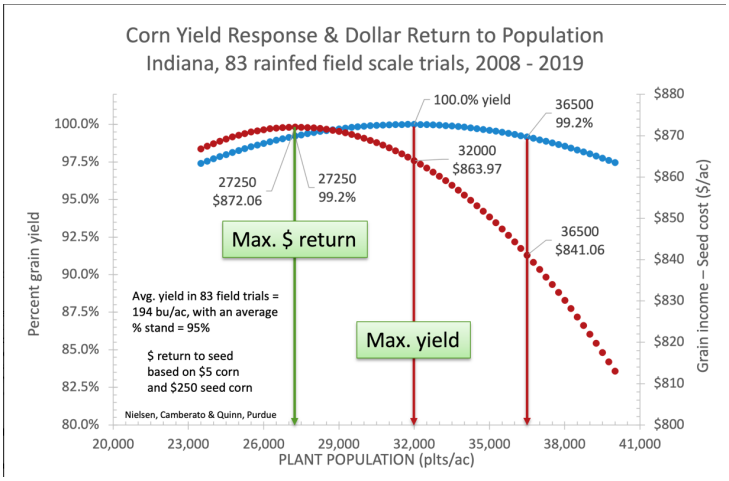

Fig. 1. Average corn yield response and dollar return to seed, based on the aggregated results of 83 field scale trials conducted across Indiana from 2008 to 2019. These trials represented a normal range of growing conditions (minimal to moderate stress). The agronomic optimum PLANT POPULATION for this group of trials was 31,800 plants per acre at harvest with an average yield of 194 bushels per acre. The economic optimum PLANT POPULATION for this group of trials occurred at 27,250 PLANTS per acre, based on the average maximum yield of 194 bushels per acre, $5.00 corn grain price, and $250 per 80,000 seed bag of seed corn.

Table 1. Plant Populations that maximize marginal return to seed relative to grain price (per bu.), seed cost (per 80,000 seed bag), a 95% success of stand establishment, and the average yield response to population in 83 field scale trials in Indiana that represented a common range of growing conditions. NOTE: To calculate seeding rates from the values of this table, divide by your expected percent stand. For example, 30,000 plants per acre divided by 95% stand = 30,000 divided by 0.95 = 31,589 seeds per acre.

	Grain $							
Seed $	**$3.00**	**$3.50**	**$4.00**	**$4.50**	**$5.00**	**$5.50**	**$6.00**	**$6.50**
$175	26549	27298	27859	28296	29645	28931	29169	29371
$200	28500	26656	27298	27797	28196	28523	28795	29025
$225	25051	26014	26736	27298	27747	28114	28421	28680
$250	24303	25372	26174	26798	27298	27706	28046	28334
$275	23554	24731	25613	26299	26848	27298	27672	27989
$300	22805	24089	25051	25800	26399	26889	27298	27643
$325	22057	23447	24490	25301	25950	26481	26923	27298
$350	21308	22805	23928	24802	25501	26072	26549	26952

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What We Know And What We Don’t Know About Corn Response To Sulfur In Indiana

(Bob Nielsen) & *(Jim Camberato)*

This presentation shares what we know and don’t know about corn response to applied sulfur fertilizer in Indiana, based on field scale research we conducted throughout the state from 2017 – 2021. While it is true that more fields of corn respond to sulfur today than decades ago, it is also true that many fields do not require sulfur fertilizer for optimum yield.

Purdue Crop Chat Episode 29, Potential Cost Cutting Moves Amid Rising Input Costs

(Shaun Casteel) & *(Dan Quinn)*

The Purdue Crop Chat is a regular podcast from Hoosier Ag Today and the Purdue University Extension Service, featuring Purdue Extension soybean specialist Dr. Shaun Casteel and Extension Corn Specialist Dr. Dan Quinn.

USDA released their final yield numbers for 2021 on Wednesday. Shaun and Dan join host Eric Pfeiffer to give their reaction to record high Indiana yields. They also welcome Purdue Ag Economist Dr. Michael Langemeier to review 2021 and look ahead to the 2022 crop season.

Langemeier says, “Certainly 2022 won’t be as good as 2021, but I don’t think it’s going to be that different from 2020, and that’s good news.”

Hear the full podcast.

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Editor: Tammy Luck | Department of Entomology, Purdue University, 901 W. State St., West Lafayette, IN 47907