

# PROFITABLE SPRAY PASS



# PROFITABLE SPRAY PASS RESOURCE GUIDE

The sprayer is one of the most essential pieces of equipment on the farm. In addition to providing weed control, sprayers can supplement nutrition, mitigate stress, and protect yield through disease suppression.

Making these applications worth your time and money will ultimately depend on factors such as crop stress, weather, and disease levels, but there are things you can control to help improve your odds of success.

This guide consists of a collection of data-backed resources compiled by Beck's agronomists and Practical Farm Research (PFR)<sup>®</sup> team to provide information on some of the most common questions we receive regarding spraying corn and soybeans and improving your profitability. Our team is always available to help you succeed, so please don't hesitate to reach out.



**CATCH UP WITH THE DIG! SCAN TO WATCH NOW.**



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# WHAT FOLIAR FUNGICIDE AND INSECTICIDE PRODUCTS SHOULD I CONSIDER AND AT WHAT GROWTH STAGE SHOULD I APPLY THEM?

Choosing fungicides and insecticides with effective modes of action and applying them at the correct growth stage will have a large impact on their performance and return on investment.

# FUNGICIDE - IS IT WORTH IT?

## PRODUCTS/PRACTICES

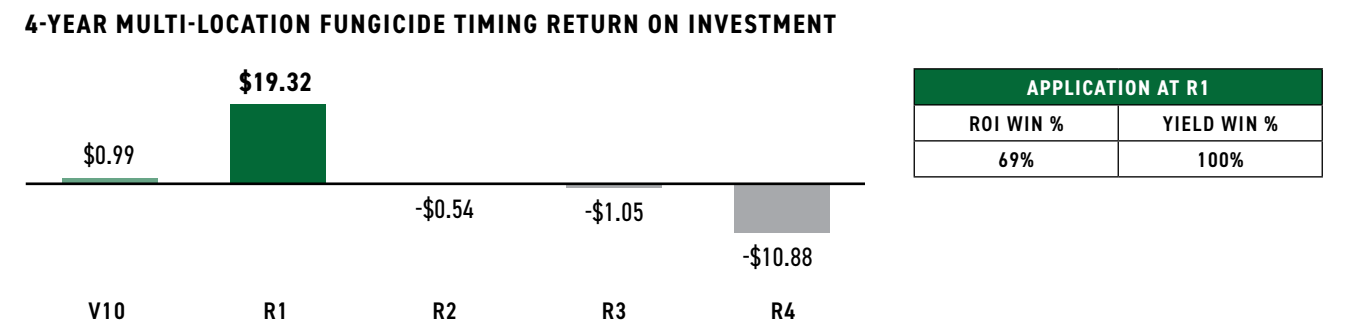
Fungicides primarily reduce or mitigate disease pressure, but they can also increase water use efficiency, photosynthesis, nitrate reductase activity, increase the window for grain fill, and improve stress tolerance. How a fungicide works depends on its mode or modes of action.

### PRODUCTS

FUNGICIDE	PFR PROVEN ROI	ROI WIN %	YIELD ADVANTAGE (BU./A.)	YIELD WIN %	APPLICATION RATE & TIMING	MODES OF ACTION	COMPANY
VELTYMA®	\$27.94	85%	10.7	100%	7 oz. @ R1	Strobilurin, Triazole	BASF
MIRAVIS® NEO	\$24.45	91%	11.0	100%	13.7 oz. @ R1	Strobilurin, Triazole, SDHI	Syngenta Group Company
TRIVAPRO®	\$23.38	69%	10.6	100%	13.7 oz. @ R1	Strobilurin, Triazole, SDHI	Syngenta Group Company
LUCENTO®	\$19.92	82%	9.4	100%	5 oz. @ R1	Triazole, SDHI	FMC Corporation
ZOLERA® FX	\$14.99	83%	7.5	92%	5 oz. @ R1	Strobilurin, Triazole	UPL NA Inc.
DELARO® 325 SC	\$13.59	73%	8.2	91%	8 oz. @ R1	Strobilurin, Triazole	Bayer Group
HEADLINE AMP®	\$13.59	64%	9.4	93%	10 oz. @ VT	Strobilurin, Triazole	BASF
DELARO® COMPLETE	\$7.71	69%	7.2	100%	8 oz. @ R1	Strobilurin, Triazole, SDHI	Bayer Group
ADASTRIO™	\$6.01	50%	6.3	100%	8 oz. @ R1	Strobilurin, Triazole, SDHI	FMC Corporation

### TIMING

Later applications in corn control diseases that tend to move in after pollination. Many fungicides provide plant health benefits that keep the plant healthier during grain fill.



# FUNGICIDE - TIMING

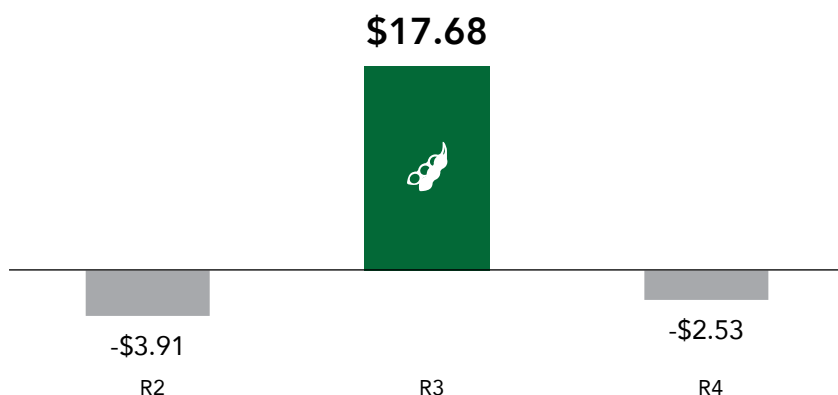
## PRODUCTS/PRACTICES

### WHEN SHOULD YOU SPRAY?

Later applications in corn control diseases that tend to move in after pollination. Many fungicides provide plant health benefits that keep the plant healthier during grain fill.

FUNGICIDE	PFR PROVEN ROI	ROI WIN %	YIELD ADVANTAGE (BU./A.)	YIELD WIN %	APPLICATION RATE & TIMING	MODES OF ACTION	COMPANY
MIRAVIS® TOP	\$48.21	86%	6.5	100%	13.7 oz. @ R3	Triazole, SDHI	Syngenta Group Company
REVYTEK®	\$27.35	75%	4.6	94%	8 oz. @ R3	Strobilurin, Triazole, SDHI	BASF
STRATEGO® YLD	\$26.76	100%	4.4	100%	4 oz. @ R3	Strobilurin, Triazole	Bayer Group
TRIVAPRO®	\$19.55	75%	3.9	94%	13.7 oz. @ R3	Strobilurin, Triazole, SDHI	Syngenta Group Company
LUCENTO®	\$18.95	63%	3.7	100%	5 oz. @ R3	Triazole, SDHI	FMC Corporation
PRIAXOR®	\$18.73	88%	3.8	100%	4 oz. @ R3	Strobilurin, SDHI	BASF
MIRAVIS® NEO	\$16.03	67%	3.7	92%	13.7 oz. @ R3	Strobilurin, Triazole, SDHI	Syngenta Group Company
DELARO® COMPLETE	\$15.22	56%	3.6	94%	8 oz. @ R3	Strobilurin, Triazole, SDHI	Bayer Group
ZOLERA® FX	\$10.01	57%	2.6	95%	5 oz. @ R3	Strobilurin, Triazole	UPL NA Inc.
DELARO® 325 SC	\$5.01	60%	2.5	95%	8 oz. @ R3	Strobilurin, Triazole	Bayer Group

### 7-YEAR MULTI-LOCATION FUNGICIDE AND INSECTICIDE TIMING RETURN ON INVESTMENT



Approximately 70% of a soybean plant's yield comes from nodes 6 to 13. Those nodes are usually present at the R3 growth stage.



Scan the QR code to watch a video on growth staging soybeans.

# INSECTICIDE - TIMING AND TANK-MIX PRODUCTS

## WHEN TO CONSIDER A FOLIAR INSECTICIDE IN SOYBEANS?

Stinkbug thresholds tend to be lower than other insects as they can quickly cause significant damage to seed number and seed quality. Treatment should be considered once you detect 9 or more adult or nymph stink bugs within 25 sweeps of a sweep net or one adult per one row foot through the R6 growth stage. If the soybeans are food grade or for seed quality, the threshold is reduced to 4 adult or nymph stink bugs per 25 sweeps.

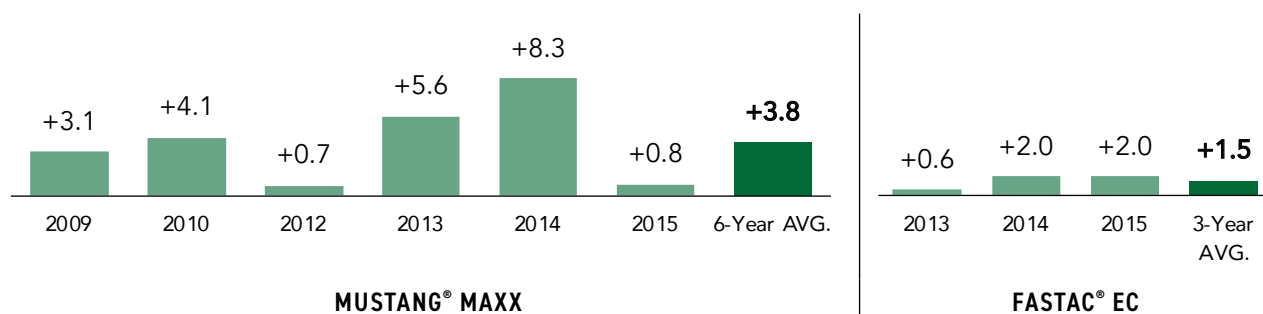
## WHAT ABOUT TANK-MIXING WITH FUNGICIDES?

Although we have focused on the control of insects and the use of insecticides, we know from previous research that a combined application of an insecticide and a fungicide can result in a synergistic or net greater effect.

INSECTICIDE	PFR PROVEN ROI	ROI WIN %	YIELD ADVANTAGE (BU./A.)	YIELD WIN %	APPLICATION RATE & TIMING	COMPANY
MUSTANG® MAXX	\$32.41	83%	3.8	100%	3.2 oz. @ R3	FMC Corporation
FASTAC™ EC	\$13.61	100%	1.5	100%	3.2 oz. @ R3	BASF





**FARMserver® has a soybean defoliation estimation tool that can help you estimate insect damage and make a control decision. Just open a soybean scouting note and select "leaf health" to get started.**

## SOYBEAN MULTI-YEAR YIELD ADVANTAGE









# FOLIAR CORN DISEASES

DISEASE		SIGNS AND SYMPTOMS	INOCULUM SOURCE
<b>Gray Leaf Spot (GLS)</b> <i>Cercospora zeae-maydis</i> fungus		<ul style="list-style-type: none"> <li>• Medium (0.5 to 2 in.) rectangular lesions</li> <li>• Red or brown and later turn grey</li> <li>• Lesions restricted by leaf veins</li> <li>• Begins on lower leaves and works its way up the canopy</li> </ul>	<ul style="list-style-type: none"> <li>• Infested corn residue from prior year(s)</li> <li>• Spread by wind or splashing water</li> </ul>
<b>Southern Rust</b> <i>Puccinia polysora</i> fungus		<ul style="list-style-type: none"> <li>• Small (1/8 in.) round pustule</li> <li>• Begin as light green or yellow and turn to orange raised pustules</li> <li>• Typically found on the upper leaf surface and seldom on lower</li> <li>• Lesions can be on the husks and stalks in addition to the leaves</li> <li>• Lesions can form concentric circles around the darker original pustule</li> </ul>	<ul style="list-style-type: none"> <li>• Does not overwinter in the Corn Belt</li> <li>• Inoculum survives the winter on corn in more southern locations and is carried north by wind</li> </ul>
<b>Common Rust</b> <i>Puccinia sorghi</i> fungus		<ul style="list-style-type: none"> <li>• Small (1/4 to 3/8 in.) round</li> <li>• Begin as light green or yellow and turn to brick-red raised pustules</li> <li>• Lesions can be on husks and stalks in addition to leaves</li> <li>• Can sometimes form a band along the leaf</li> </ul>	<ul style="list-style-type: none"> <li>• Does not overwinter in Corn Belt</li> <li>• Inoculum survives the winter on corn in more southern locations and is carried north by wind</li> </ul>
<b>Bacterial Leaf Streak</b> <i>Xanthomonas vasicola</i> pv. <i>vasculorum</i>		<ul style="list-style-type: none"> <li>• Narrow stripes between leaf veins may initially look like Gray Leaf Spot.</li> <li>• Lesions can be brown, orange, and/or yellow and are often yellow when backlit</li> <li>• Lesions usually have slightly wavy edges</li> </ul>	<ul style="list-style-type: none"> <li>• The pathogen survives in infected corn debris from previous seasons</li> <li>• Is thought to infect the plant through natural openings in the leaves</li> </ul>



WHEN TO SCOUT	CONDITIONS CONDUCIVE TO INFECTION	MANAGEMENT STRATEGIES
Normally seen starting two weeks prior to tassel	<ul style="list-style-type: none"> <li>Hot and humid (80° F and above) and cloudy</li> <li>Wet, humid weather that keeps the leaves wet for long periods</li> </ul>	<ul style="list-style-type: none"> <li>Yield impact depends on when it establishes and how quickly it spreads. If the infestation occurs at or around the VT growth stage, it will likely impact yield. Conversely, if the infestation occurs several weeks after VT, the yield impact will be negligible</li> <li>If inoculum is present, rotate to a non-host crop</li> <li>Reduce corn residue on the soil surface</li> <li>Select for a hybrid with a good GLS rating</li> </ul>
Reaches the Corn Belt in July or later	<ul style="list-style-type: none"> <li>Humid and warm (around 80° F)</li> </ul>	<ul style="list-style-type: none"> <li>Develops faster than common rust</li> <li>Can be found throughout the Corn Belt, but severe cases have been limited to the southern states</li> <li>Severity depends on when southern rust arrives</li> <li>Crop rotation and residue management are irrelevant because the inoculum does not overwinter</li> <li>Damage is often more severe in later planting dates or late-maturing hybrids</li> <li>Hybrids vary in resistance to southern rust</li> </ul>
Normally seen between the V6 and R2 growth stages	<ul style="list-style-type: none"> <li>Humid with moderate temperatures (60 to 77°F)</li> <li>Younger leaf tissue is more susceptible to rust, so later planted corn may show higher levels of rust than early planted corn</li> </ul>	<ul style="list-style-type: none"> <li>Severity depends on when common rust arrives</li> <li>Crop rotation and residue management are irrelevant because the inoculum does not overwinter</li> <li>Most modern hybrids have adequate resistance to common rust</li> </ul>
As early as the V7 growth stage	<ul style="list-style-type: none"> <li>Irrigation and wind-driven rain, as well as warm temperatures, are thought to exacerbate the disease</li> </ul>	<ul style="list-style-type: none"> <li>Cleaning debris from combines and other equipment between fields can help slow spread</li> <li>Use of crop rotation or tillage may help degrade infected corn debris and reduce the surviving bacteria</li> <li>Neither practice will eradicate the bacterium and eliminate the risk of disease. Until more research has been conducted to determine the most effective management strategies producers are advised to use standard management practices for bacterial diseases.</li> </ul>

# FOLIAR CORN DISEASES

DISEASE		SIGNS AND SYMPTOMS	INOCULUM SOURCE
<b>Northern Corn Leaf Blight</b> <i>Exserohilum turcicum</i> fungus		<ul style="list-style-type: none"> <li>• Begins on lower leaves and works its way up the canopy</li> <li>• Large (1 to 6 in.) elliptical lesions that form parallel to the leaf</li> <li>• Begin as greyish-green lesions which then turn tan; not restricted by leaf veins</li> </ul>	<ul style="list-style-type: none"> <li>• Infested corn residue from prior year(s)</li> <li>• Spread primarily by wind</li> </ul>
<b>Physoderma Brown Spot</b> <i>Physoderma maydis</i> fungus		<ul style="list-style-type: none"> <li>• Very small (1/8 to 1/4 in.) purple or black circles</li> <li>• Lesions found on the leaves in the middle of canopy</li> <li>• Usually form a band along the leaf midrib, but it can also form on the stalk and leaf sheath</li> </ul>	<ul style="list-style-type: none"> <li>• Overwinters in infested corn residue from prior year(s)</li> <li>• Water loving pathogen that can also survive in soil</li> </ul>
<b>Goss's Wilt</b> <i>Clavibacter michiganensis</i> bacterium		<ul style="list-style-type: none"> <li>• Large (1 to 6 in.) elliptical lesions with small black freckles</li> <li>• Lesions appear wilted and water soaked and start off as dark green to black and eventually turn tan</li> <li>• Most often seen in the top of the canopy</li> </ul>	<ul style="list-style-type: none"> <li>• Infested corn residue from prior year(s)</li> <li>• Spread by splashing water, but bacteria are also carried by wind</li> <li>• Can move throughout infected plants</li> </ul>
<b>Tar Spot</b> <i>Phyllachora maydis</i>		<ul style="list-style-type: none"> <li>• Tar Spot releases the majority of its spores at night when the relative humidity is more than 85%.</li> <li>• Lesions form on the upper and lower leaf surface. In some situations, lesions can form on the husk and leaf sheaths.</li> <li>• Tar Spot has a latent period (between sporulation and infection symptoms) of approximately 14 days.</li> </ul>	<ul style="list-style-type: none"> <li>• Spores are spread by wind and splashing from rain. Moisture increases the spread</li> <li>• Polycyclic = infests, forms spores, reinfects and spread in approx. 21 days</li> <li>• Is known to overwinter in the US in two fungal forms of the same species: stroma and ascospores. The overwintering survival rate is unknown.</li> </ul>

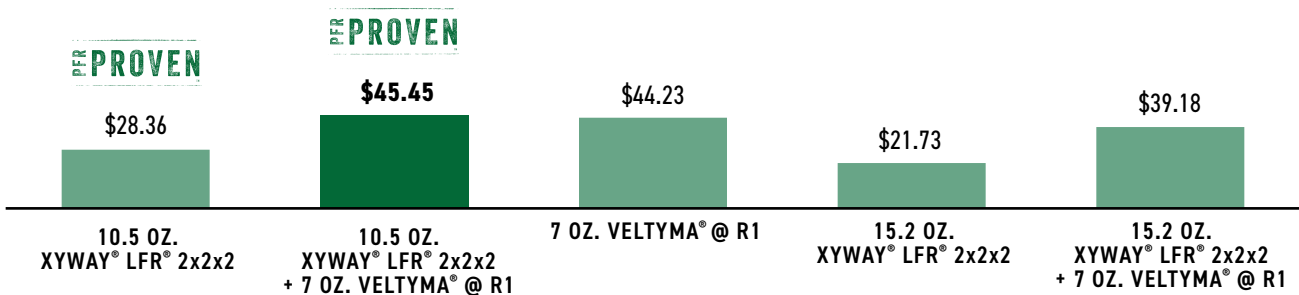
WHEN TO SCOUT	CONDITIONS CONDUCIVE TO INFECTION	MANAGEMENT STRATEGIES
As early as the V6 growth stage	<ul style="list-style-type: none"> <li>• Cool (64 to 81° F), wet, and cloudy</li> <li>• Wet, humid weather that keeps the leaves wet for long periods</li> </ul>	<ul style="list-style-type: none"> <li>• Can quickly cover the canopy (and impact yield) due to large lesion size</li> <li>• If inoculum is present, rotate to a non-host crop</li> <li>• Reduce corn residue on soil surface</li> <li>• Select for a hybrid with a good NCLB rating</li> </ul>
Typically symptoms first appear in mid to late vegetative stages. The lesions can be mistaken for Common Rust.	<ul style="list-style-type: none"> <li>• Prolonged wet periods early in the season with warm temperatures (75 to 85°F)</li> <li>• Infection takes place when the whorl is full of water for an extended period of time</li> </ul>	<ul style="list-style-type: none"> <li>• If inoculum is present, rotate to a non-host crop</li> <li>• Reduce corn residue on the soil surface</li> <li>• Corn plants become more resistant in the late vegetative growth stages</li> <li>• Disease has historically been of minor importance</li> </ul>
Leaves can be infected at any time, but disease is usually seen around the VT growth stage	<ul style="list-style-type: none"> <li>• Warm, wet conditions (65 to 82°F)</li> </ul>	<ul style="list-style-type: none"> <li>• Can quickly cover the canopy (and impact yield) due to large lesion size</li> <li>• If inoculum is present, rotate to a non-host crop</li> <li>• Reduce corn residue on the soil surface</li> <li>• Select a hybrid with a good Goss's Wilt rating</li> <li>• Fungicides are not an effective means of control</li> </ul>
Leaves can be infected at any time, but disease is usually seen around the VT growth stage	<ul style="list-style-type: none"> <li>• Temperatures of 60 to 72°F and 75% average relative humidity over a 30-day period</li> <li>• 7 hours of leaf wetness while the conditions mentioned above are met increases infection.</li> </ul>	<ul style="list-style-type: none"> <li>• Due to weaker stalks, prioritize harvest of Tar Spot infested fields when possible.</li> <li>• Rotate away from corn in infected fields</li> <li>• Consider tillage to bury residue</li> <li>• Plan for adequate fertility so plants are strong and healthy in June and July</li> <li>• Select hybrids with strong plant health characteristics including ybrids with good stay green</li> <li>• Fungicide application timing is generally recommended for the VT to R1 growth stage.</li> </ul>

# FUNGICIDE RATE & TIMING STUDY - CORN

## XYWAY® LFR®

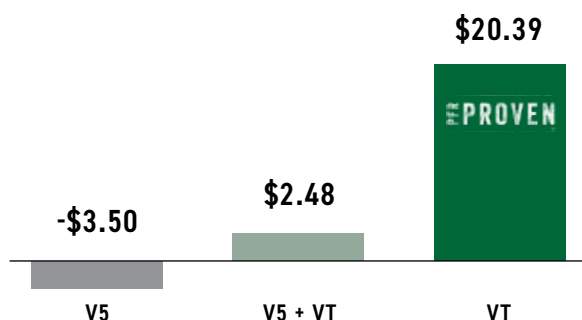
Xyway® LFR® is unique in that it's applied with the planter and offers protection through the VT growth stage. Beck's multi-location testing showed it was most advantageous in heavier clay soils with a higher probability of Crown Rot. Layering Xyway with a late-season foliar application of Veltyma® has provided the highest return.

### 3-YEAR MULTI-LOCATION FUNGICIDE RATE & TIMING RETURN ON INVESTMENT



# FOLIAR FUNGICIDES IN CORN

3-YEAR MULTI-LOCATION FUNGICIDE TIMING ROI - CORN



Data from Beck's Practical Farm Research (PFR)<sup>®</sup> studies show that there are several multiple mode of action (MOA) fungicides, that when applied at VT/R1, have provided a positive return on investment (ROI). When applying a fungicide, farmers not only expect to protect their crop from yield-robbing leaf diseases, but also to improve late-season standability by reducing stalk rot infection and maximizing harvestability.

One of the benefits from a strobilurin (QoI)-containing fungicide, such as those containing the active ingredients azoxystrobin, fluoxastrobin, picoxystrobin, pyraclostrobin, or trifloxystrobin, is the reduction of ethylene production

within the crop canopy. Ethylene is a naturally-produced gaseous plant hormone. In a healthy corn crop, ethylene gas is produced within the crop canopy once pollination is complete and kernels begin to develop. This initiates the processes leading to plant senescence. Common signs of plant senescence in corn include the transition of green leaf tissue to yellow/tan/brown color, leaf drop, tassel and silk drop, etc. If a strobilurin-containing fungicide is applied near pollination, ethylene production is significantly reduced, thus promoting a "greening" effect. This is usually beneficial for grain yield since it will allow the maximum amount of carbohydrates stored in the leaves and stalks to enter the developing kernels. A strobilurin-containing fungicide application near VT/R1 not only protects yield by helping control diseases and delaying senescence, but it can also help manage environmental stresses. When plants are subjected to a variety of abiotic (temperature and drought) and biotic (pathogen and insect) stresses, they will naturally produce more ethylene to regulate developmental processes within the plant. Although results have been somewhat inconsistent, there is evidence that improved nitrogen utilization may also be a benefit where fungicides have been applied. Lastly, if corn plants are kept healthier longer into the growing season, there is less ability for stalk rot pathogens to infect and cause stalk quality and harvestability issues.

Previous research has shown that a strobilurin-containing fungicide applied in corn at VT/R1 can cause increased grain moisture at harvest. This is likely due to delayed senescence and the aforementioned "greening" effect. The difference in grain moisture between fungicide-treated and untreated can depend on many variables; however, one of the most significant variables is the harvest moisture level. In general, if corn grain moisture at harvest is below 20%, there is typically about 0.5 to 1% higher grain moisture where a strobilurin-containing fungicide was applied. As harvest grain moisture increases above 20%, there is usually a larger difference in moisture between treated and untreated.

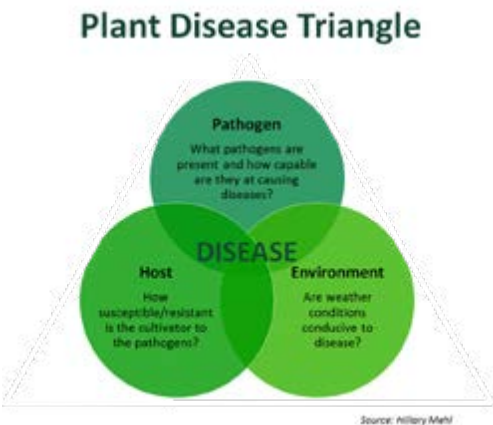
Carboxamide (SDHI)-containing fungicides such as those containing the active ingredient benzovindiflupyr, bixafen, fluxapyroxad, or pydiflumetofen, are being evaluated to determine if there are beneficial physiological responses like those found with strobilurin-containing fungicides described above. Initial results suggest this class of fungicides also has plant health and "greening" effect benefits.

For up-to-date PFR studies on Foliar Fungicides in Corn,  
visit [beckshybrids.com/resources/pfr-studies](https://beckshybrids.com/resources/pfr-studies)

# PLANT HEALTH AND FUNGICIDES IN CORN

Fungicide applications in corn production mitigate foliar disease during grain fill. Other uses for fungicides in corn production are to increase water use efficiency, increase stress tolerance, and to decrease ethylene production in the corn plant.

Fungicide applications are not a one-size-fits-all program. Many factors are involved when making the decision to apply a fungicide to a corn crop. Factors to consider when evaluating fungicide applications include:

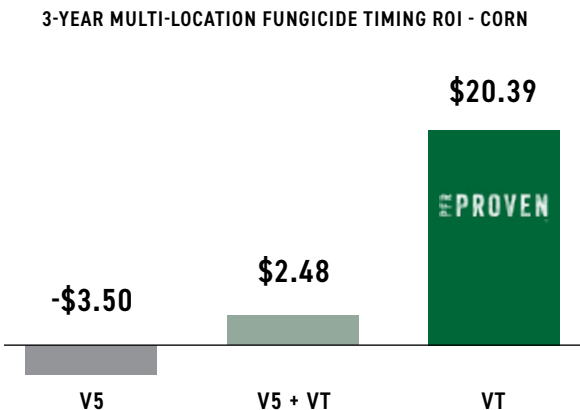


1. Is the hybrid prone to infection to foliar diseases and are diseases present?
2. Does the hybrid respond favorably (positive ROI) to fungicides?
3. Are the current and forecasted weather conditions favorable to the development of disease?
4. What active ingredient will provide the best result based on the situation?
5. What plant growth stage and time of day will provide the best protection and benefit to the plant?

## STAGING AND IDENTIFICATION

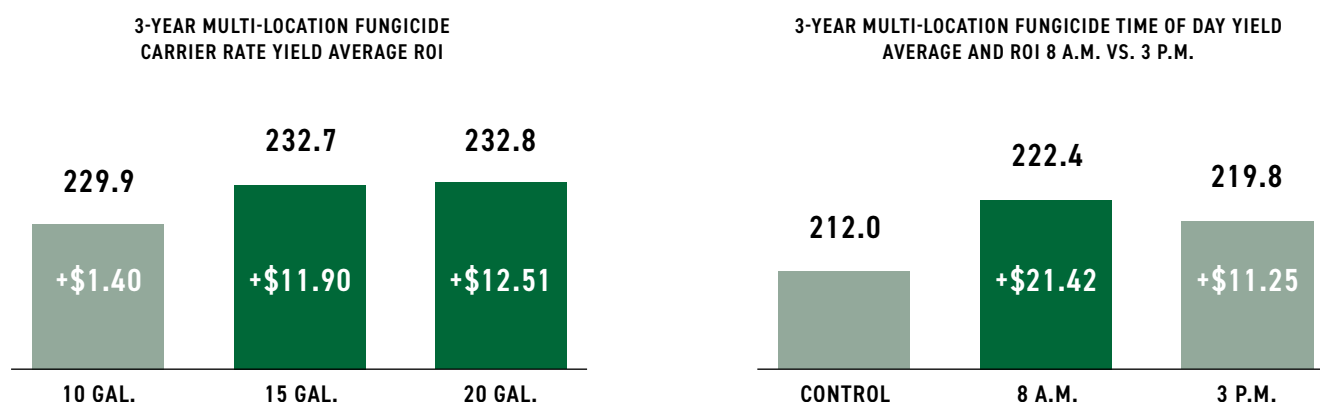
Accurate disease scouting and plant growth staging are crucial to optimizing fungicide applications. It is pertinent to identify the disease species, the severity of the disease infection, and the location of the disease within the crop canopy. Fungicides are classified into FRAC groups by their method of inhibiting the progression of fungal growth within the plant. Each FRAC group of fungicides and specific MOA within each group will have varying efficacy depending on the target disease(s). A resource to reference effective fungicide MOAs is the Crop Protection Network publication CPW-2011-W at [bit.ly/2Qykeol](http://bit.ly/2Qykeol). This publication will provide valuable information on each fungicide's usefulness against specific diseases.

Another important aspect when making fungicide decisions is the growth stage of the crop. Foliar diseases in corn add stress to the plant and reduces the amount of available surface area for photosynthesis. The most critical time to protect the corn plant is tassel emergence (VT) through the completion of grain fill and maturation (R6). Plants affected by disease during this time increase ethylene gas hormone production, which slows plant growth, triggers leaf and plant senescence, and can cause kernel abortion, ultimately leading to decreased yield. This optimal timing for foliar applications has been PFR Proven™ and supported by university data at the VT growth stage.



## CARRIER RATE AND TIME OF DAY

Fungicide applications vary, but based on multi-year PFR studies, there are two key components that boost productivity. For ground-applied fungicides, increased carrier rates result in more complete coverage of the essential canopy, the two leaves above and below the ear leaf. Increased coverage of the essential canopy also prevents disease from progressing higher in the canopy. The application time of day also impacts the efficacy of fungicide applications. Early morning applications in PFR testing have shown benefits versus afternoon applications. Dew present on the leaf surface may aid in the spreading and increased absorption of the fungicide into the plant. Cooler temperatures and higher humidity in the morning increase droplet survival time.



## PROPER FUNGICIDE SELECTION

Fungicides, much like herbicides, can be vulnerable to diseases that evolve and become resistant to a specific MOA. When selecting a fungicide, it is crucial to utilize fungicide pre-mixes that include multiple effective MOAs. Also, each MOA will have ratings for efficacy against specific diseases.

## SCOUTING

The most important leaves are the ear leaf and those above, which contribute 75% to 90% of the carbohydrates to the ear. Many diseases start toward the bottom of the plant and work their way up. When scouting your fields, find the ear leaf and look three leaves below that ear. Are you seeing large lesions? If you planted a susceptible hybrid that has yet to reach R3, have experienced favorable conditions for disease development, and those lesions add up to the size of a quarter or a silver dollar, then it may be time to pull the trigger and get out and spray your fields.



# FUNGICIDES AND MOAs

Diseases in cultivated crops are not a new phenomenon. The root cause of the Irish Potato Famine was a fungal disease, *Phytophthora infestans*, commonly called late blight. Today, late blight is still a primary disease concern in potatoes; proactive management practices are in place. Genetics, cultural management, and timely, preventative applications of fungicides are critical.

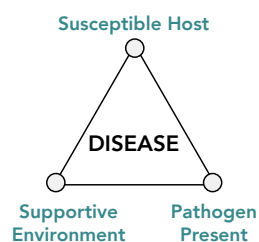
## Why Fungicides?

Fungicides are an integral part of efficient food production to not only protect yield, but to maintain the quality of the grain, vegetable, or fruit. A fungicide is not needed in every field, nor in every year to manage diseases, but the availability of fungicides is a valuable tool. Equally so, the loss of a fungicide through disease resistance is a problem that affects us all.

At the core of fungicide use is an understanding of the disease triangle. Disease can only occur if all three of these factors are present:

- If a plant is susceptible to the disease-causing organism(s)
- A fungal pathogen is present to infect the host
- A proper environment exists for the crop and pathogen to grow

**PLANT DISEASE TRIANGLE**



## Disease Management

With disease management and the subsequent use of a fungicide, you must consider: the fungal pathogen life-cycle; a given fungicide's efficacy on the target pathogen; and the application timing, requirements, and restrictions.

Farmers have excellent resources to address these considerations. The first is the Take Action Fungicide Resistance Management Tool which can be found at [iwilltakeaction.com/diseases/about-the-program](http://iwilltakeaction.com/diseases/about-the-program). The second resource is produced by the Crop Protection Network (CPN) and can be accessed at [cropprotectionnetwork.org](http://cropprotectionnetwork.org).

Using both resources provides a foundation to understand what fungicide active ingredients (a.i.) are contained within a branded product and the efficacy of the a.i. on the crop and disease being managed. Integral to both resources is categorization of the fungicide a.i. by their respective mode of action (MOA).

## Understanding MOA

The MOA is the "how" the fungicide controls a susceptible fungus. The "what" is the defined target site of control: the specific process and/or enzyme that the fungicide a.i. interferes with in development of the disease. Each fungicide is assigned an official FRAC (Fungicide Resistance Action Committee) code to keep track of MOA and target sites. Fungicides may have the same MOA but different target sites and, therefore, separate FRAC codes.

Today, there are three primary fungicide MOAs used in corn and soybeans: triazoles, SDHI, and strobilurin fungicides. The latter two share the same MOA—they both inhibit fungal respiration, but they target different parts of the respiratory system.

Disease resistance to fungicides deserves our collective attention. Understanding fungicides and their respective modes of actions is critical. It is important to note that when a fungal plant pathogen becomes resistant to a specific fungicide, the pathogen is either less or completely insensitive to fungicides in that entire group.

### Maximize Benefits from a Fungicide

- Apply according to label recommendations and when the pathogen pressure is high enough to warrant treatment.
- Repeated use of a fungicide with a single FRAC code is not typically recommended.
- Fungicide mixtures that combine two or more FRAC codes provide additional security that one of the a.i. will kill the pathogen even if it is resistant to the other a.i. in the mixture.
- If the pathogen is already resistant to one component of a fungicide mixture, using a fungicide mixture may eventually select for resistance to the other component.
- Be aware that chemical treatments are not the only disease management option.
- Planting highly tolerant or resistant varieties is the first line of defense against many pathogens, and crop rotation often reduces disease.

### Recommendations for Management of Fungicides

- Scout; know before you go
- Use the high label rate of all fungicides; don't cut rates
- Incorporate application best management practices for equipment, volume, and timing

To learn more about fungicides and fungicide MOA, please reference your respective state extension service bulletins on these topics.

The fungicide decision making process is a "top – down" flow. Know what you are using and how it works on the target pathogens before you purchase and/or use.



**FRAC CODE**  
**Mode of Action**  
**Target Site**  
**Chemical Family**  
**Active Ingredient**  
**Product/Trade Names**

# INSECTICIDES IN CORN AND SOYBEANS

When it comes to insecticides in corn and soybeans, it's important to remember that different pests are present at different points in the season. Whether or not an insecticide is warranted can be determined by a few factors. What insects are present? Does this field have a history of a particular insect pest? Are these insects present at a level that will impact your yield and ROI?

## IN-FURROW INSECTICIDES

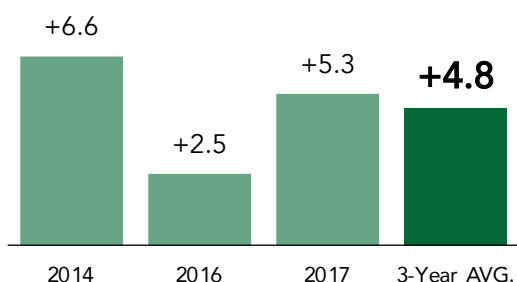


### BLACK CUTWORM

Black cutworm is usually the most damaging cutworm species found in the Corn Belt.

Economic damage is more likely when weed hosts, such as winter annuals, are killed at or just before planting. This causes the cutworms to leave their host plant and relocate to the emerging corn crop.

### 3-Year Capture® LFR® Return on Investment on Corn

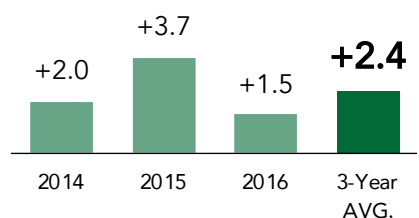


### CORN - CAPTURE® LFR®

3.4 oz./A. In-Furrow

**Labeled for Control of:** Black Cutworm, Armyworm spp., Stalkborer, and Seed Corn Maggot and Beetle, and Wireworm

### 3-Year Capture® LFR® Return on Investment on Soybeans



### SOYBEAN - CAPTURE® LFR®

3.4 oz./A. In-Furrow

**Labeled for Control of:** Bean Leaf Beetle (larvae), Grubs, Seed Corn Maggot and Beetle, and Wireworm

## SOYBEAN FOLIAR INSECTICIDES (R3)

Late-season foliar insecticides have shown the potential to provide synergistic effects when applied with fungicides. For this reason, many farmers choose to apply this combination of products, while others choose to apply insecticides based off of economic thresholds.



### GREEN STINK BUG

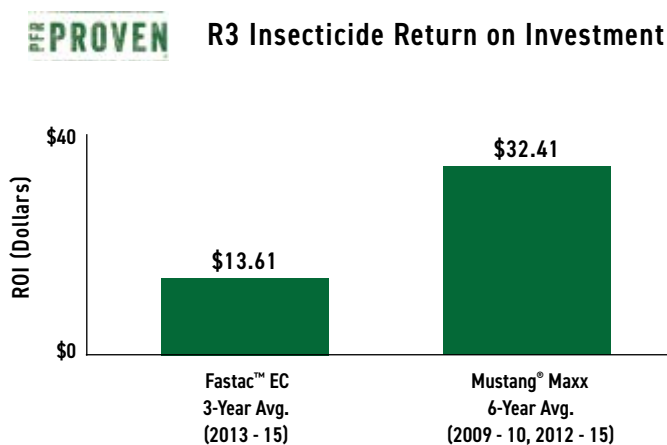
When we think of stink bugs creating issues in soybeans, we primarily think of the green stink bug. The green stink bug can produce multiple generations in a single crop season. The stink bug feeds on pods and the developing seed by puncturing tissue with their mouth. Stink bugs prefer to feed on developing seed pods which can result in shriveled and deformed seeds. In some cases, abortion of the seed has been observed.

### THRESHOLD

Stink bug thresholds tend to be lower than other insects as they can quickly cause significant damage to seed numbers and seed quality. Consider treatment once you detect nine or more adults or nymphs collected with 10 sweeps of a sweepnet. If the soybeans are food-grade or for seed quality, this threshold is reduced to two adults or nymphs detected per 10 sweeps.

### WHAT ABOUT TANK MIXING WITH FUNGICIDES?

Although we have focused on the control of insects and the use of insecticides, we do know from previous research that a combined application of an insecticide and fungicide can result in a synergistic or net greater effect. In other words, 1+1 does not equal 2 in this case but more like 3 or greater with the combined application of both products. Reference the PFR Proven™ soybean fungicide handout for a list of soybean fungicides that have worked at our PFR sites!



### FASTAC™ EC

Alpha-cypermethrin | 3.2 oz./A. at R3

**Labeled for Control of:** Bean Leaf Beetle, Japanese Beetle, Leafopper spp., Soybean Aphid, Grasshopper spp., and Stink Bug spp.

### MUSTANG® MAXX

Zeta-cypermethrin | 3.2 oz./A. at R3

**Labeled for Control of:** Bean Leaf Beetle, Japanese Beetle, Mexican Bean Beetle, Soybean Aphid, and Stink Bug spp.

PFR Proven™ is a trademark of Beck's Superior Hybrids, Inc. Fastac™ is a trademark of BASF. Mustang®, Capture® and LFR® are trademarks of FMC Corporation.

# SOYBEAN FUNGICIDES/GROWTH STAGING

## WHY FUNGICIDES?

Fungicides are an integral part of maximizing soybean production to protect yield, improve harvestability, and preserve grain quality. While they are a valuable tool, fungicides are not needed in every field or every year to manage diseases. At the core of fungicide use is an understanding of the disease triangle. Disease can only occur if all three of the factors at right are present.

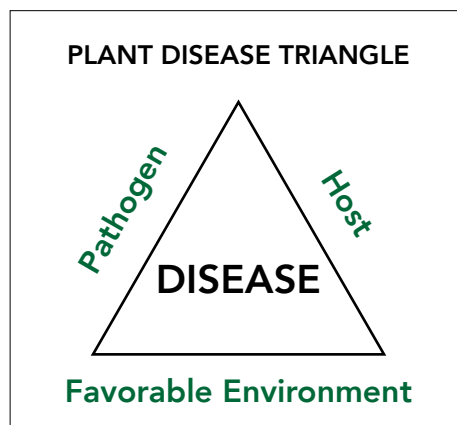
## FUNGICIDE MOAs

Fungicides primarily prevent or mitigate disease, but they can also increase water use efficiency, photosynthesis, and nitrate reductase activity. In addition, they widen the window for grain fill and improve stress tolerance. How a fungicide works depends on its mode or modes of action (MOAs). Today, there are three primary fungicide MOAs used in soybeans: Group 11 – strobilurins (QoI), Group 3 – triazoles (DMI), and Group 7 – carboxamides (SDHI). Group 11 and Group 7 fungicides both inhibit fungal respiration, but they target different parts of the respiratory system. Group 3 fungicides inhibit sterol production in membranes. When selecting a fungicide, it's important to consider products that have multiple MOAs to effectively target fungal pathogens in your area that are a risk to crop yield and/or seed quality. In addition, it's important to understand that repeated use of the same fungicide MOA(s) can create disease resistance.

Farmers have excellent resources to address these considerations. The Take Action Fungicide Resistance Management Tool can be found at [iwilltakeaction.com/diseases](http://iwilltakeaction.com/diseases). In addition, the Crop Protection Network (CPN) resources can be accessed at [cropprotectionnetwork.org](http://cropprotectionnetwork.org).

## BECK'S PRACTICAL FARM RESEARCH (PFR)<sup>®</sup> RESULTS

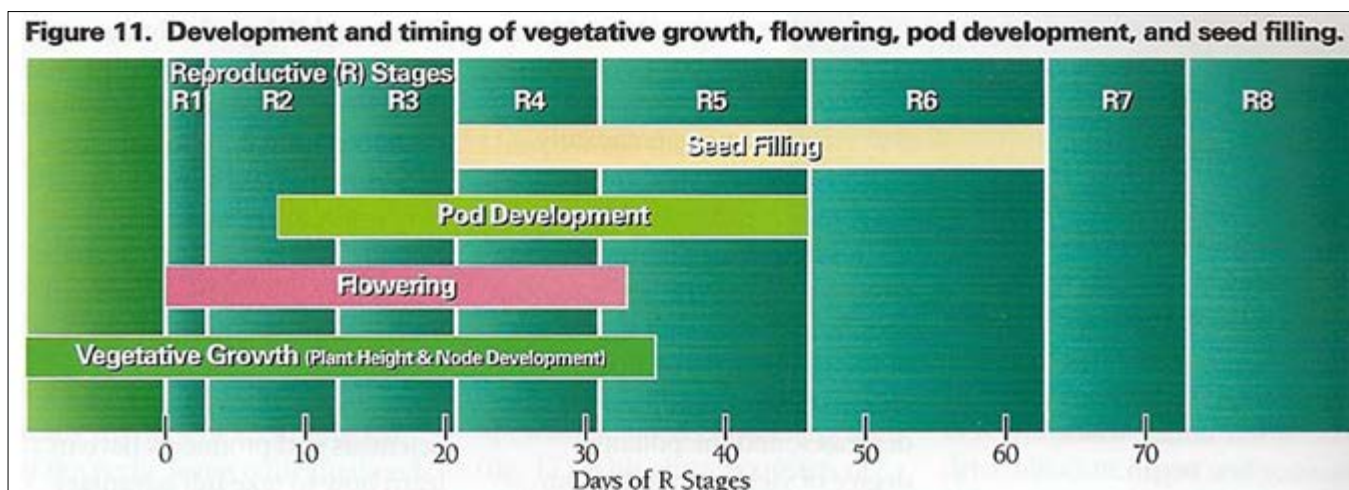
Seven-year PFR data has shown a \$17/A. return on investment (ROI) advantage from an R3 application of a fungicide and an insecticide. Multi-year data summaries using various soybean fungicides indicate that R3 is the optimum growth stage for making a foliar fungicide application to maximize ROI. The R3 growth stage in soybeans is identified by having at least one pod that is 3/16 in. long at one of the four uppermost nodes on the main stem with a fully developed leaf (as shown below). Because R3 is the start of pod development, it's also the best time to control diseases and insects. The majority of soybean grain yield (about 70%) comes from nodes 6 to 13. An R3 application would provide additional protection to those nodes, which might explain the positive yield response.



Pictures show 3/16 in. - 1/4 in. pods at the 4 node down from the top of the plant, indicating R3 growth stage. Photos by: Chad J Kalaher

## HOW LONG ARE SOYBEANS IN THE R3 GROWTH STAGE?

According to research by Iowa State University (Figure 11 below), soybeans enter the R3 growth stage about 12 days after R1 (flower initiation). Regardless of the planting date, Purdue University's data from 2010 and 2011 suggests that soybeans reach R1 when approximately 520 GDDs have accumulated from planting. It's important for soybean farmers to track GDD accumulation from planting and scout fields for flower initiation. This will help plan for proper timing of an R3 fungicide application. Lastly, it's important to recognize that soybeans will remain at R3 for about 10 days.



Source: Iowa State PM1945, 2009

## ARE THERE EXCEPTIONS TO R3 BEING THE OPTIMUM APPLICATION TIMING?

Most soybean fungicide labels give a range of application between R2 and R4 for the most common foliar diseases. However, Beck's PFR has identified R3 as the optimum application timing. One exception to this rule is when managing white mold using foliar fungicide. If you are growing soybeans in an area where white mold is an annual concern, or you have experienced cool (<85°F high temperatures) and wet conditions with high relative humidity and a dense canopy, the optimum fungicide application timing is at flower initiation (R1). In recent university research, Endura®, a Group 7 fungicide (SDHI), has provided the best white mold protection with a single application at R1.

## DOES CARRIER RATE AND FUNGICIDE APPLICATION TIME OF DAY MATTER?

Beck's PFR data indicates that a fungicide application appears to be more effective when applied in the morning compared to mid-afternoon. A dew may help spread the fungicide over the leaf surface. This may have even greater significance when comparing aerial application to ground application. In addition, PFR results suggest that when using ground application, a carrier volume of 15 or 20 gal./A. of water with the fungicide provides a yield advantage compared to 10 GPA of water.

# DOES FOLIAR FEEDING PAY?

Supplying small doses of necessary nutrients through foliar feeding is a viable option when soils cannot provide what is needed. Targeting the correct nutrient and matching these applications with already planned herbicide or fungicide passes can help simplify and justify their use.



# FOLIAR NUTRITION

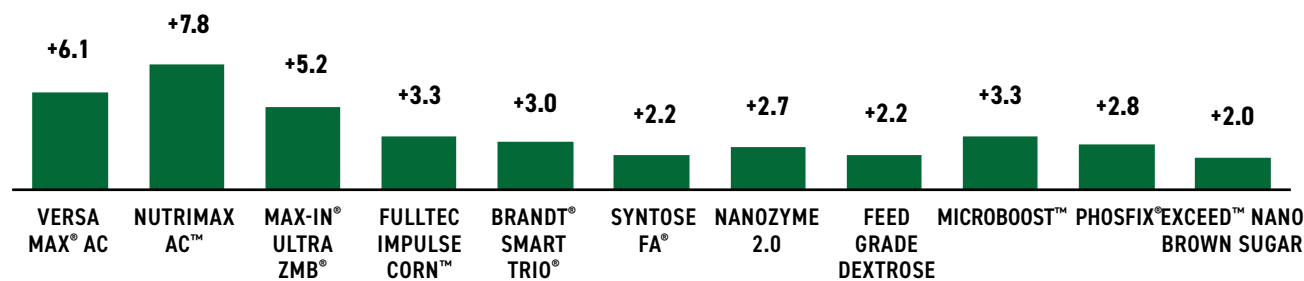
## CORN

Foliar feeds in corn can be added to a post-emerge herbicide application targeted at the V4/V5 growth stage. Environmental stresses at this time could limit nutrient availability and uptake, resulting in increased potential for a positive response from foliar feeding.

NEW

FOLIAR NUTRITION	PFR PROVEN ROI	ROI WIN %	YIELD ADVANTAGE (BU./A.)	YIELD WIN %	APPLICATION RATE & TIMING	COMPANY
VERSA MAX® AC	\$18.80	88%	6.1	88%	1 qt. @ V4	Rosen's Inc.
NUTRIMAX AC™	\$16.36	67%	7.8	100%	24 oz. @ V4	Excel Ag, Corp., USA
MAX-IN® ULTRA ZMB®	\$15.72	71%	5.2	100%	1 qt. @ V4	Winfield Solutions, LLC.
FULLTEC IMPULSE CORN™	\$9.05	60%	3.3	100%	1 Box/100 Acres @ V4	Spraytec Fertilizers LLC.
BRANDT® SMART TRIO®	\$9.00	73%	3.0	82%	1 qt. @ V4	Brandt Consolidated, Inc.
SYNTOSE FA®	\$7.72	73%	2.2	73%	1 pt. @ V4	Conklin Company, Inc.
NANOZYME 2.0	\$6.54	50%	2.7	50%	1 pt. @ V4	Max Systems, LLC.
FEED GRADE DEXTROSE	\$6.04	67%	2.2	78%	4 lb. @ V4	International Ingredient Corporation
MICROBOOST™	\$5.88	56%	3.3	56%	1 qt. @ V4	Max Systems, LLC.
PHOSFIX®	\$5.45	44%	2.8	78%	1 pt. @ V4	The Andersons, Inc.
EXCEED™ NANO BROWN SUGAR	\$5.28	78%	2.0	78%	8 oz. @ V4	Max Systems, LLC.

PFR PROVEN™ FOLIAR NUTRITION YIELD ADVANTAGE (BU./A.)



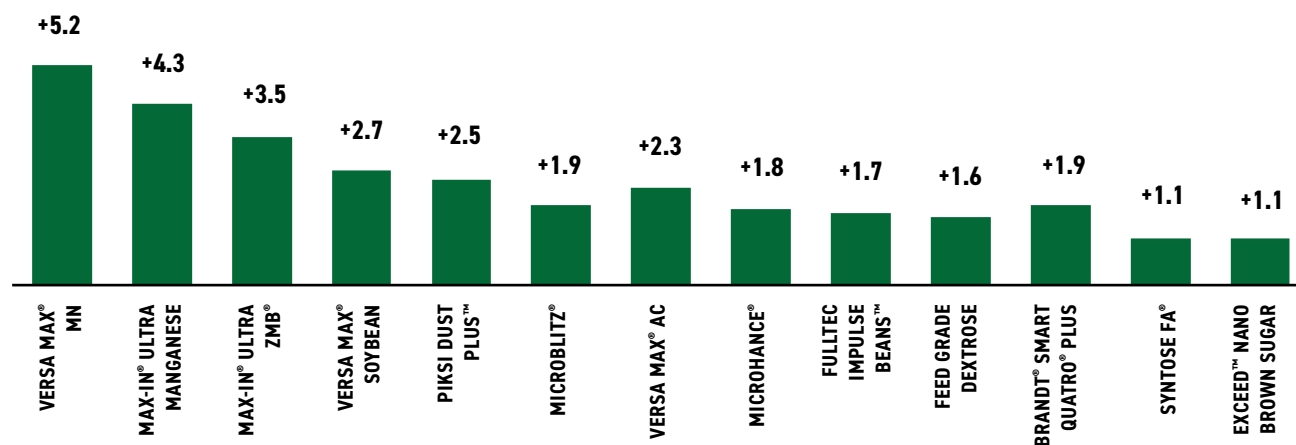
**WHAT WE RECOMMEND:** During the rapid growth phase (beginning about V8), plants require large amounts of essential nutrients to sustain growth. Utilize foliar products to help plant growth when facing reduced access to soil nutrients, restricted root growth, dry soil conditions, high pH, or coarse-textured soils.

# FOLIAR NUTRITION & STRESS MITIGATION

## SOYBEANS

FOLIAR NUTRITION	PFR PROVEN ROI	ROI WIN %	YIELD ADVANTAGE (BU./A.)	YIELD WIN %	APPLICATION RATE & TIMING	COMPANY
VERSA MAX® MN	\$58.22	100%	5.2	100%	2 qt. @ V4	Rosen's Inc.
MAX-IN® ULTRA MANGANESE	\$33.57	80%	4.3	80%	2 qt. @ V4	Winfield Solutions, LLC.
MAX-IN® ULTRA ZMB®	\$32.16	75%	3.5	88%	2 qt. @ R1	Winfield Solutions, LLC.
VERSA MAX® SOYBEAN	\$24.29	100%	2.7	100%	2 qt. @ R1	Rosen's Inc.
PIKSI DUST PLUS™	\$19.30	69%	2.5	85%	1.8 grams/gal. of Liquid @ V3	Alchemy Bioscience, LLC.
MICROBLITZ®	\$16.70	100%	1.9	100%	1 qt. @ R1	The Andersons, Inc.
VERSA MAX® AC	\$16.64	50%	2.3	70%	2 qt. @ R1	Rosen's Inc.
MICROHANCE®	\$13.98	100%	1.8	100%	1 qt. @ R1	Monty's Plant Food.
FULLTEC IMPULSE BEANS™	\$13.80	60%	1.7	73%	1 Box/100 Acres @ R1	Spraytec Fertilizers LLC.
FEED GRADE DEXTROSE	\$12.85	78%	1.6	78%	4 lb. @ R1	International Ingredient Corporation
BRANDT® SMART QUATRO® PLUS	\$11.57	67%	1.9	67%	1 qt. @ R1-R3	Brandt Consolidated, Inc.
SYNTOSE FA®	\$9.75	65%	1.1	70%	1 pt. @ R1	Conklin Company, Inc.
EXCEED™ NANO BROWN SUGAR	\$8.90	72%	1.1	72%	8 oz. @ R1	Max Systems, LLC.

### PFR PROVEN™ FOLIAR NUTRITION & STRESS MITIGATION PRODUCTS - YIELD ADVANTAGE (BU./A.)



**WHAT WE RECOMMEND:** When applying foliar nutrition products in the early vegetative growth stages, select products that contain manganese. Boron is the primary nutrient to include when making foliar applications during the reproductive stages.

# FOLIAR NUTRITION & STRESS MITIGATION

## SOYBEANS

### STRESS MITIGATION

These products contain components like bio-stimulants, carbon sources, and nutrition to help plants mitigate the physiological impact of stress. In our studies, a Group 14 herbicide was applied to induce crop stress. We believe these products will be effective in the presence of other stresses like adverse weather and growing conditions.

STRESS MITIGATION	PFR PROVEN ROI	ROI WIN %	YIELD ADVANTAGE (BU./A.)	YIELD WIN %	APPLICATION RATE & TIMING"	COMPANY
EXCEED™ NANO BROWN SUGAR	\$19.95	83%	1.7	83%	8 oz. With POST Herbicide	Max Systems, LLC.
STIMTIDE®	\$15.37	58%	1.9	83%	1 pt. With POST Herbicide	Hello Nature USA, Inc.
APPLE CIDER VINEGAR	\$11.33	75%	1.0	75%	1 qt. With POST Herbicide	Varies
VALUPAK™	\$10.02	75%	1.3	83%	12 oz. With POST Herbicide	AgXplore International, LLC.

### WATER CONDITIONER

The properties in water that bind or reduce plant mobility most commonly are pH (causing alkaline hydrolysis) and water hardness (causing negative molecular binding). Water conditioners can mitigate these problems by lowering the pH and adding molecules that counteract these harmful properties.

WATER CONDITIONER	PFR PROVEN ROI	ROI WIN %	YIELD ADVANTAGE (BU./A.)	YIELD WIN %	APPLICATION RATE & TIMING	COMPANY
BRANDT® INDICATE 5®	\$9.58	75%	1.1	75%	1.5 oz. @ R1	Brandt Consolidated, Inc.

### ADJUVANT

Spray adjuvants perform many functions, such as enhancing plant uptake, reducing droplet evaporation, and reducing the surface tension of the spray droplet. Many perform multiple functions, so select the product that best serves your needs.

FOLIAR ADJUVANT	PFR PROVEN ROI	ROI WIN %	YIELD ADVANTAGE (BU./A.)	YIELD WIN %	APPLICATION RATE & TIMING	COMPANY
NANOPRO®	\$8.75	67%	0.9	72%	4 oz. @ V4	Aqua Yield Operations, LLC.

# LATE-SEASON NUTRITION

## SOYBEAN PRODUCTS AND YIELD ADVANTAGE

### WHY SHOULD I APPLY LATE-SEASON NUTRITION ON MY SOYBEANS?

Although the micronutrient we commonly think about in soybeans is manganese, boron deficiencies are not uncommon, especially on calcareous soils. Because boron must be mineralized from organic matter, coarse-textured soils often experience deficiencies. Dry weather reduces mineralization and limits the movement of boron to the plant, which is another common cause of deficiency. Soybean plants do not require large amounts of boron, so foliar applications may be an effective method of remediation. Dry weather also impacts potassium availability by collapsing the clay lattice and trapping the molecules, preventing them from moving to the plant in soil water. Potassium is often one of the first visual deficiencies we see in a dry spell. Although large quantities of potassium are required, we have seen some benefits to supplemental foliar K, especially in dry years.

LATE-SEASON NUTRITION	PFR PROVEN ROI	ROI WIN %	YIELD ADVANTAGE (BU./A.)	YIELD WIN %	APPLICATION RATE & TIMING	ANALYSIS	COMPANY
BRANDT® SMART K B	\$16.73	73%	1.5	73%	1 pt. @ R3	2-0-16-2.5B-0.2Mo	Brandt Consolidated, Inc.
BRANDT® SMART B-MO™	\$13.18	82%	1.8	82%	1 pt. @ R3	0-0-0-5B-0.5Mo	Brandt Consolidated, Inc.
NACHURS® K-FLEX®	\$6.51	67%	1.3	73%	1 gal. @ R3	0-0-19-6S	NACHURS ALPINE SOLUTIONS
FULLTEC K™	\$5.81	60%	1.0	67%	4 oz. @ R3	0-0-9-1.9B-0.3Co	Spraytec Fertilizers LLC.
HARVEST MORE® UREA MATE	\$2.22	50%	0.8	58%	2.5 lb. @ R3	5-10-27-0.15B	StollerUSA

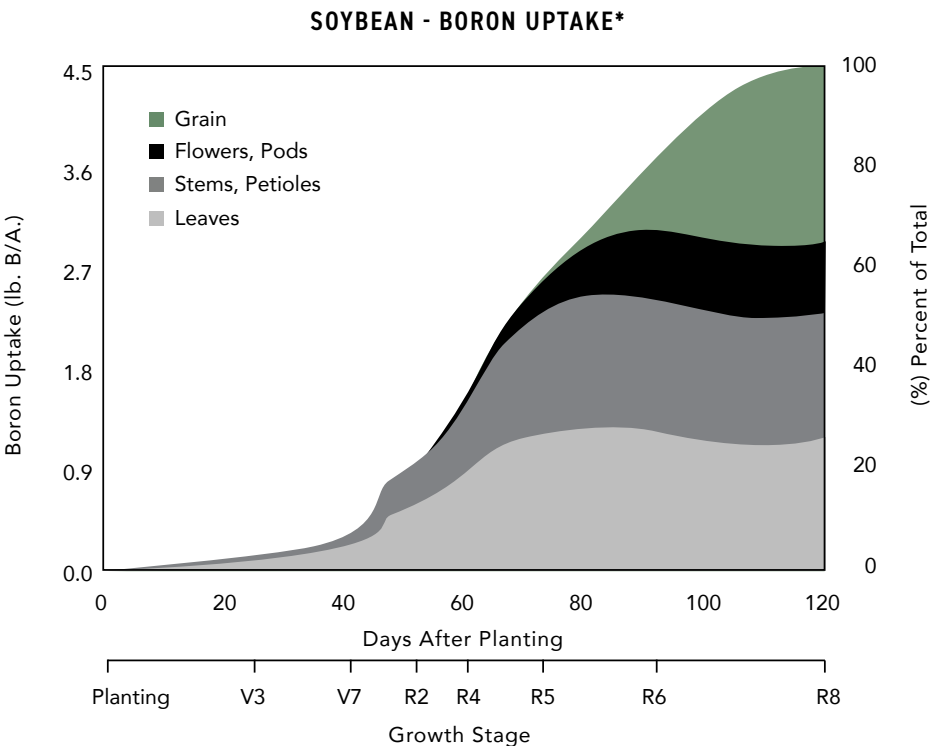
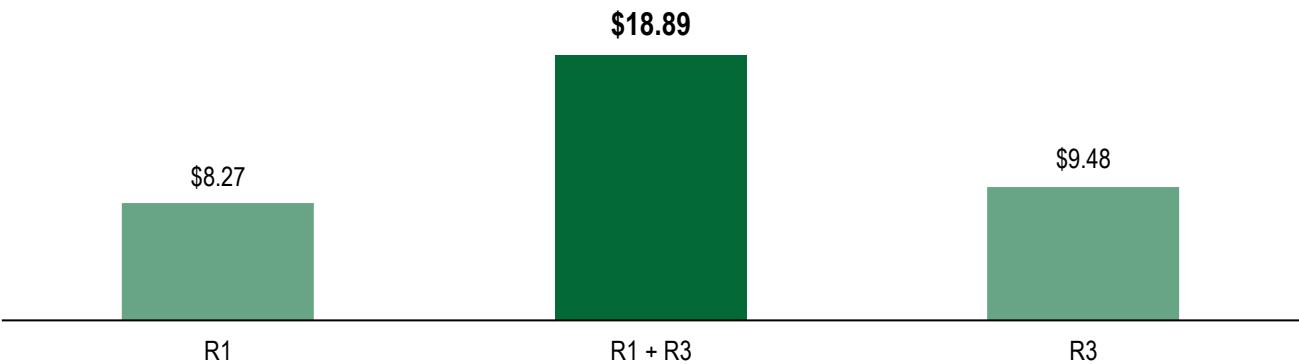
# LATE-SEASON NUTRITION

## SOYBEAN PRACTICES

### WHEN SHOULD I APPLY BORON TO SOYBEANS?

Boron performs many functions in the soybean plant, including nodulation effectiveness and assisting in pollination and pod fill. The application window for boron is wider than corn, likely due to the extended flowering and pod fill period. Although single applications of boron have proven effective, our data indicates the highest returns come from multiple applications during the reproductive phases. However, the practicality of a single pass solely for the application of boron is low.

### 3-YEAR MULTI-LOCATION BORON TIMING RETURN ON INVESTMENT - SOYBEAN



\*Bender, R.R., J.W. Haegle and F.E. Below. Modern soybean varieties' nutrient uptake patterns. Better Crops with Plant Food 2015;99(2):7-10.

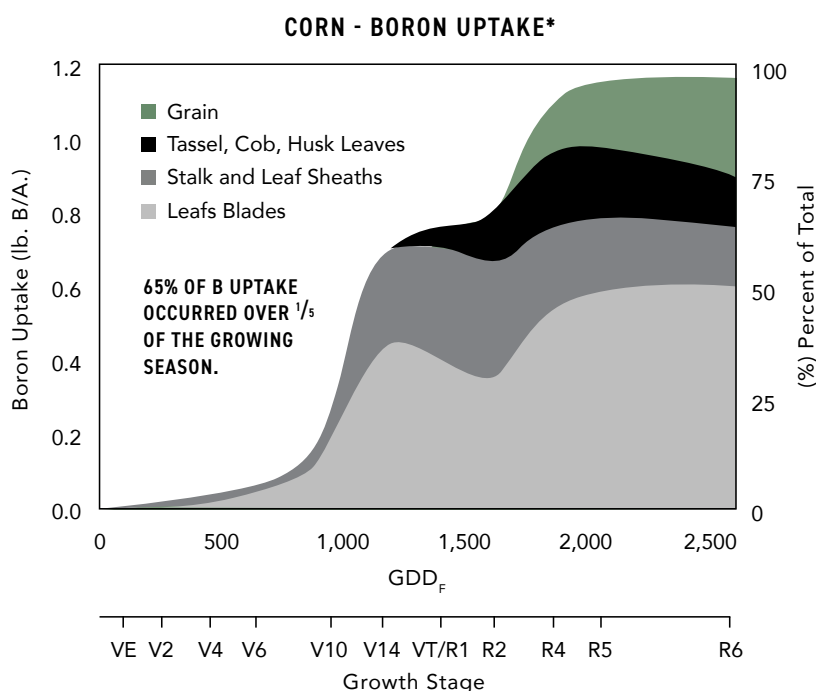
# LATE-SEASON NUTRITION

## CORN PRODUCTS

### WHY SHOULD I APPLY LATE-SEASON NUTRITION TO MY CORN?

Boron (B) has a unique uptake curve with a spike in uptake at flowering. It is mobile in soil water; thus, uptake can be limited in dry spells. Because B is mineralized from organic matter, fields with coarse-textured soils are more likely to respond to foliar applications of B. Potassium availability can also be limited in dry spells when the clay sheets collapse and trap the potassium ions. In these situations, it may be beneficial to supply additional nutrition like potassium and boron to the plant.

LATE-SEASON NUTRITION	PFR PROVEN ROI	ROI WIN %	YIELD ADVANTAGE (BU./A.)	YIELD WIN %	APPLICATION RATE & TIMING	ANALYSIS	COMPANY
HARVEST MORE® UREA MATE	\$13.60	78%	4.6	100%	2.5 lb. @ VT-R1	5-10-27-0.15B	StollerUSA
BRANDT® SMART B-MO™	\$11.22	64%	3.5	82%	1 pt. @ R1	0-0-0-5B-0.5Mo	Brandt Consolidated, Inc.
BRANDT® SMART K B	\$8.18	75%	2.0	83%	1 pt. @ R1	2-0-16-2.5B-0.2Mo	Brandt Consolidated, Inc.
FEAST®-XL PROFIT MASTER™ 26-0-0 W/0.5B	\$7.53	57%	4.3	100%	1.5 gal. @ VT	26-0-0-0.5B	Conklin Company, Inc.
KORRECT® (3-0-20)	\$7.38	58%	2.7	75%	1 gal. @ R1	3-0-20	The Andersons, Inc.
BORON PLUS®	\$7.29	78%	2.3	89%	6 oz. @ VT	0-0-0-5B	DeltAg Formulations



**A 200-bushel corn crop requires about 0.6 lb. of boron.**

**Boron is needed in small amounts and at very specific times; therefore, foliar applications have a meaningful impact when timed correctly.**

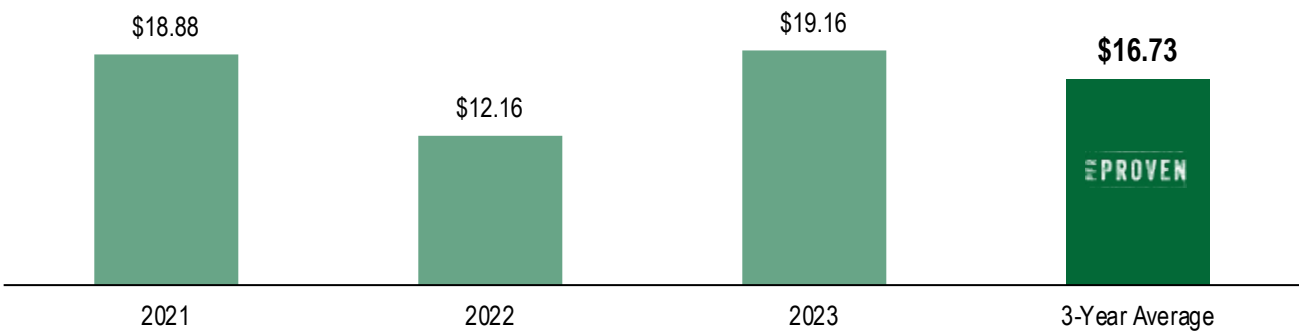
\*Adapted from Agronomy Journal 105 (1), 2013

# FUNGICIDE ADDITIVE STUDY - CORN

When making a fungicide pass at the R3 growth stage, it may be profitable to include foliar nutrition. Boron must be mineralized from soil organic matter and moved via soil water to the plant. Potassium can be trapped between clay layers when dry conditions persist and also become unavailable. Most of our sites experienced dry conditions during grain fill; therefore, it is unsurprising to see a response to supplemental applications of boron and potassium. Brandt® Smart K B has provided consistent returns for three years and is now PFR Proven™.

2023 MULTI-LOCATION RESULTS				MULTI-YEAR RESULTS		
R3 TREATMENTS	PERCENT MOISTURE	BU./A.	BU./A. DIFFERENCE	RETURN ON INVESTMENT	MULTI-YEAR RETURN ON INVESTMENT	YEARS TESTED
Control: Fungicide (5 oz. Lucento®)	11.3	64.0	--	--	--	--
Fungicide + 1 pt. BRANDT® Smart K B	11.3	65.7	+1.7	+\$19.16	+\$16.73	3
Fungicide + 4 oz. Fulltec K™	11.3	64.5	+0.5	-\$0.90	+\$6.06	2
Fungicide + 4 oz. NanoK®	11.4	64.4	+0.4	-\$1.83	-\$0.32	2
Fungicide + 1 gal. Korrect® Plus	11.4	64.0	+0.0	-\$9.00	-\$9.00	1
Soybeans \$13.39/Bu. BRANDT® Smart K B \$28.80/gal. NanoK® \$230.00/gal. Fulltec K™ \$243.20/gal. Korrect® Plus \$9.00/gal. These results are based on the disclosed study parameters and participating sites.						

3-YEAR MULTI-LOCATION BRANDT® SMART K B RETURN ON INVESTMENT

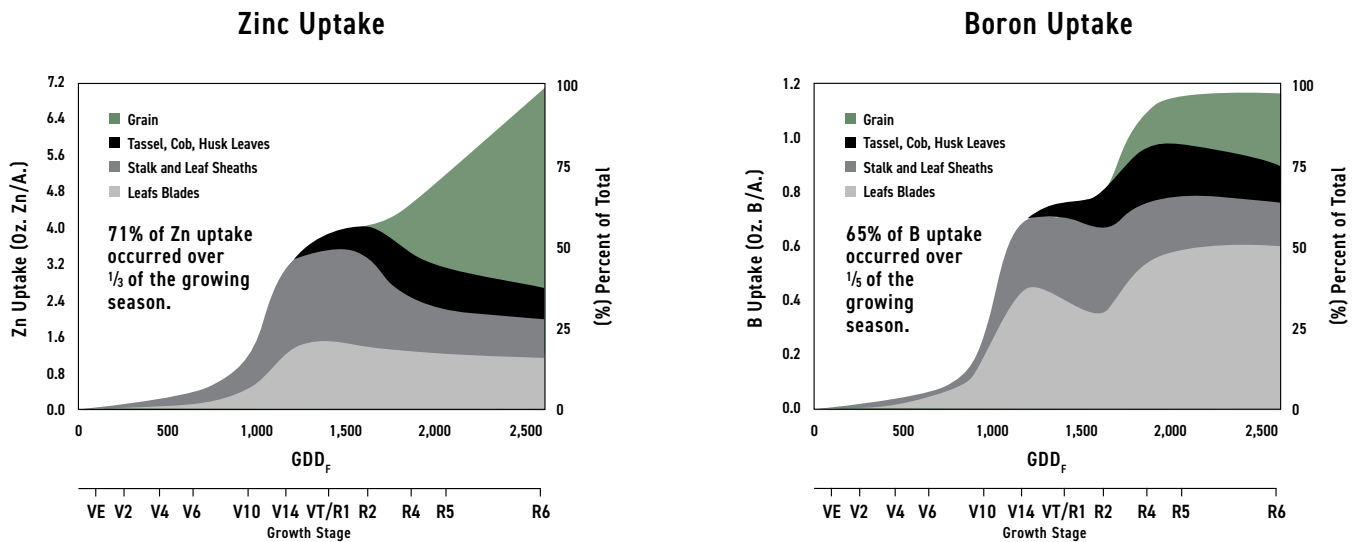


Scan the QR Code to watch a video about this study!



# CORN FOLIAR NUTRITION

We know that micronutrients such as zinc (Zn), manganese (Mn), and boron (B) are important for the growth and development of a corn plant. These nutrients are especially important at grain fill, as shown below. While timing is key, we also know that plants only require approximately 0.6 lb. of both Zn and B to produce a 220 Bu./A. corn crop, so foliar applications could potentially supply an adequate amount.



Charts adapted from Bender, et. al., 2015

## AS STATED IN "MODERN CORN HYBRIDS NUTRIENT UPTAKE PATTERNS"

- Effectively minimizing nutrient stress requires the matching of nutrient supply with plant needs, especially in high-yielding conditions.
- Matching corn micronutrient needs in high-yielding conditions requires us to supply nutrient sources and rates that can meet the crop's needs during key growth stages.
- Micronutrients demonstrated more narrow periods of nutrient uptake than macronutrients, especially Zn and B.

Source: Bender, R.R., J.W. Haegle, M.L. Ruffo, and F.E. Below. 2013. Modern Corn Hybrids Nutrient Uptake Patterns. 97 (1): 7-10.



A & L Great Lakes soil test results also demonstrate declining soil levels of both Zn and B in the Midwest.

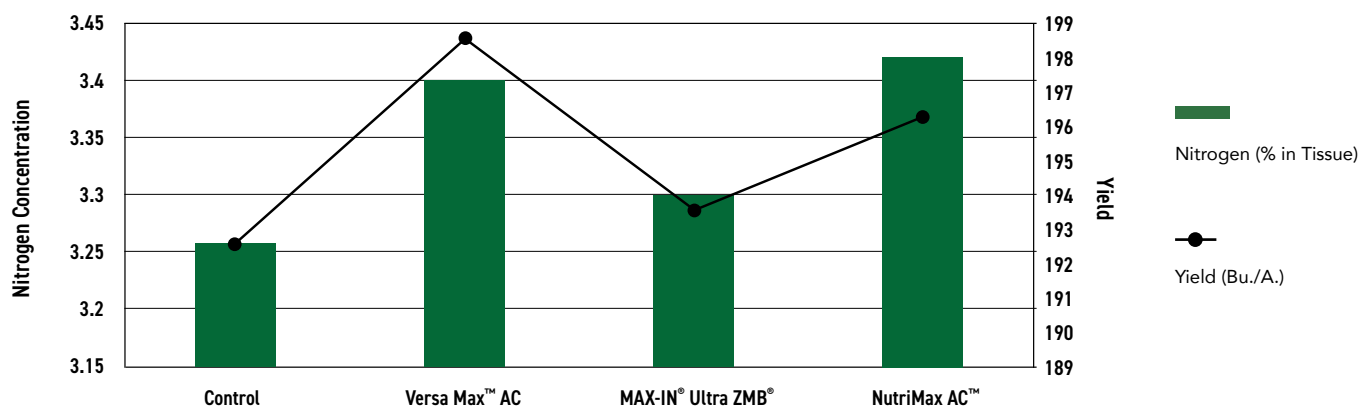
## WHY ARE WE POTENTIALLY SEEING MORE RESPONSES TO FOLIAR NUTRITION?

We are experiencing increased yield levels that stretch the soil's ability to provide the necessary nutrients. For many necessary nutrients, we rely on mineralization to provide them from organic matter in the soil. Mineralization requires key environmental conditions like moisture, oxygen, and temperature, to operate at peak efficiency. In addition, key micronutrients such as B and Zn have tight windows for uptake. Therefore, environmental conditions that impede mineralization during these peak uptake times may limit availability, even in soils with good organic matter and fertility levels.

## PFR PROVEN™ FOLIAR PRODUCTS NUTRIENT CONTENT (%)

Product	N	P	K	S	Zn	Mn	B	Fe	Ca	Mg	Cu	Mo	Humic Acid
MicroBoost™	--	--	--	--	2.3	0.50	0.10	1.8	1.7	0.35	0.25	--	--
Phosfix™	7.0	4.0	9.0	--	--	--	--	--	--	--	--	--	--
eXceed™ Nano Brown Sugar	--	--	--	--	--	--	--	--	--	--	--	2.5	6.0
NanoZyme 2.0	--	--	--	--	--	4.0 - 6.0	--	4.0 - 6.0	--	--	--	--	10.0 - 12.0

## Yield Response and Nitrogen Concentration as Related to Foliar Nutrition



PFR Proven Products	Rate and Application Timing	Multi-Year Yield Advantage	Multi-Year ROI Average
Versa Max™ AC	1 qt. @ V4	+6.1 Bu./A.	\$18.80/A.
MAX-IN® Ultra ZMB®	1 qt. @ V4	+5.2 Bu./A.	\$15.72/A.
NutriMax AC™	24 oz. @ V4	+7.8 Bu./A.	\$16.36/A.
MicroBoost™	1 qt. @ V4	+3.3 Bu./A.	\$5.88/A.
Phosfix™	1 qt. @ V4	+2.8 Bu./A.	\$5.45/A.
eXceed™ Nano Brown Sugar	8 oz. @ V4	+2.0 Bu./A.	\$5.28/A.
NanoZyme 2.0	1 pt. @ V4	+2.7 Bu./A.	\$6.54/A.
Feed Grade Dextrose	4 lb. @ V4	+2.2 Bu./A.	\$6.04/A.

## FOLIAR TIMING

Beck's PFR results have both shown the potential to increase yields with foliar products simply by focusing applications to a certain time of day. These results indicate that morning and late evening applications deliver greater nutrient uptake, and ultimately greater yields. There could also be a correlation to timing with certain hybrids. We will continue to research this in PFR to determine when peak yields can be achieved.

# FOLIAR NUTRITION & TISSUE SAMPLING IN CORN

There are two primary reasons to consider a foliar nutrient application:

1. The crop is showing visual symptoms of a deficiency.
2. There is a goal to ensure that the crop has all nutrients necessary to maximize yield potential.

Before applying a foliar nutrition product, it's important to find out if there is a need for such an application by visually identifying nutrient deficiencies or performing a tissue test.

MOBILE	IMMOBILE
Nitrogen	Calcium
Phosphorus	Sulfur
Potassium	Boron
Magnesium	Copper
Chlorine	Iron
Molybdenum	Zinc
Nickel	Manganese

**Identifying Nutrient Deficiencies:** Some nutrient deficiencies have distinct symptoms; others can look similar. Some nutrients are mobile in plants and some are not, which determines where deficiency symptoms show up. If the symptoms are present on the lower leaves of a plant, that indicates that the plant is moving the nutrients up to the newer growth, and the deficient nutrient is mobile. If the symptoms are in the new growth, then an immobile nutrient is the issue. Several common deficiencies are pictured below.

The ideal timing for tissue sampling in corn is 7-10 days before these critical growth stages:

**V5:** Determination of ear girth (rows around)

**VT/R1:** Pollination & determination of kernel count (length of ear)

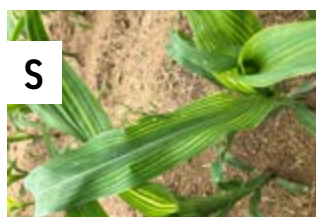
When walking the field, look for patterns to explain the deficiency. Soil type, soil moisture, compaction, disease, pH, or other factors affect nutrient availability and the plant's ability to access nutrients in the soil.

**Sample Timing:** Take tissue samples as soon as you suspect a nutrient deficiency. If you're sampling as a proactive measure to ensure the corn is not running short on nutrients, time the sample to

prior to critical yield-determining growth stages. That way, an application can be made to correct any shortfalls and allow the plant to set its yield potential at the highest level possible.

**Sampling Method:** When taking tissue samples to confirm a suspected deficiency, be sure to sample both healthy and unhealthy areas of the field so that results can be compared. When there are no visual signs of deficiency, take a representative sample(s) of the field being tested. As far as number of samples, this will vary from as few as 15 leaves to 30 plants, depending on the corn's growth stage. The key is to entirely fill a tissue sample bag.

## NUTRIENT DEFICIENCY EXAMPLES IN CORN



**Parts of a corn plant to collect for a tissue sample:**

**<12 IN. TALL:** Collect all of the above-ground tissue of 25-30 plants

**>12 IN. TALL:** Collect the newest fully-collared leaf from 15-20 plants

**AFTER TASSEL:** Collect the leaf below and opposite the ear from 15-20 plants

**Sample Handling** – Tissue samples should arrive at the lab in the freshest state possible. Generally, this means samples should be pulled Monday-Wednesday, so they reach the lab quickly and do not sit over the weekend. Samples should be free of any dirt, water, or other debris; cleaning samples may be necessary. If you are not able to ship samples immediately, they should be placed in a refrigerator for short-term storage. Using a lab-provided tissue sample bag is advisable but not necessary. Use a bag that will allow for air movement; lunch-sized paper bags work well. Don't use sealed plastic bags or wax coated soil sample bags.

**Understanding Test Results** – You will generally receive results within a few days of the lab receiving the samples. The results will look like soil sample results, except with more nutrients listed. Macronutrients are generally reported as a percentage and micronutrients in parts per million (ppm). Most labs will provide a sufficiency range for each nutrient and show how each sample compares to that range.

**Making an Application** – Some deficiencies are easily corrected with foliar applications and some are not. For most micronutrient deficiencies, foliar application works well because micronutrients are needed in very small amounts. Macronutrient deficiencies are not corrected with foliar applications because of the large amount of nutrient required to make a correction.

Choose the right foliar product by ensuring that the product contains the nutrients the corn requires. Using a product that contains a wide array of nutrients like Versa Max™ AC can be a good strategy, but if there are only one or two deficient nutrients, there may be a more efficient way to deliver those.

Time your application to coincide with crop needs. For example, in PFR, the only time that applying boron has shown a positive ROI is at VT. Boron is immobile in the plant, so when it is applied, it moves to the newest growth and stays there. At VT, the newest growth is the ear, so boron moves straight to the ear, where it is needed most.

Foliar applications may not always produce a positive ROI. The chances of a foliar application being beneficial increase when scouting and tissue sampling are used strategically to direct the decision. Tissue sampling can be instructive in evaluating your fertility management, and may help identify other areas of improvement outside of foliar nutrient applications.

**PFR PROVEN™ CORN FOLIAR PRODUCTS**

PRODUCT	RATE/TIMING	YIELD GAIN	ROI	YEARS TESTED	MANUFACTURER
Versa Max™ AC	1 qt. @ V4	+6.1 Bu./A.	+\$18.80	4	Rosens, Inc.
Nutrimax AC™	24 oz. @ V4	+7.8 Bu./A.	+\$16.36	3	Excel Ag, Corp., USA
Max-In® Ultra ZMB®	1 qt. @ V4	+5.2 Bu./A.	+\$15.72	4	Winfield United
Boron Plus®	6 oz. @ VT	+2.3 Bu./A.	+\$7.29	3	DeltAg Formulations
Microboost™	1 qt. @ V4	+3.3 Bu./A.	+\$5.88	3	Max Systems, LLC
Phosfix™	1 pt. @ V4	+2.8 Bu./A.	+\$5.45	3	The Andersons, Inc.

Photo Credits:

N - University of Illinois: <http://bulletin.ipm.illinois.edu/print.php?id=1163>

P & K - University of Nebraska: <https://cropwatch.unl.edu/soils/keys/soilnutrientdef>

Mg & Mn – Purdue University: [https://www.agry.purdue.edu/ext/soilfertility/news/Striped\\_Corn.pdf](https://www.agry.purdue.edu/ext/soilfertility/news/Striped_Corn.pdf)

Zn – Purdue University: <https://www.agry.purdue.edu/ext/soilfertility/ZincDeficiencyCorn.pdf>

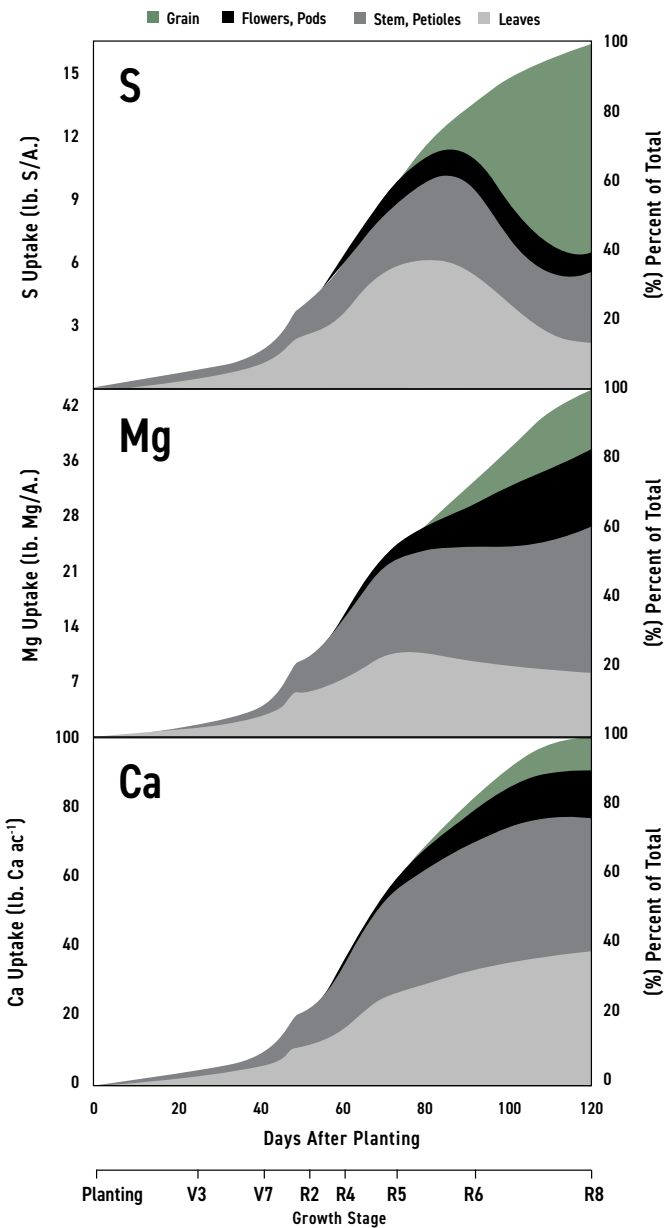
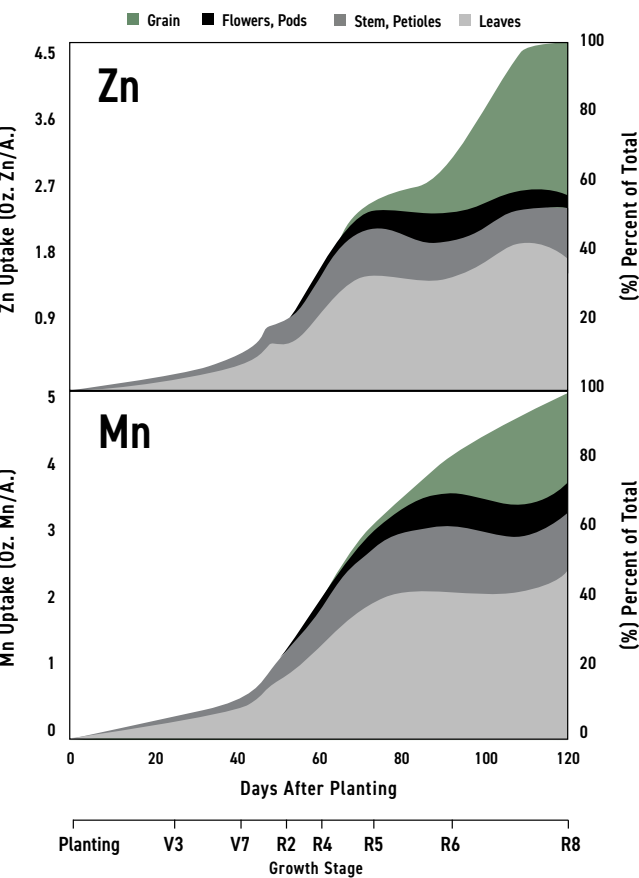
# SOYBEAN FOLIAR NUTRITION

We know that different nutrients are required at different times for optimum soybean yields. Current soybean biomass production shows a two-fold increase from the 1930s, and yields show a three-fold increase. With these drastic changes in genetics, it only makes sense that we would also see changes in nutrient uptake. In addition to genetics, there is evidence that environmental factors like temperature, moisture, and soil fertility influence nutrient uptake.

To the right is the nutrient content found in grain at the end of the season from research conducted in *Nutrient Uptake, Partitioning, and Remobilization in Modern Soybean Varieties*. Nutrient uptake is slow and steady for the first 40 days after germination. It isn't until V4 that a steady increase in secondary and micronutrient uptake occurs while macronutrients are taken up in the greatest amounts starting between V7 and R2 (full flowering).

Bender, Ross R., et al. "Nutrient Uptake, Partitioning, and Remobilization in Modern Soybean Varieties." *Agronomy Journal*. Volume 107, Issue 2. February 25, 2015.

Nutrient	Macronutrients (lbs./Bu.)						Micronutrients (oz./Bu.)			
	N	P	K	Ca	Mg	S	Zn	Mn	B	Cu
Nutrient Removal	2.98	0.25	0.95	0.15	0.13	0.17	.033	.022	.026	.0093





## WHEN DOES THE SOYBEAN NEED EACH NUTRIENT

Harvest index is a measure of the percentage of an applied nutrient that is removed in the grain. Several nutrients have consistently shown high harvest index values. In other words, these nutrients are closely correlated to yield. The nutrients on this list: N, P, S, Cu, have all shown a harvest index value greater than 50 percent. The importance of these nutrients in grain fill emphasizes the need to have adequate amounts of these nutrients during reproductive growth stages.

Nutrient uptake in soybeans closely aligns with dry matter accumulation. Nearly 75% of K uptake occurs prior to seed fill. Then during seed fill the plant moves, or remobilizes, K mostly from the stem and to a lesser degree from the leaves to the grain. The soybean plant remobilizes most of the N and P for seed fill from the stem. The plant steadily accumulates N, P, S, Mg, Ca, Zn, B, and Mn throughout the season and partitions the nutrients to the leaf, stem and petiole. There are increases in plant demand, and therefore uptake, for micronutrients at V4 and for macronutrients between V7 and R2. Because the plants have increased demand at those times in the season, the windows of application found with positive ROI in PFR testing make sense.

PFR Proven Foliar Products/Results	N	P	K	S	Zn	Mn	B	Fe	Cu	Mo	Yield Advantage (Bu./A.)	ROI (Dollars/A.)
<b>V4-R1</b>	-----%-----											
Versa Max™ Mn	--	--	--	3	--	5	--	--	--	--	+5.2	\$58.22/A.
MAX-IN® Ultra Manganese	--	--	--	--	--	5	--	--	--	--	+4.3	\$33.57/A.
<b>R1-R3</b>	-----%-----											
Versa Max™ AC	7	--	1	3	2	2	--	1	--	--	+2.3	\$16.64/A.
Versa Max™ Soybean	8	--	--	3	2	3	--	1	--	--	+2.7	\$24.29/A.
MAX-IN® Ultra ZMB®	--	--	--	3.6	4	3	0.1	--	--	--	+3.5	\$32.16/A.
Microhance™	3	--	--	1	0.25	0.25	0.25	0.15	--	--	+1.8	\$13.98/A.
MicroBlitz™	11	8	5	--	0.05	0.05	0.05	--	0.05	0.0005	+1.9	\$16.70/A.

Versa Max™ is a trademark of Midtech R&D, Inc. (Manufactured for: Rosen's, Inc.). MAX-IN® is a trademark of WinField Solutions, LLC. First Pass® and MicroCarb ZMB™ are trademarks of The Andersons, Inc.



# SOYBEAN FUNGICIDE & FOLIAR Mn APPLICATION

## Mn DEFICIENCY

Manganese (Mn) is important in a soybean plant for its role in the activation of enzymes and in the process of photosynthesis. Additionally, Mn is known to regulate potassium (K) uptake. Mn deficiency can be characterized by interveinal yellowing of soybeans. Early on, it can be confused with iron deficiency and can be referred to as “yellow flash.” This deficiency is often found in higher pH soils, dry soil conditions, depressed areas of the field, and soils high in organic matter, sand, peat, or muck. A combination of any of these can amplify Mn deficiency. A lack of moisture causes Mn to be present in a form that is not plant available. A rain event can alleviate Mn deficiency in cases where Mn is present in the soil but not available to the plant.



Photo by Mississippi State University Extension

## FUNGICIDE APPLICATIONS

Fungicide applications are often made to prevent disease from entering a soybean field. Once a disease has set in, it is likely that yield has been lost, but the amount can be unclear. University and industry research alike has shown a synergistic effect with the combined use of fungicides and insecticides however, specific yield gains will vary from one year to the next. In a meta-analysis done at the University of Wisconsin, a 0.5 to 1.0 Bu./A. advantage was noted in various Midwestern states. Additionally, we know that the damage caused by insects can further promote diseases and therefore justifies the combined application.

## WHAT HAVE WE OBSERVED IN PFR?

Many soybean fungicides are recommended at an R3 application. What does R3 look like and why is it important? The R3 growth stage in soybeans is identified by having at least one pod that is 3/16 in. long at one of the four uppermost nodes (as demonstrated to the right). Because R3 is the start of pod development, it's also the best time to control diseases and insects. A majority of yield (about 60 percent) comes from nodes 7 - 13. An R3 application would add protection to those nodes, which might explain the positive yield response.

Seven-year PFR data has shown a \$17/A. ROI advantage from an R3 application of fungicide and insecticide with a breakeven soybean grain price of \$5.75/Bu. If soybeans are sprayed at R2, our per bushel price to breakeven rises to \$11.50/Bu. By missing the application by a single growth stage (R4), the breakeven rises to \$10.91/Bu. Essentially, missing the R3 timing results in a cost of roughly \$5/Bu.

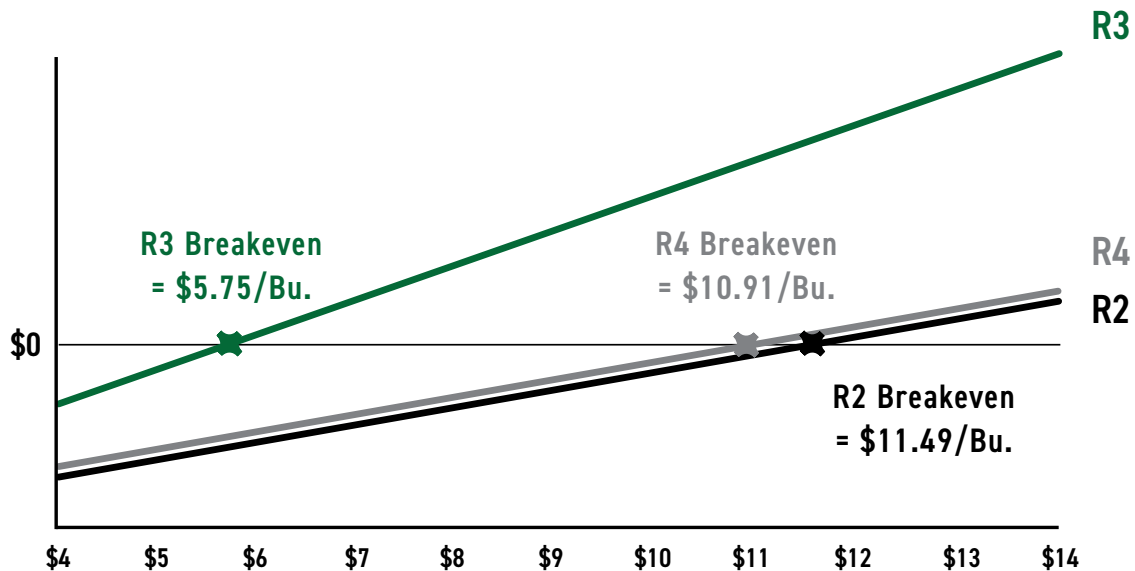


Photo by Iowa State University Extension





## Fungicide/Insecticide Timing R0I

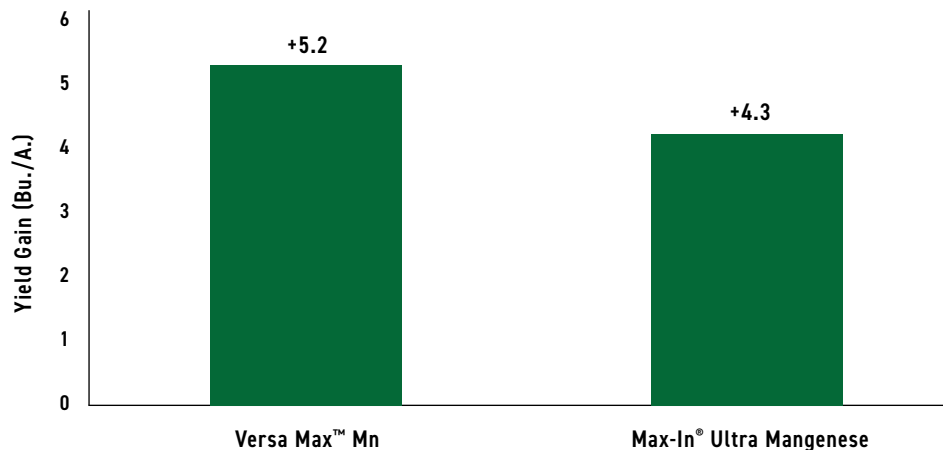


## Mn APPLICATIONS

Both university and PFR data have shown that foliar applications of Mn are recommended to provide the crop with additional Mn in a plant available form. PFR results showed Versa Max™ Mn and MAX-IN® Ultra Manganese to be PFR Proven in 2016. When applied between V3 and V4 at 2 qt./A., Versa Max Mn has shown an average yield increase of 5.2 Bu./A. MAX-IN Ultra Manganese is also applied at a 2 qt./A. rate between V3 and V4, and has averaged a yield increase of 4.3 Bu./A. Data from The Ohio State University has shown yield advantages when applying MAX-IN Ultra Manganese at R3, providing an increase of 8.0 Bu./A. in sandier locations (<https://stepupsoy.osu.edu/soybean-production/high-input-production>). This yield advantage was present in fields where the control plots did not show deficiency symptoms.



## 3-Year Yield Gain Average



Versa Max™ is a trademark of Midtech R&D, Inc. (Manufactured for: Rosen's, Inc.). MAX-IN® is a trademark of WinField Solutions, LLC. First Pass® and MicroCarb ZMB™ are trademarks of The Andersons, Inc. Priaxor® is a registered trademark of BASF. Stratego® is a registered trademark of Bayer. Preemptor™ is a trademark of FMC Corporation.

# SHOULD I STILL SPRAY A FUNGICIDE OR FOLIAR NUTRITION ON A LATE PLANTED OR REDUCED STAND?

PFR Research has shown that early planting and uniform full stands will produce the highest yields, but sometimes Mother Nature has other plans. Later planting dates and reduced stands will bring challenges, but multiple studies have proven that it still pays to invest in your crop, regardless of planting date or final stand.

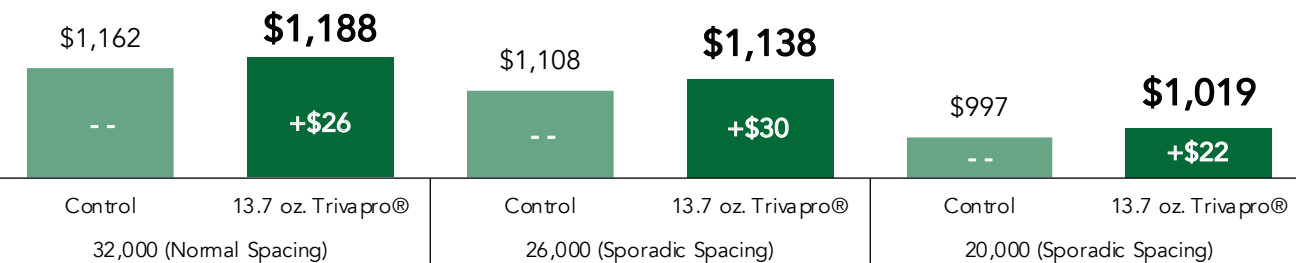
# FUNGICIDE

## THIN STAND AND PLANTING DATE

### CORN: THIN STAND FUNGICIDE RESPONSE

You likely have heard the phrase, "Don't throw good money after bad," which is how some view thin stands in corn. When faced with thin stands, does it pay to invest in a fungicide, or should you just walk away? Our three-year data is very consistent over multiple years of testing across multiple locations; it does indeed pay to invest in a fungicide application, even when stands fall into the 20,000 plants/A. range. Although the overall net returns on a per-acre basis will likely be lower, it pays to not walk away from a thin stand. The value of each individual plant goes up in this scenario, so protecting every plant is essential.

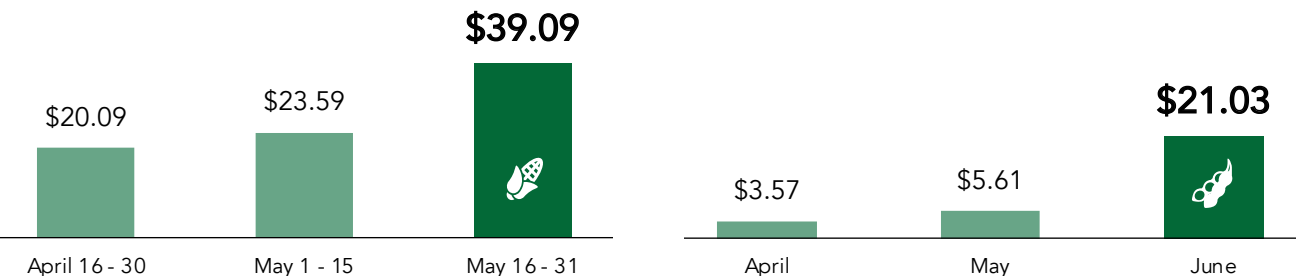
### 3-YEAR MULTI-LOCATION THIN STAND MANAGEMENT - FUNGICIDE RESPONSE NET RETURN & ROI



### CORN AND SOYBEANS: PLANTING DATE FUNGICIDE RESPONSE

In some years, the weather does not cooperate, and we are faced with delayed planting of corn and soybeans. When this occurs, it's assumed that yield levels and profitability are reduced, so the desire to invest in the crop declines. While this assumption can seem valid, a decision still needs to be made about how heavily to invest in the crop. With corn, there are several agronomic reasons to continue investing. A few significant diseases we are encountering are Southern Rust and Tar Spot, which can appear later in the season and can be detrimental to the crop. On late-planted corn, infection of these diseases would occur earlier in the grain fill stage, and thus the potential yield loss is even more significant. Fungicides can also help mitigate plant stress and respiration and, therefore, could benefit late-planted corn that is more susceptible to stress during the grain fill stage. Our PFR data is consistent; it pays to invest in a fungicide application for late-planted corn. For soybeans, the results are very similar in that investing in a fungicide application in a late-planted crop is just as essential to optimize yield. Late-planted soybeans will have fewer nodes, so protecting those nodes and extending growth and protection further into the growing season is critical. One thing to consider with fungicide applications on soybeans is that they keep the plants alive and greener longer (which helps explain the yield bump), so harvest timing should be accounted for.

### 3-YEAR MULTI-LOCATION PLANTING DATE - FUNGICIDE RESPONSE RETURN ON INVESTMENT



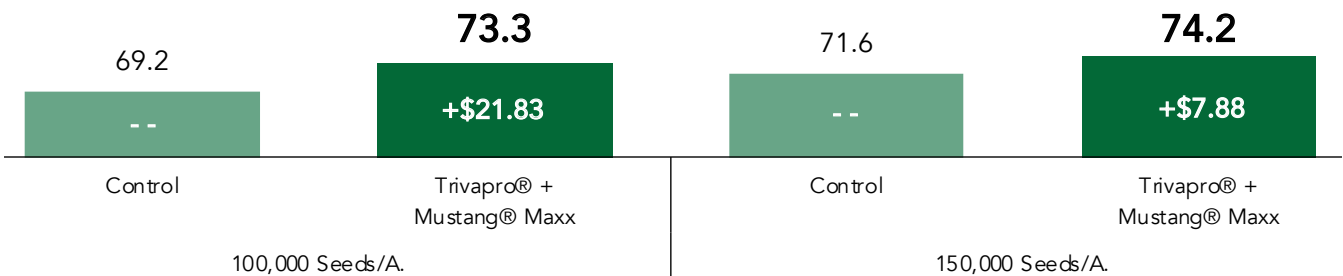
# FUNGICIDE - SOYBEANS

## REDUCED STANDS

### REDUCED STANDS - FUNGICIDE/INSECTICIDE RESPONSE

It's a PFR Proven™ practice to invest in a soybean fungicide/insecticide application at the R3 growth stage. The studies we conducted to reach this conclusion were done with full stands, but is it beneficial to invest in these applications when faced with a reduced stand? Our three-year data indicates that it still pays to invest in a reduced stand of soybeans, which makes sense given that soybeans have an incredible capacity to compensate for stand loss. The bottom line is that when faced with lower initial stands, it still pays to protect the plant's photosynthetic capacity with a fungicide/insecticide application.

### 3-YEAR MULTI-LOCATION POPULATION - FUNGICIDE RESPONSE YIELD AVERAGE & ROI - SOYBEANS



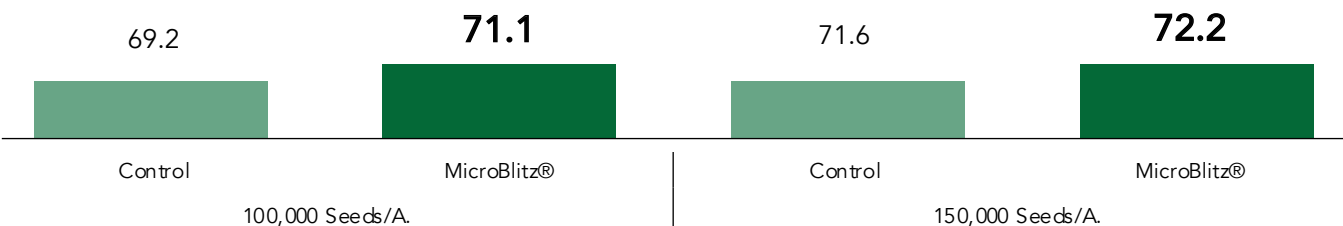
# FOLIAR NUTRITION - SOYBEANS

## REDUCED STANDS

### REDUCED STANDS - FOLIAR NUTRITION RESPONSE

When growers face reduced soybean stands, they understandably question whether it still pays to invest in a foliar nutrition application. We set out to see if we could achieve a positive response with foliar applications when the final stands were less than 100,000 plants/A. Interestingly, we observed an elevated response to foliar nutrition, and we theorize that this could result from improved canopy penetration and coverage with the lower stands. Regardless, the main takeaway from this study is that it still pays to invest in the crop even when you have lower stands.

### 3-YEAR MULTI-LOCATION POPULATION - FOLIAR NUTRITION RESPONSE YIELD AVERAGE - SOYBEANS



# WHAT CAN I ADD TO THE SPRAY TANK TO IMPROVE EFFECTIVENESS?

There are a handful of products to consider adding to your tank to improve the effectiveness of your spray pass. Water conditioners can lower pH and mitigate the antagonistic properties found in spray water. Surfactants help improve effectiveness and coverage by reducing drift and lowering surface tension between the spray droplet and leaf surface.

# FOLIAR NUTRITION - WATER CONDITIONERS

The properties in water that bind or reduce plant uptake most commonly are pH (causing alkaline hydrolysis) and water hardness (causing negative molecular binding). Water conditioners can mitigate these problems by lowering the pH and adding molecules that counteract these harmful properties.

## CORN

WATER CONDITIONER	PFR PROVEN ROI	ROI WIN %	YIELD ADVANTAGE (BU./A.)	YIELD WIN %	APPLICATION RATE & TIMING	COMPANY
BRANDT® INDICATE 5°	\$9.76	70%	2.7	70%	1.5 oz. @ V4-V5	Brandt Consolidated, Inc.
CHOICE® TRIO	\$4.96	70%	2.0	80%	9.6 oz. @ V4-V5	Loveland Products, Inc.

## SOYBEANS

WATER CONDITIONER	PFR PROVEN ROI	ROI WIN %	YIELD ADVANTAGE (BU./A.)	YIELD WIN %	APPLICATION RATE & TIMING	COMPANY
BRANDT® INDICATE 5°	\$9.58	75%	1.1	75%	1.5 oz. @ R1	Brandt Consolidated, Inc.

# FUNGICIDE - ADJUVANT

Adjuvants are designed to reduce drift by improving spray pattern deposition, meaning more droplets contact the targeted plants. Surfactants work by lowering the surface tension between the spray droplet and plant surface, keeping droplets on the leaf surface longer, allowing more time for plant intake.

## CORN

FUNGICIDE ADJUVANT	PFR PROVEN ROI	ROI WIN %	YIELD ADVANTAGE (BU./A.)	YIELD WIN %	APPLICATION RATE & TIMING	COMPANY
FULLTEC ADJUVANT™	\$20.94	69%	1.8	75%	3 oz. @ R3	Spraytec Fertilizers LLC.
XION SILICONGEL®	\$15.25	63%	1.4	63%	0.68 oz. @ R3	Agricultural Innovations, LLC.
BRANDT® SUPER 7	\$14.87	80%	1.7	87%	6.4 oz. @ R3	Brandt Consolidated, Inc.
NANOPRO®	\$14.86	72%	1.4	83%	4 oz. @ R3	Aqua Yield Operations, LLC.

## SOYBEANS

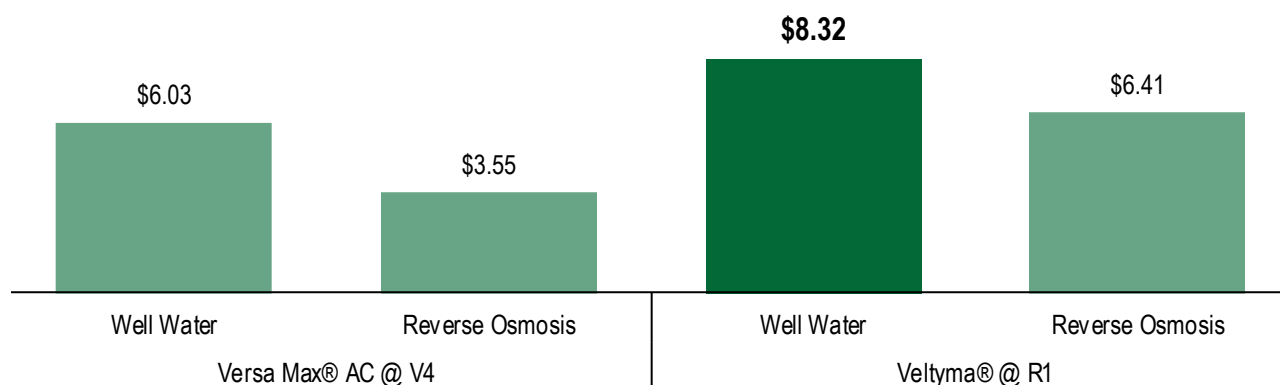
FUNGICIDE ADJUVANT	PFR PROVEN ROI	ROI WIN %	YIELD ADVANTAGE (BU./A.)	YIELD WIN %	APPLICATION RATE & TIMING	COMPANY
FULLTEC ADJUVANT™	\$12.12	82%	2.9	91%	3 oz. @ R1	Spraytec Fertilizers LLC.
XION SILICONGEL®	\$6.93	55%	2.0	55%	0.68 oz. @ R1	Agricultural Innovations, LLC.

## WATER CONDITIONING STUDY - CORN

### REVERSE OSMOSIS

Reverse osmosis removes hard water ions like calcium and magnesium that can bind with spray ingredients and render them less effective. This is especially true when hard water combines with weak acid compounds. Two years of research has not shown an advantage to the reverse osmosis treatments.

#### 2-YEAR MULTI-LOCATION WATER CONDITIONING RETURN ON INVESTMENT

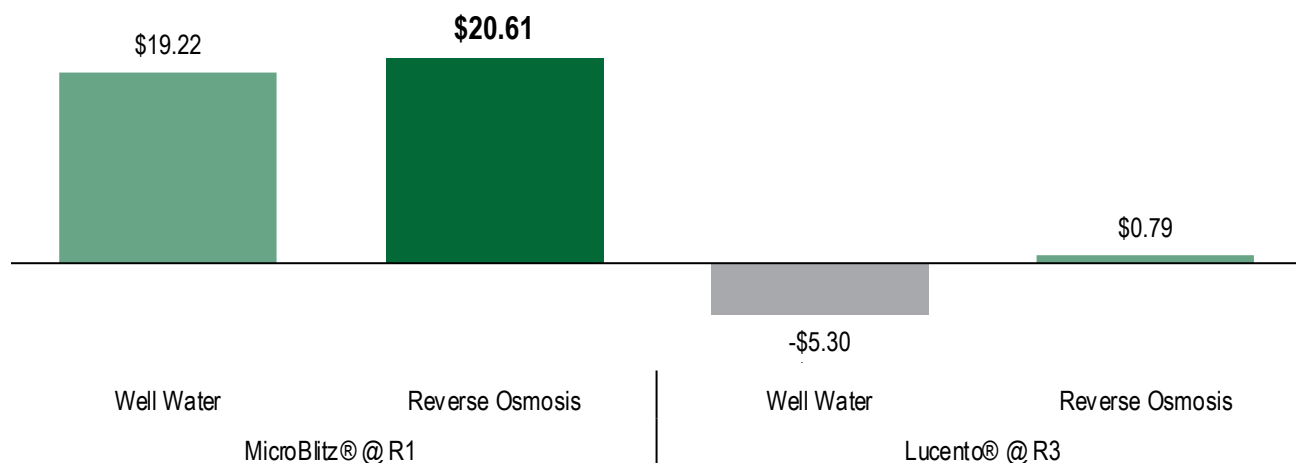


## WATER CONDITIONING STUDY - SOYBEANS

### REVERSE OSMOSIS

Hard water ions in well water can bind with spray ingredients, especially weak acids, and tie them up in a spray solution, rendering it less effective. The reverse osmosis process removes the hard water ions such as Calcium and Magnesium from the spray water.

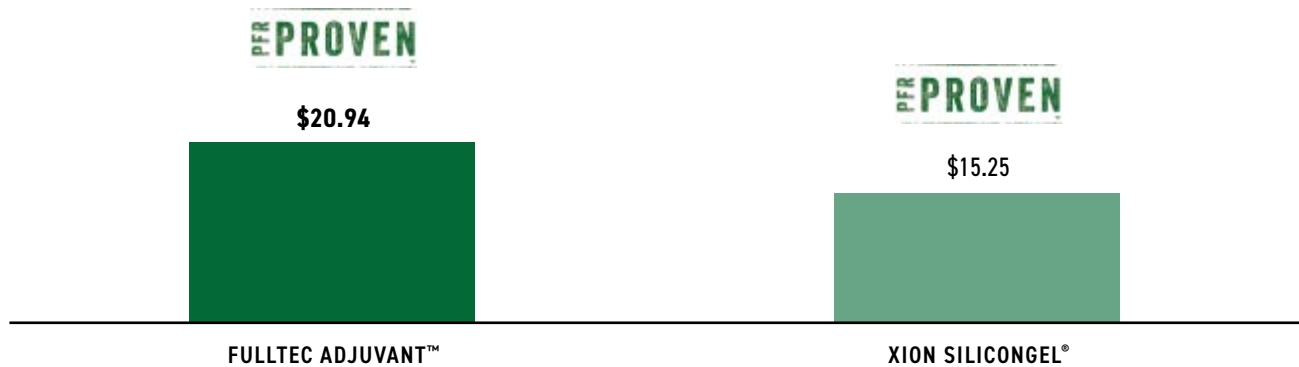
#### 2-YEAR MULTI-LOCATION WATER CONDITIONING RETURN ON INVESTMENT



# FUNGICIDE ADJUVANT STUDY - SOYBEANS

Spray adjuvants perform many functions and are especially important with fungicides that require good coverage for best performance. Fulltec Adjuvant™ conditions the spray water, serves as a drift retardant, and helps the spray solution penetrate the leaf surface.

## 3-YEAR MULTI-LOCATION FUNGICIDE ADJUVANT RETURN ON INVESTMENT

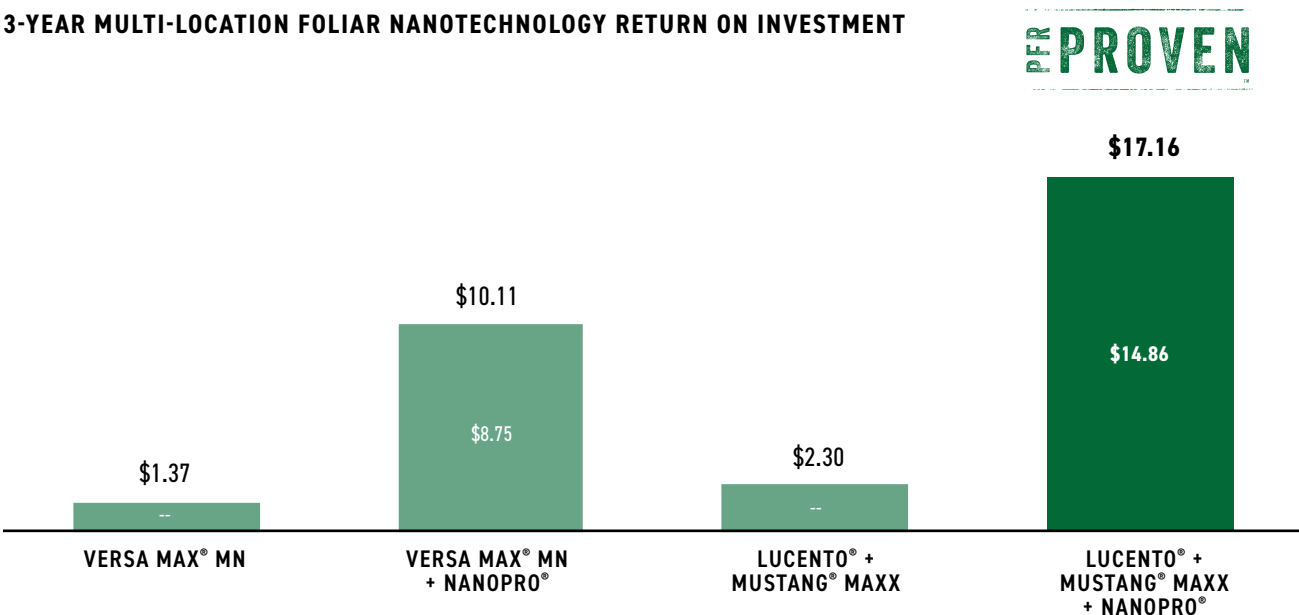


# FOLIAR STUDY - SOYBEANS

## NANOTECHNOLOGY

Nanotechnology is relatively new to agriculture. The basic concept is to take a nanoparticle with a charged shell and bind additional molecules to improve uptake efficiency. The results from two years of testing have demonstrated a consistent advantage to adding NanoPro® to the tank.

## 3-YEAR MULTI-LOCATION FOLIAR NANOTECHNOLOGY RETURN ON INVESTMENT





# WHAT PRACTICES AND EQUIPMENT CAN I IMPLEMENT TO MAKE MY SPRAY PASS MORE PROFITABLE?

When it comes to a making a spray pass more profitable, things like spraying in the morning, utilizing higher carrier rates, and choosing the correct nozzle can all have an impact.

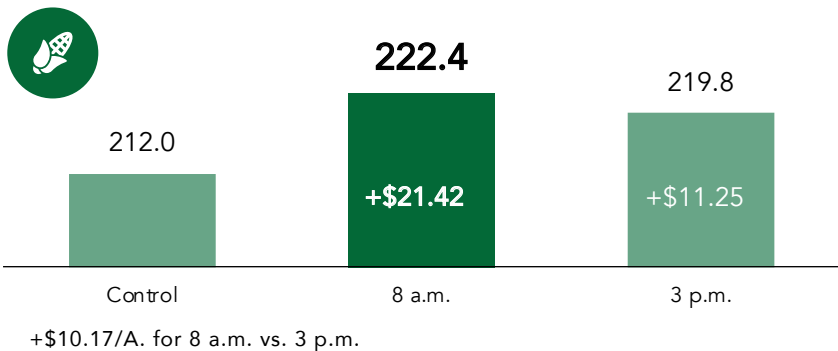
# FUNGICIDE - CARRIER RATE AND TIME OF DAY PRACTICES

## TIME OF DAY

Fungicide applications appear to be more effective when applied in the morning. A dew may help spread the fungicide over the surface of the leaf.

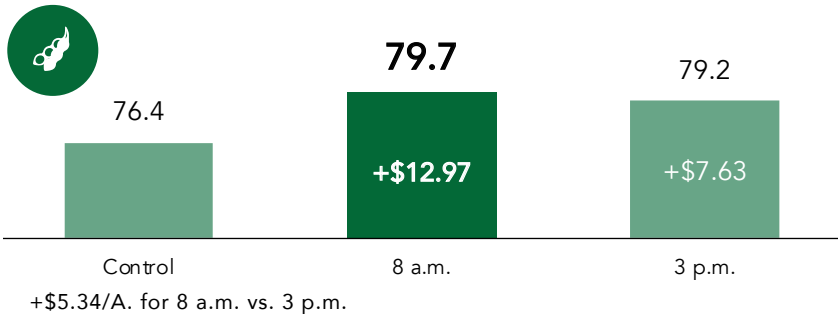
Cooler temperatures and higher humidity in the morning also increase the length of droplet survival.

## 3-YEAR MULTI-LOCATION FUNGICIDE TIME OF DAY YIELD AVERAGE & ROI (8 A.M. VS. 3 P.M.)

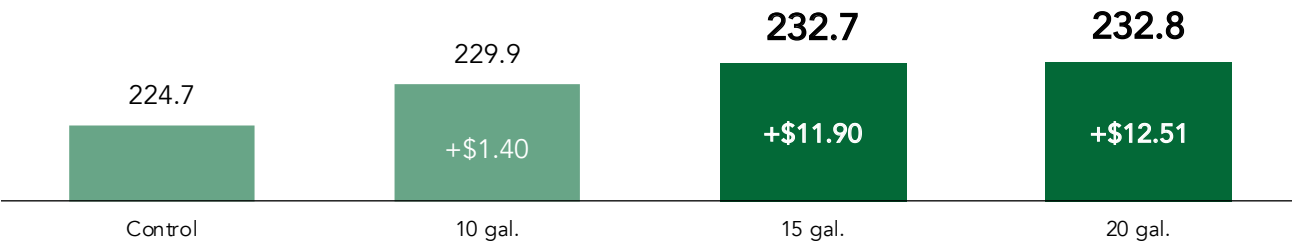


## HOW MUCH CARRIER?

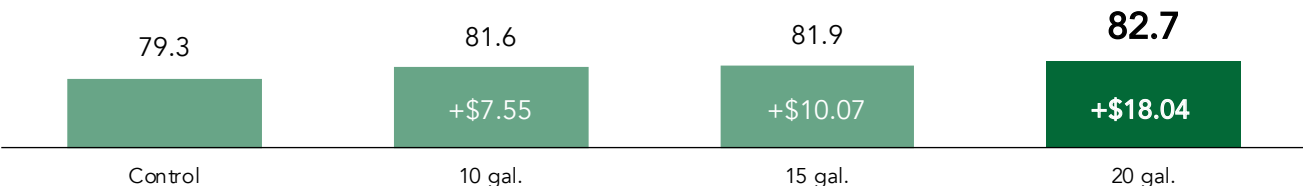
PFR data indicates that 15 to 20 gallons of carrier rate is the sweet spot. Always read and follow label directions.



## 3-YEAR MULTI-LOCATION FUNGICIDE CARRIER RATE YIELD AVERAGE & ROI



## 3-YEAR MULTI-LOCATION FUNGICIDE CARRIER RATE YIELD AVERAGE & ROI



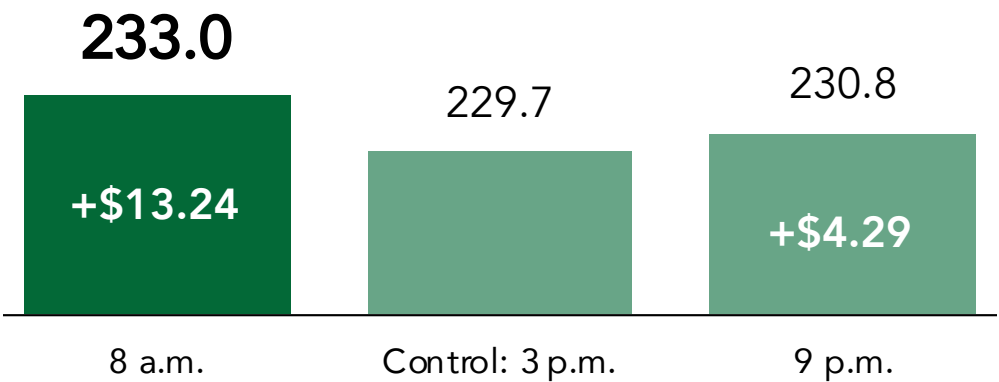
# FOLIAR NUTRITION - TIME OF DAY PRACTICES

## WHEN DO I APPLY A FOLIAR FEED?

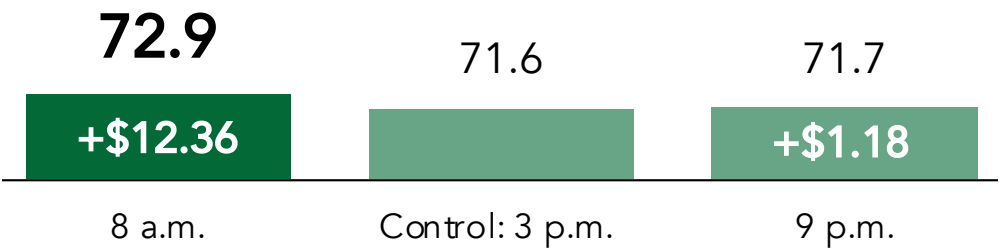
Making foliar applications early in the morning (i.e., 8:00 a.m.) is more profitable than the same application made at 3:00 p.m. in both corn and soybeans. In the morning, the plant’s stomata are open, exposing the pores on the guard cells. This means that the plants are predisposed to take up nutrition products early versus later in the heat of the day.



3-YEAR MULTI-LOCATION FOLIAR TIME AND TEMPERATURE YIELD AVERAGE AND ROI



3-YEAR MULTI-LOCATION FOLIAR TIME AND TEMPERATURE YIELD AVERAGE AND ROI

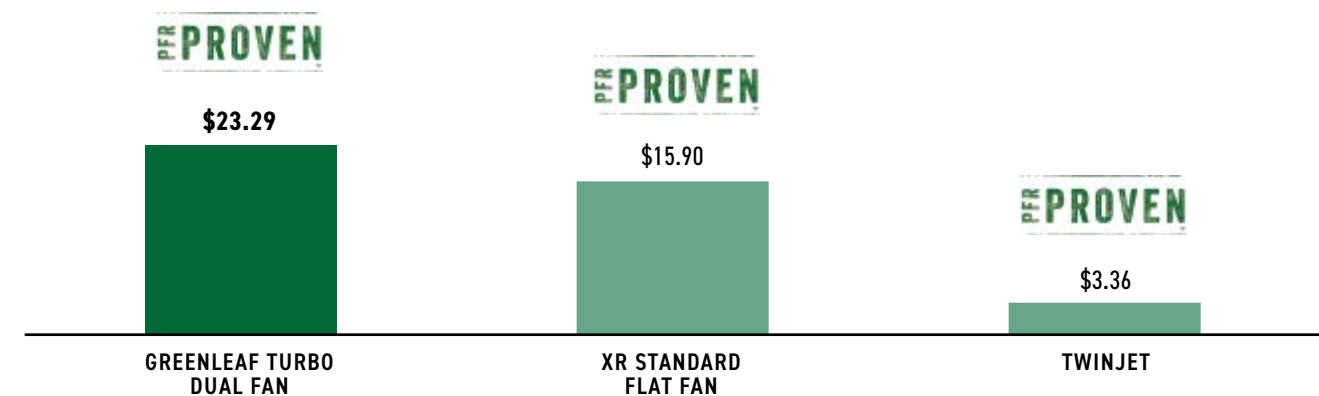


# FUNGICIDE/INSECTICIDE STUDY - SOYBEANS

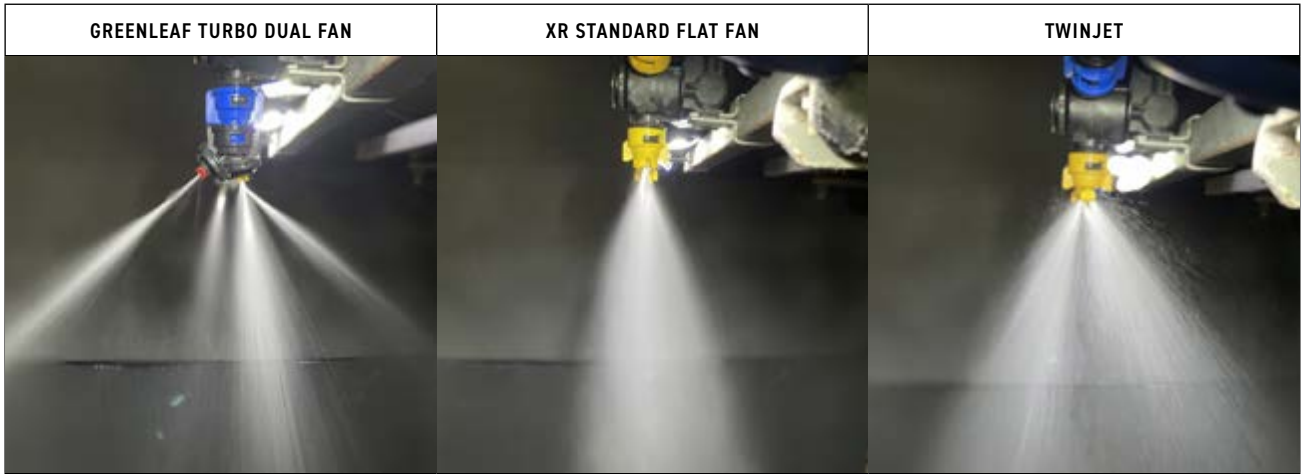
## NOZZLE TYPE

The purpose of the study is to measure the potential impact that nozzle types can have on performance. The Greenleaf Turbo Dual Fan sprays in multiple directions to help cover both sides of the plant. Over two years of research, it has demonstrated an advantage, but the 2023 data was very different than 2022. This is why we continue to conduct tests over multiple years and locations.

### 3-YEAR MULTI-LOCATION FUNGICIDE/INSECTICIDE NOZZLE TYPE RETURN ON INVESTMENT



### NOZZLE SPRAY PICTURES



# FUNGICIDE APPLICATION STUDY

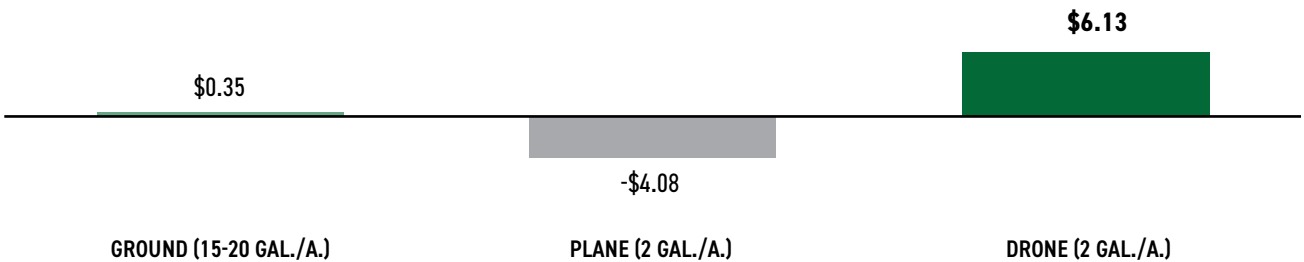
## GROUND VS. PLANE VS. DRONE

This study evaluates different fungicide application methods at the R1 growth stage and their impact on yield.

### 2024 RESULTS

R1 TREATMENTS	APPLICATION METHOD	PERCENT MOISTURE	BU./A.	BU./A. DIFFERENCE	RETURN ON INVESTMENT
Control: No Fungicide	--	18.1	232.2	--	--
Fungicide	Ground (15-20 gal./A.)	18.8	236.5	+4.3	-\$7.71
	Plane (2 gal./A.)	18.8	237.9	+5.7	-\$1.20
	Drone (2 gal./A.)	18.8	237.5	+5.3	-\$2.98
Corn \$4.73/Bu. Veltyma® \$502.29/gal. Miravis® Neo \$268.28/gal. These results are based on the disclosed study parameters and participating sites.					

### 2-YEAR FUNGICIDE APPLICATION - GROUND VS. PLANE VS. DRONE RETURN ON INVESTMENT



## NOTES

## NOTES

