2020 PRODUCT GUIDE

BIO-ENHANCER SOLUTIONS FOR SOYBEANS, CORN AND WHEAT

ACCELERON® BIOAG


Discover More
AcceleronSAS.com

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Fungicides

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Bio-Enhancers

Rise Stronger With Coverage on 4 Fronts

Maximizing your yield potential requires the right combination of protection. That's why the Acceleron® portfolio provides coverage on four fronts, protecting your seeds against insects, diseases, nematodes, as well as moisture and nutrient stress. So you can rise ready for whatever the season holds.

Seed treatments can be the difference-maker season to season. Particularly early in the year, when conditions can be unpredictable, an effective seed treatment package can protect your crops from devasting threats. Nematodes can be especially harmful to plants, stealing valuable nutrients and water, weakening their roots, and making plants even more susceptible to the impacts of diseases and insects.

Bio-enhancers from Acceleron® BioAg are another essential component of a four-part approach to protection. Nutrient and moisture deficiencies can impair root growth, making it even harder for plants to get the nutrients and moisture they need. Many bio-enhancers make nutrients available to plants, helping maximize yield potential. While benefits vary by crop, these products can also enhance functional root volume and increase nutrient uptake, protecting plants from moisture or nutrient stress.

Bio-enhancers are not only compatible with our fungicides, insecticides and nematicides but they also complement each other, rounding out critical early season protection with the nutrient support growers can count on for improved, more stable outcomes.

Our Approach to Innovation

As the innovation leader in the marketplace, Acceleron® BioAg continues to develop bio-enhancers that help growers produce more with less. As we bring new products to market, we focus on:

- Leveraging naturally occurring processes to **boost productivity**.
- Supporting the **management of natural resources** on your farm.
- Promoting **sustainability** in a way that benefits agriculture, consumers, the environment and society as a whole.
- Delivering **even more measurable impact** to farming operations.
- Helping **meet the demands** of an ever-growing world.

Other Products Beyond This Guide

In addition to the products for soybeans, corn and wheat that are found in this guide, we also offer products for the crops below. Visit Acceleron® BioAg at AcceleronSAS.com for more information.

Pulse

(peas, chickpeas and lentils)

Forage

(alfalfa, clover and sweet clover)

Other Crops

(canola, cotton, sorghum, sugar beets and more)

Learn more at: AcceleronSAS.com

Our Commitment to Quality Bio-Enhancers

Every batch of every Acceleron® BioAg product is developed with rigorous quality control and held to the highest standards. We take extra steps to design and produce reliable products that help optimize the value of every seed.

1 DAILY QUALITY CHECKS ON EVERY FERMENTATION TANK AND CONTINUED EVALUATION

Trained experts examine samples from every batch under the microscope, every day, to look for potential contaminants. This is standard operating procedure during commercial production.

Every sample is closely monitored on agar plates as it grows over time. This enables us to find any undesirable organisms that were too small to detect at first.

WHAT THIS MEANS

You can feel confident that the amount of active microorganisms meets or exceeds what is on the label.

2 FINE-TUNED NUTRIENT SOURCES

Like elite athletes, bacteria need specific amounts of high-quality carbohydrates and other nutrients to perform their best. Their "food" is the liquid they live in — which is what you see in the bag you buy. We're constantly improving the recipe.

WHAT THIS MEANS

Our products keep getting better and better. To date, we've:

- Lengthened shelf life.
- Achieved consistent quality from batch to batch.
- Lowered application rates.
- Improved in-field performance.

3 <0.1% BAG CONTAMINATION RATE

Our specially designed bag-filling system reduces the risk of contamination at this critical stage. We wish we could tell you more, but it's proprietary.

WHAT THIS MEANS

The quality we achieve during fermentation is protected as our products leave the tank and move one step closer to the field.

4 BREATHABLE BAGS AND IDEAL SURFACE AREA-TO-VOLUME RATIO

Bradyrhizobia need oxygen, just like you do. Our breathable bags let oxygen in and CO2 out, unlike hard-sided containers that can trap and prevent gas exchange. Plus, our optimized surface area-to-volume ratio (which affects the gas exchange rate) helps the *Bradyrhizobia* remain effective for up to two years.

Our clear bags also help you make sure that the bacteria are evenly mixed before use, so your customers get what they're paying for on every seed. By comparison, some keg-style systems make it difficult to resuspend product once they're connected to treaters. Identifying contamination in a keg is also more difficult, which can lead to lost time cleaning contaminated equipment. Bladders and separate cone tank systems are far less likely to have this problem.

WHAT THIS MEANS

- Longer shelf life helps improve inventory management.
- Growers get a reliable product, every time.
- Our products can be agitated in treaters to ensure the active microorganisms are evenly suspended, resulting in a uniform application to every seed.

Notes

SOYBEAN TECHNOLOGIES

ACCELERON® BIOAG

SOYBEAN TECHNOLOGIES

ACCELERON® BIOAG

ACCELERON BIOAG TECHNOLOGIES	Rhizobia	LCO	*Penicillium bilaiae*	*Trichoderma virens*	*Bacillus amyloliquefaciens*
Cell-Tech®	✓				
Optimize® XC	✓	✓			
TagTeam®	✓		✓		
TagTeam® LCO XC	✓	✓	✓		

"TagTeam® LCO technology is a very inexpensive insurance policy, and we see a decent yield boost to cover the cost of it. So, it's a good return on investment."

CHAD MCDANIELS, NEBRASKA

Cell-Tech® Technology

Nitrogen-fixing inoculant for soybeans

Cell-Tech® technology contains specially selected *Bradyrhizobium* that can provide highly effective nodulation to enhance nitrogen fixation, even in cooler soils — increasing yield potential as planting conditions change.

BENEFITS OF USING CELL-TECH SOYBEAN LIQUID INOCULANT

- Four-day on-seed guarantee when applied with most common chemical seed treatments (please check compatibility chart* before application)
- Flexible — can be applied on-seed or in-furrow
- Convenient liquid formulation for on-farm application

BENEFITS OF USING CELL-TECH SOYBEAN GRANULAR INOCULANT

- Ideal inoculant formulation for air seeders or planters with granular applicators
- Granular formulation offers added protection to *Bradyrhizobium*
- No mixing or seed application required
- More nitrogen-fixing bacteria per linear foot than seed treatment inoculants
- Granular, peat-based formulation helps to provide an ideal environment for rhizobia

*Check compatibility at AcceleronSAS.com

PRODUCT DETAILS

Packaging may vary.

Cell-Tech® Soybean Liquid Inoculant

Active Ingredients	Packaging	Application Rate	Case Treats
2 billion (2 x 10^9) viable cfu/ml *Bradyrhizobium japonicum*	4 x 50 unit	2.1 fl oz/unit (50 lbs of seed) (63 ml/23 kg)	200 units or 28,000,000 seeds

Always read and follow label directions

4 x 50 unit

104.7 fl oz (3.1 L)

Bladder

Cell-Tech® Soybean Granular Inoculant

Active Ingredients	Packaging	Application Rate	Case Treats
100 million (1 x 10^8) viable cfu/g *Bradyrhizobium japonicum*	1,000 lbs (454 kg) 39.7 lbs (18 kg)	Varies by row spacing	Varies by row spacing

Always read and follow label directions

PACKAGE NOT AVAILABLE

1,000 lbs (454 kg)

40 lbs (18 kg)

Application Rates for Cell-Tech® Soybean Granular Inoculant

Row Spacing (cm)	6.0 in (15.2 cm)	7.0 in (17.8 cm)	8.0 in (20.3 cm)	9.0 in (22.9 cm)	10 in (25.4 cm)	12 in (30.5 cm)	15 in (38.1 cm)	24 in (61.0 cm)	30 in (76.2 cm)
(lb/acre) Low Range	7.7	6.6	5.8	5.1	4.6	3.8	3.1	1.9	1.5
(lb/acre) High Range	32.7	28	24.5	21.8	19.6	16.3	13.1	8.2	6.5

Optimize® XC Inoculant

Up to 2X the rate of early nodulation for soybeans, with an extra-concentrated formulation

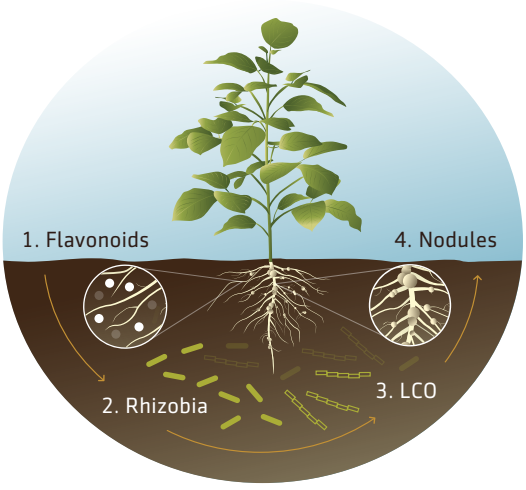
Optimize® XC Inoculant is a retailer-applied dual-action technology that combines *Bradyrhizobium japonicum* with exclusive LCO (lipo-chitooligosaccharides) technology. In 2016, a growth chamber study showed that combining LCO with rhizobia increases the rate of early soybean nodulation, resulting in 2X as many nodules compared to rhizobia alone. Plus, the LCO in Optimize XC Inoculant enhances mycorrhizal colonization, which increases functional root volume and helps the plant uptake more water and nutrients through the root.

BENEFITS OF USING OPTIMIZE XC INOCULANT

- Combines *Bradyrhizobium japonicum* and LCO, which can double the rate of early nodulation
- Enhances mycorrhizal colonization, which increases functional root volume and helps the plant uptake more water and nutrients through the roots
- Increases nitrogen fixation through nodule formation
- Enhances nutrient availability which supports root and shoot growth
- Broad seed treatment compatibility* with 120 days on-seed life with most seed treatments
- The industry's lowest application rate for soybeans — leaving more space on your seed for additional treatments (0.75 fl oz per unit of seed with minimum of 1.5 fl oz total volume with water when applied alone)
- A convenient, easy-to-handle package

HOW THE TECHNOLOGY WORKS

1. Needing nitrogen, the plant releases flavonoids to signal rhizobia.
2. Sensing the flavonoids, the rhizobia signal LCO back to the plant.
3. The plant can respond to the LCO, allowing the rhizobia to infect its roots.
4. This symbiotic relationship creates nodules, which can help fix atmospheric nitrogen.



*Check compatibility at AcceleronSAS.com/Compatibility

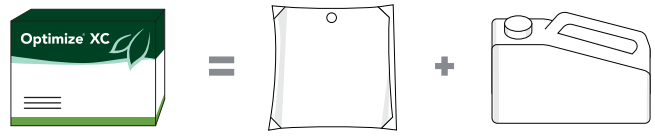
PRODUCT DETAILS

Packaging may vary.

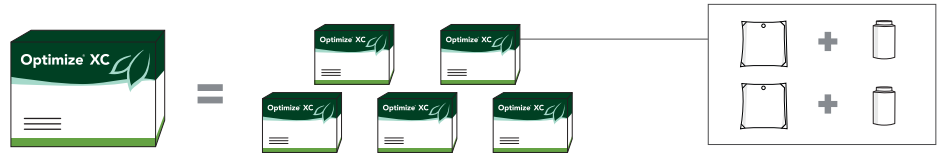
Optimize® XC Inoculant

Active Ingredients	Packaging	Application Rate	Case Treats
10 billion (1 x 10^{10}) viable cfu/g *Bradyrhizobium japonicum* 1 x 10^{-7}% lipo-chitooligosaccharides	400 units 5 x 2 x 40 unit	1.5 fl oz/100 lbs of seed (44.4 ml/45.4 kg)	400 units or 56,000,000 seeds

Always read and follow label directions



400 units = Rhizobia + LCO + Liquid additive



5 x 2 x 40 unit = Rhizobia + LCO + Liquid additive

TagTeam® Soybean Granular Inoculant

Two powerful technologies combined to benefit your soybeans

TagTeam® Soybean Granular Inoculant combines the phosphate-solubilizing microbe *Penicillium bilaiae* with a specially selected nitrogen-fixing rhizobia. It can create more fixed nitrogen and improve access to the relatively immobile phosphate in the soil, helping to provide the best yield potential for your soybeans. In 2016, a growth chamber study showed that combining LCO with rhizobia increases the rate of early soybean nodulation, resulting in 2X as many nodules compared to rhizobia alone.

BENEFITS OF USING TAGTEAM SOYBEAN GRANULAR INOCULANT

- Enhances nutrient availability including phosphate, which supports root and shoot growth, as well as nitrogen
- Improves fertilizer efficiency
- Greater opportunity for the development of nitrogen-fixing nodules
- Increases nitrogen fixation through nodule formation

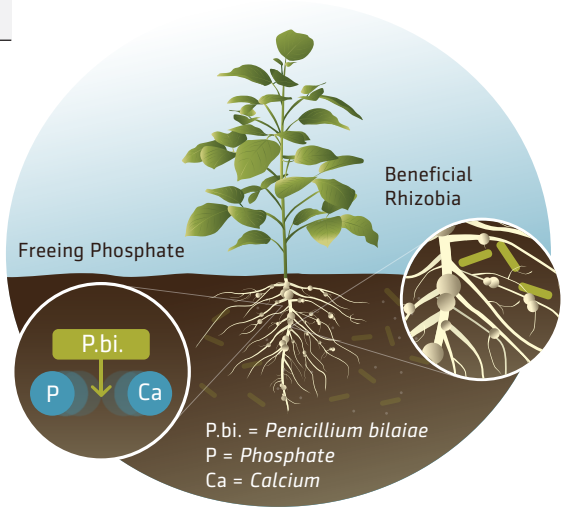
HOW THE TECHNOLOGY WORKS

1. **Freeing Phosphate**

   Penicillium bilaiae releases bound mineral forms of soil and fertilizer phosphate, making it more available for the plant to use.

2. **Beneficial Rhizobia**

   Specially selected rhizobia form a beneficial relationship with the plant, creating nodules which help fix atmospheric nitrogen.



PRODUCT DETAILS

Packaging may vary.

TagTeam® Soybean Granular Inoculant

Active Ingredients	Packaging	Application Rate	Case Treats
100 million (1.0 X 108) viable cfu/g *Bradyrhizobium japonicum* 100 thousand (1.0 X 105) cfu/g *Penicillium bilaiae*	39.7 lbs (18 kg) 582.4 lbs (264 kg)	Varies by row spacing	Varies by row spacing

Always read and follow label directions

39.7 lbs (18 kg)

PACKAGE NOT AVAILABLE

582 lbs (264 kg)

Application Rates for TagTeam® Soybean Granular Inoculant

Row Spacing (cm)	6.0 in (15.2 cm)	7.0 in (17.8 cm)	8.0 in (20.3 cm)	9.0 in (22.9 cm)	10 in (25.4 cm)	12 in (30.5 cm)	15 in (38.1 cm)	24 in (61.0 cm)	30 in (76.2 cm)
Application Rate	7.1 lbs/ac (8.0 kg/ha)	6.2 lbs/ac (6.9 kg/ha)	5.4 lbs/ac (6.0 kg/ha)	4.7 lbs/ac (5.3 kg/ha)	4.3 lbs/ac (4.8 kg/ha)	3.6 lbs/ac (4.0 kg/ac)	2.9 lbs/ac (3.2 kg/ha)	1.8 lbs/ac (2.0 kg/ha)	1.4 lbs/ac (1.6 kg/ha)
Area Treated per 582.4 lb Bag	82 ac (33.2 ha)	93.9 ac (38 ha)	107.9 ac (43.6 ha)	123.9 ac (50.1 ha	135.4 ac (54.8 ha)	161.8 ac (65.5 ha)	200.8 ac (81.3 ha)	323.6 ac (130.9 ha)	416 ac (168.4 ha)

TagTeam® LCO XC Inoculant

Up to 2X more nodules, plus more available phosphate, in an extra-concentrated formulation

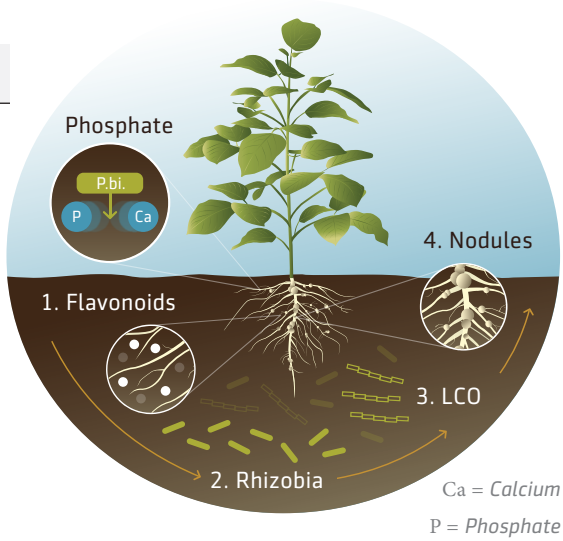
TagTeam® LCO XC Inoculant is a triple-action technology that combines *Bradyrhizobium japonicum* with exclusive LCO (lipo-chitooligosaccharides) technology, and the phosphate-solubilizing benefits of *Penicillium bilaiae*. In 2016, a growth chamber study showed that combining LCO with rhizobia increases the rate of early soybean nodulation, resulting in 2X as many nodules compared to rhizobia alone. Plus, the LCO in TagTeam LCO XC Inoculant enhances mycorrhizal colonization, which increases functional root volume and helps the plant uptake more water and nutrients through the root.

BENEFITS OF USING TAGTEAM LCO XC INOCULANT

- Combines *Bradyrhizobium japonicum* and LCO, which can double the rate of early nodulation
- Enhances mycorrhizal colonization, which increases functional root volume and helps the plant uptake more water and nutrients through the roots
- Increases nitrogen fixation through nodule formation
- Enhances phosphate availability, which supports root and shoot growth
- Broad seed treatment compatibility* with 120 days on-seed life with most seed treatments
- The industry's lowest application rate for soybeans — leaving more space on your seed for additional treatments (0.75 fl oz per unit of seed with minimum of 1.5 fl oz total volume with water when applied alone)
- A convenient, easy-to-handle package

HOW THE TECHNOLOGY WORKS

1. **Freeing Phosphate**
   Penicillium bilaiae releases bound mineral forms of soil and fertilizer phosphate, making it more available for the plant to use.
2. **More nitrogen**
   A. Needing nitrogen, the plant releases flavonoids to signal rhizobia.
   B. Sensing the flavonoids, the rhizobia signal LCO back to the plant.
   C. The plant can respond to the LCO, allowing the rhizobia to infect its roots.
   D. This symbiotic relationship can create nodules, which help fix atmospheric nitrogen.



Ca = *Calcium*
P = *Phosphate*
P.bi. = *Penicillium bilaiae*

*Check compatibility at AcceleronSAS.com

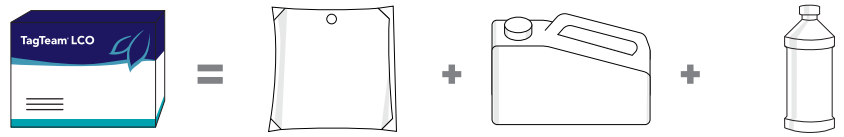
PRODUCT DETAILS

Packaging may vary.

TagTeam® LCO XC Inoculant

Active Ingredients	Packaging	Application Rate	Case Treats
10 billion (1 x 10^{10}) viable cfu/ml *Bradyrhizobium japonicum* 1 x 10^{-7} % lipo-chitooligosaccharides 720 million (7.2 x 10^{8}) cfu/g *Penicillium bilaiae*	400 units 5 x 2 x 40 unit	1.5 fl oz/100 lbs of seed (44.4 ml/45.4 kg)	400 units or 56,000,000 seeds

Always read and follow label directions



400 units = Rhizobia + LCO + Liquid additive + *Penicillium bilaiae*

5 x 2 x 40 unit =

Rhizobia + LCO + Liquid additive + *Penicillium bilaiae*

Notes

CORN TECHNOLOGIES

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CORN TECHNOLOGIES

ACCELERON® BIOAG

ACCELERON BIOAG TECHNOLOGIES	Rhizobia	LCO	*Penicillium bilaiae*	*Trichoderma virens*	*Bacillus amyloliquefaciens*
QuickRoots®				✓	✓

"QuickRoots® technology gave us extra confidence knowing that seed was going to have the ability to fight off and defend itself against those tough variables that the weather was providing us."

NICK EMANUEL, NEBRASKA

QuickRoots® Technology

Protect corn from stress with increased moisture and nutrient availability

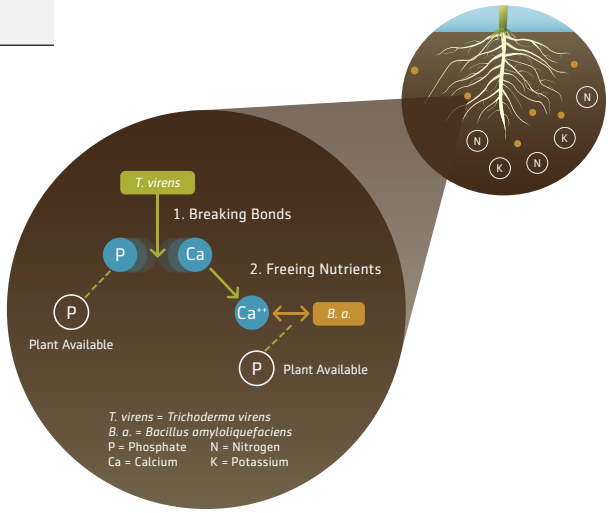
QuickRoots® technology helps maximize corn yield — especially in fields with limitations in moisture or nutrient availability.

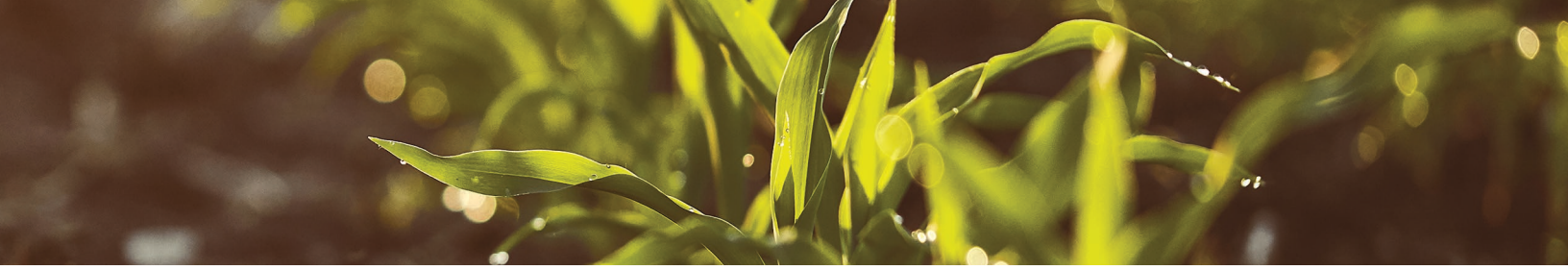
BENEFITS OF USING QUICKROOTS TECHNOLOGY

- Increases phosphate availability and uptake, which increases root volume
- Larger root volume helps the plant access more moisture and nutrients, including nitrogen and potassium

HOW THE TECHNOLOGY WORKS

1. The microbes *Bacillus amyloliquefaciens* and *Trichoderma virens* release enzymes that convert organic phosphate, which is not readily available to the plant, to plant-available phosphate.
2. Improved phosphate availability can lead to expanded root volume, which enhances moisture, nitrogen and potassium uptake.
3. This ultimately can enable optimal plant growth and increased yield potential.





PRODUCT PERFORMANCE

70.4%
Win Rate

In 670 independent, replicated small-plot and large-plot trials conducted over 12 years, corn treated with QuickRoots® technology microbial seed inoculant outyielded corn not treated with QuickRoots technology by an average of 5.6 bushels per acre. Data as of April 16, 2018. Individual results may vary.

PRODUCT DETAILS

Packaging may vary.

QuickRoots® technologies are not fungicides and will not replace your current fungicide seed treatment.

QuickRoots® PB Corn Multi-Crop Inoculant

Active Ingredients	Packaging	Application Rate	Case Treats
210 million (2.1 x 10^8) viable cfu/g *Bacillus amyloliquefaciens* 50 million (5 x 10^7) cfu/g *Trichoderma virens*	10 x 25 unit 200 units	16 g/80,000 seeds (unit)	250 units 200 units

Always read and follow label directions

10 x 25 unit

400 g (0.88 lbs)

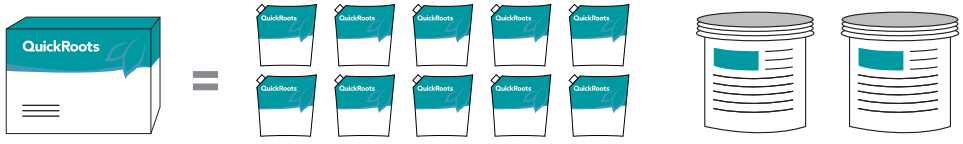
PACKAGE NOT AVAILABLE

200 units

QuickRoots® WP Corn Multi-Crop Inoculant

Active Ingredients	Packaging	Application Rate	Case Treats
310 million (3.1 x 10^8) viable cfu/g *Bacillus amyloliquefaciens* 74 million (7.4 x 10^7) cfu/g *Trichoderma virens*	10 x 25 unit 625 units 3,125 units	7.2 g/80,000 seeds (unit)	250 units 625 units 3,125 units

Always read and follow label directions



10 x 25 unit

180 g (0.396 lbs)

625 units

3,125 units

Notes

WHEAT TECHNOLOGIES

ACCELERON® BIOAG

WHEAT TECHNOLOGIES

ACCELERON® BIOAG

ACCELERON BIOAG TECHNOLOGIES	Rhizobia	LCO	*Penicillium bilaiae*	*Trichoderma virens*	*Bacillus amyloliquefaciens*
JumpStart®			✓		
QuickRoots®				✓	✓

"This year's been kind of a trying time with different environmental attributes that we've had thrown at us. Anything that can possibly increase the plant health of these varieties is a big plus. The QuickRoots® technology products have really helped us get to that point. Emergence was tremendously good."

MIKE SIECK, KANSAS

JumpStart® Wettable Powder Inoculant

Increase phosphate availability to support early vigor in wheat

JumpStart® Wettable Powder Inoculant contains the naturally occurring soil fungus *Penicillium bilaiae*. It grows along plant roots releasing nutrients like phosphate bound in the soil, making them more available for the crop to use. *Penicillium bilaiae* does not replace the need for phosphate fertilizer, but does provide crops access to more nutrients for higher yield potential.

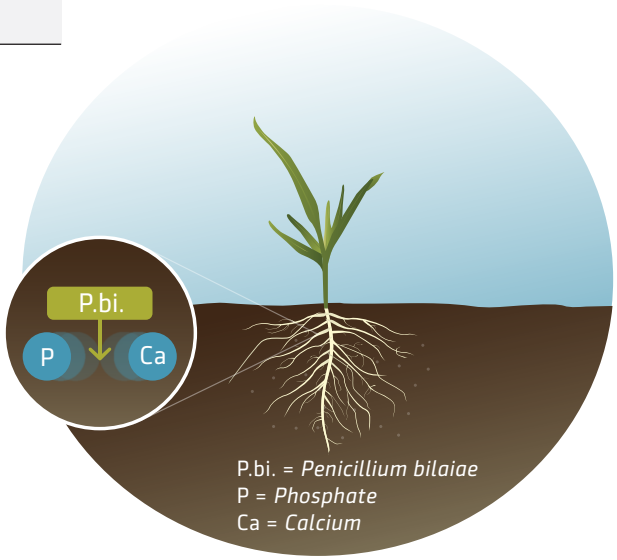
BENEFITS OF USING JUMPSTART WETTABLE POWDER INOCULANT

- Improves phosphate availability which:
  - Enhances early vigor
  - Bolsters root and shoot growth, supporting greater stress tolerance and earlier, more uniform plant development
  - Improves yield potential
- Improved plant nutrition enables plants to better handle environmental pressures
- Better potential for winter wheat survival through enhanced root systems
- Active in cool soil temperatures when phosphate is less available, which can help get the crop off to an early start

HOW THE TECHNOLOGY WORKS

Freeing Phosphate

Penicillium bilaiae releases bound mineral forms of soil and fertilizer phosphate, making it more available for the plant to use.



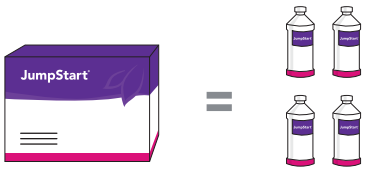
PRODUCT DETAILS

Packaging may vary.

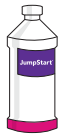
JumpStart® Wettable Powder Inoculant

Active Ingredients	Packaging	Application Rate	Case Treats
720 million (7.2 x 10^8) cfu/g *Penicillium bilaiae*	4 x 40 bu (2.0 oz/57 g) 280 bu (14.0 oz/400 g)	Varies (see below)	160 bu = 9,600 lbs of seed 280 bu = 16,800 lbs of seed

Always read and follow label directions



4 x 40 bu
(2.0 oz/57 g)



280 bu
(14.0 oz/400 g)

On-Seed Application Rates and Bare Seed Planting Windows for JumpStart® Wettable Powder Inoculant

40 bu (57 g/2.0 oz)

Crop	Seed Inoculated by 57 g/2.0 oz	Approximate Water Volume	Planting Window (Bare Seed)
Wheat	40 bu = 2,400 lbs (1,090 kg)	7.6 quarts (7.2 liters)	30 days

280 bu (400 g/14.0 oz)

Crop	Seed Inoculated by 400 g/14.0 oz	Approximate Water Volume	Planting Window (Bare Seed)
Wheat	280 bu = 16,800 lbs (7,620 kg)	53.0 quarts (50 liters)	30 days

QuickRoots® WP Small Grains Inoculant

Protect wheat from stress with increased moisture and nutrient availability

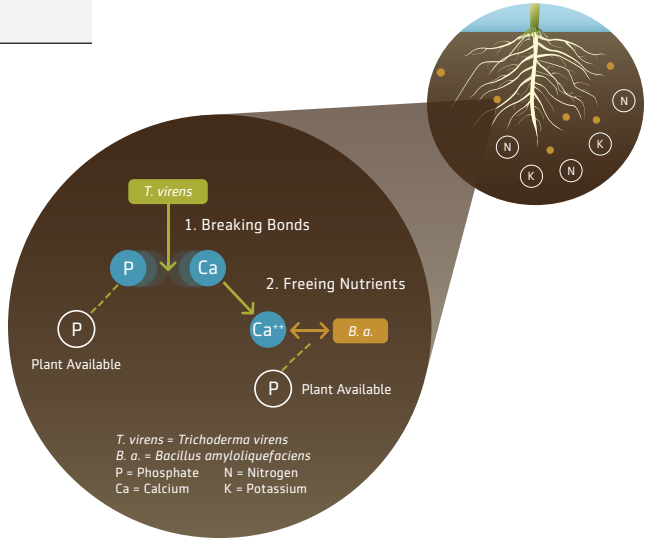
QuickRoots® WP Small Grains Inoculant helps maximize wheat yields — especially in fields with limitations in moisture or nutrient availability.

BENEFITS OF USING QUICKROOTS WP SMALL GRAINS INOCULANT

- Increases phosphate availability and uptake, which increases root volume
- Larger root volume helps the plant access more moisture and nutrients, including nitrogen and potassium

HOW THE TECHNOLOGY WORKS

1. The microbes *Bacillus amyloliquefaciens* and *Trichoderma virens* release enzymes that convert organic phosphate, which is not readily available to the plant, to plant-available phosphate.
2. Improved phosphate availability can lead to expanded root volume, which enhances uptake of moisture, nitrogen and potassium.
3. This ultimately can enable optimal plant growth and increased yield potential.



PRODUCT DETAILS

Packaging may vary.

QuickRoots® technologies are not fungicides and will not replace your current fungicide seed treatment.

QuickRoots® WP Small Grains Inoculant

Active Ingredients	Packaging	Application Rate	Case Treats
730 million (7.3 x 10^8) viable cfu/g *Bacillus amyloliquefaciens* 22 million (2.2 x 10^7) cfu/g *Trichoderma virens*	10 x 100 bu 2,500 bu	3 g/45 kg (100 lbs of seed)	2,500 bu = 150,000 lbs of seed

Always read and follow label directions

10 x 100 bu = 4 lbs (1.8 kg)

9.9 lbs (4.5 kg)

Notes

RESOURCES

ACCELERON® BIOAG

RESOURCES

ACCELERON® BIOAG

Section Overview

Who we are

Acceleron® brand has a dedicated sales team that offers a comprehensive portfolio of bio-enhancer and synthetic products. Our premium, proven lineup of fungicides, insecticides, nematicides and bio-enhancers work together to help dealers deliver more value and protect crops from unpredictable early season threats.

- We have the industry's largest team of dedicated sales managers who undergo extensive training and are committed to providing field sales service, support and expertise.
- Our product portfolio is the most complete and most advanced in the industry.
- Every product is thoroughly tested and held to the highest standards to optimize the value of every seed.
- Our five custom blending sites help us enhance product quality, improve delivery times and help dealers better manage their inventory.
- Preseason maintenance and support helps dealers ensure their equipment is up and running.

Contacts and Compatibility

ORDERING OPTIONS

Phone: (877) 775-8787
Online: operations.acceleron@monsanto.com

KEY CONTACTS

Acceleron® Operation Team: (877) 775-8787

Incident Response: In case of an emergency that endangers life or property involving these products, call collect day or night at 1-314-694-4000.

SEED TREATMENT COMPATIBILITY

Compatibility tests are conducted with registered seed treatments to ensure the viability of our inoculants is not compromised by pesticides and other seed treatments.

Each inoculant formulation is tested with various seed treatments using different application methods on specific crops. The planting windows presented are specific to JumpStart®, TagTeam®, QuickRoots®, Optimize® and Cell-Tech® technologies only and should not be used for other inoculants.

Compatibility tests are ongoing. For the most up-to-date seed treatment compatibility, please visit AcceleronSAS.com/CompatibilityGuide.

It is important to use proper PPE when handling treated seed.

Best Management Practices

OPTIMIZE® XC AND TAGTEAM® LCO XC TECHNOLOGIES

With these two Acceleron® BioAg products, applicators can provide high-quality inoculants with a lower application rate. Optimize® XC and TagTeam® LCO XC technologies both have application rates of 1.5 fluid ounces per 100 pounds of seed. Earlier Optimize and TagTeam formulations had an application rate of 2.8 fluid ounces per 100 pounds of seed. Following these best management practices will provide dealers and their growers a good experience.

Living Organisms – Microbes are living organisms and depend on us as applicators to exercise good storage practices before and after application. In general, cooler temperatures will favor survival of the living bacteria found in inoculants. Store the products and seed to which the products have been applied in cool, dry conditions and refer to product and seed labels for specific recommendations.

Dedicated Tank – Use a tank and pump system dedicated to liquid inoculants. This will allow for easy management of both your Acceleron® Seed Applied Solutions and Acceleron BioAg products. While standard seed treatments are generally stable if left in a mix tank for a few days before consumed, this is not true for most inoculants. A dedicated tank will allow you to open and mix only what you need for immediate use, keeping your inoculant source as fresh and viable as possible. Even with a dedicated tank, you need to plan to apply all product within 24 hours after opening. If you don't have a dedicated tank, you may choose to mix your inoculants with your Acceleron Seed Applied Solutions for soybean. If this is done, please be aware that this entire mixture needs to be applied to soybean seed within a four-hour window of application. Clean your inoculant tank weekly at a minimum to maintain good sanitation throughout the treating season.

Water Quality – Under some treating conditions, you may find it desirable to add a small amount of water to your seed treatment or your inoculant. You will need to use nonchlorinated water as chlorine added into most public water supplies can harm the live rhizobia in the inoculant. You can install a water filter designed to remove chlorine or use a spare tank to hold water for 24 hours, allowing the chlorine to dissipate out of the water.

Use the Correct Pump Hose – Most sites use peristaltic pumps to meter inoculants. If the lower-use rate of 1.5 fluid ounces per 100 pounds of seed is difficult for your pump, try installing a smaller pump hose such as an LS24 size.

Soybean Oil – Many treating sites add a small amount of soybean oil to their seed treatment tank as a practice to reduce buildup in the equipment, enabling longer periods of treating. This practice does not harm the living organisms in the inoculant and may have a beneficial effect in that the oil dries more slowly than water.

Quick Reference

SOYBEAN

	Active Ingredients	Packaging	Application Rates	Case Treats
Cell-Tech® Soybean Liquid Inoculant	2 billion (2 x 10^9) viable cfu/ml *Bradyrhizobium japonicum*	4 x 50 unit	2.1 fl oz/unit (50 lbs) of seed (63 ml/23 kg)	200 units or 28,000,000 seeds
Cell-Tech® Soybean Granular Inoculant	100 million (1 x 10^8) viable cfu/g *Bradyrhizobium japonicum*	1,000 lbs (454 kg) 40 lbs (18 kg)	Varies by row spacing	Varies by row spacing
Optimize® XC Inoculant	10 billion (1 x 10^{10}) viable cfu/g *Bradyrhizobium japonicum* 1 x 10^{-7}% lipo-chitooligosaccharides	400 units 5 x 2 x 40 unit	1.5 fl oz/100 lbs (44.4 ml/45.4 kg)	400 units or 56,000,000 seeds
TagTeam® Soybean Granular Inoculant	100 million (1 x 10^8) viable cfu/g *Bradyrhizobium japonicum* 100 thousand (1 x 10^5) cfu/g *Penicillium bilaiae*	39.7 lbs (18 kg) 582 lbs (264 kg)	Varies by row spacing	Varies by row spacing
TagTeam® LCO XC Inoculant	10 billion (1 x 10^{10}) viable cfu/ml *Bradyrhizobium japonicum* 1 x 10^{-7}% lipo-chitooligosaccharides 720 million (7.2 x 10^8) cfu/g *Penicillium bilaiae*	400 units 5 x 2 x 40 unit	1.5 fl oz/100 lbs 44.4 ml/45.4 kg	400 units or 56,000,000 seeds

Quick Reference (cont.)

CORN

	Active Ingredients	Packaging	Application Rates	Case Treats
QuickRoots® PB Corn Multi-Crop Inoculant	210 million (2.1 x 10^8) viable cfu/g *Bacillus amyloliquefaciens* 50 million (5 x 10^7) cfu/g *Trichoderma virens*	10 x 25 unit 200 units	16 g/80,000 seeds (unit)	250 units 200 units
QuickRoots® WP Corn Multi-Crop Inoculant	310 million (3.1 x 10^8) viable cfu/g *Bacillus amyloliquefaciens* 74 million (7.4 x 107) cfu/g *Trichoderma virens*	10 x 25 unit 625 units 3,125 units	7.2 g/80,000 seeds (unit)	250 units 625 units 3,125 units

WHEAT

	Active Ingredients	Packaging	Application Rates	Case Treats
JumpStart® Wettable Powder Inoculant	720 million (7.2 x 10^8) cfu/g *Penicillium bilaiae*	4 x 40 bu (2 oz/57 g) 280 bu (14 oz/400 g)	Varies	160 bu = 9,600 lbs of seed 280 bu = 16,800 lbs of seed
QuickRoots® WP Small Grains Inoculant	730 million (7.3 x 108) viable cfu/g *Bacillus amyloliquefaciens* 22 million (2.2 x 107) cfu/g *Trichoderma virens*	10 x 100 bu 1,000 bu	3 g/45 kg (100 lbs) of seed	1,000 bu = 60,000 lbs of seed 2,500 bu = 150,000 lbs of seed

Flooding Effects on Soil Biodiversity

WHAT YOU'LL LEARN

- Flooding in a field prior to planting may lead to "fallow syndrome" in the crop due to a decrease in soil microbial communities
- Utilizing an inoculant at planting may help increase the beneficial rhizobia populations in soybean fields
- Using an inoculant for corn may improve the availability of phosphorus

Fields that recently experienced flooding before planting may have reduced soil biological diversity. The decrease in soil microbial communities following flooding is due to the depletion of oxygen in the soil profile. Silt deposited by a flood may add to the problem by sealing the field and further preventing oxygen from entering the soil. Fallow syndrome is the nutrient deficiencies and reduced growth of a crop that result from the absence of sufficient populations of beneficial soil microbes and can dramatically affect crop production.

EFFECTS OF FLOODING IN SOYBEAN FIELDS

Long periods of soil saturation and anaerobic conditions (three days or longer) decrease populations of the nitrogen-fixing rhizobial bacteria. Soybeans need rhizobia for optimal nitrogen fixation and without this beneficial bacteria, significant yield reductions can occur.[1]

When planting into a field that was previously flooded, the use of rhizobia inoculants may improve root development, nodulation, vigor and plant stand establishment, which can lead to faster canopy closure, better plant health, higher yields and a higher return on investment (ROI). In addition to these benefits, rhizobia inoculants provide the convenience of retail application and can be used in tandem with fungicidal and insecticidal seed inoculants.

TagTeam® LCO and Optimize® products combine nitrogen-fixing rhizobia with the LCO molecule — a combination that, based on a 2016 growth chamber study, can result in 2X as many nodules compared to rhizobia alone. Plus, the LCO enhances mycorrhizal colonization, which increases functional root volume and helps the plant uptake more water and nutrients through the roots.

EFFECTS OF FLOODING IN CORN FIELDS

Corn and small grains that have been planted into a field following flooding may show symptoms of phosphorous or zinc deficiency accompanied by slow, uneven early growth and stunting. These deficiencies are often due to a decrease in populations of vesicular-arbuscular mycorrhizal fungi, which act as an extension of corn roots. The LCO in BioRise™ Corn Offering* enhances mycorrhizal colonization, which increases functional root volume and helps the plant absorb additional nutrients.

QuickRoots® technology helps maximize corn yields — especially in fields with limitations in moisture or nutrient availability. The microbes in QuickRoots technology help increase the availability and uptake of phosphate, which increases root volume. With more root volume, the plant can access additional nutrients, including nitrogen and potassium, protecting it from stress.

Sources: [1]Staton, M. 2014. Identifying and responding to soybean inoculation failures. Michigan State University. http://msue.anrmsu.edu. Other sources: Ellis, J. R. 1998. Post flood syndrome and vesicular arbuscular mycorrhizal fungi. J. Prod. Agric. 11:200-204. Monsanto BioAg 2016 Product Guide. Web source verified 2/29/16.

*Class of 2017, 2018, 2019 and 2020 base genetics are treated with either BioRise™ 360 ST or BioRise™ 2 Corn Offering (the on-seed application of the separately registered products Acceleron® B-300 SAT and BioRise™ 360 ST).

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Chlorinated Water and Biological Seed Treatments

WHAT YOU'LL LEARN

- Biological seed treatments — also called bio-enhancers — contain living organisms
- Municipal water supplies contain chlorine that can impact the effectiveness of bio-enhancers
- When preparing bio-enhancers for treatment, dechlorination systems are recommended for water sources that contain chlorine

BIO-ENHANCERS CONTAIN LIVING ORGANISMS

Biological seed treatments, also known as bio-enhancers, contain living organisms such as bacteria and fungi; therefore, anything that can kill or injure these organisms can be detrimental to the effectiveness of these seed treatments (Figure 1).

CHLORINATED WATER

To keep water safe for human consumption, municipalities treat their water supply with variable levels of chlorine to kill bacteria and fungi that might be within pipes and water storage facilities. If chlorinated water is used while seeds are being treated with bio-enhancers, it can have an adverse effect on the treatment's effectiveness. Therefore, the recommendation is to avoid using water directly from a municipal supply line in the preparation of bio-enhancers (Figure 2). The best water source is from a nonchlorinated source.

RECOMMENDATIONS IF CHLORINATED WATER IS THE ONLY SOURCE

- Install a chlorine filter in the water line to remove chlorine. In general, these filters are comprised of activated carbon
- Allow chlorine to dissipate by leaving in an open container for six to 24 hours
- Use dechlorination tablets
- These practices can help bio-enhancers deliver the full benefits to a crop

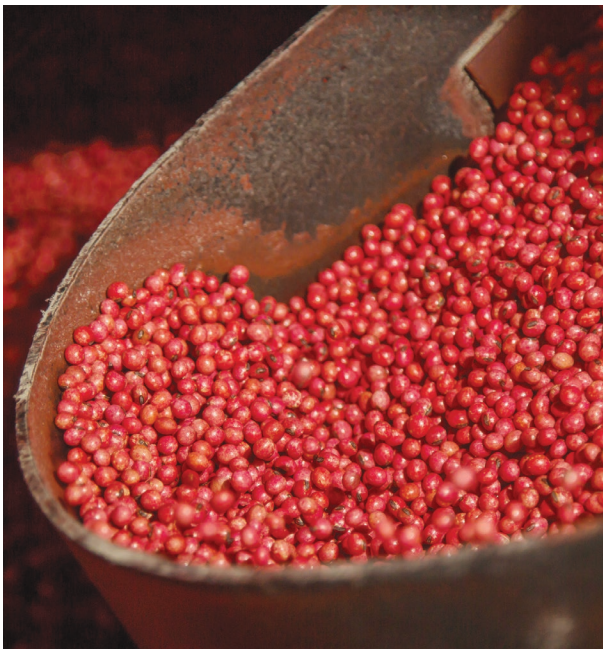

Figure 1. *Freshly treated seed.*

Figure 2. *Seed-treating mix tank.*

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Factors Influencing Soybean Nodulation

WHAT YOU'LL LEARN

- Many factors, both environmental and man-made, can affect the level of rhizobial nodulation on soybeans
- Nodulation is a natural process that is initiated by the plant through a complex signaling relationship with rhizobia
- Because it is a natural process, the signaling events between the soybean plant and the rhizobia can become disrupted by several factors

BACKGROUND

Nodulation generally begins about three to four weeks after emergence once the plant senses a need for nitrogen. The following factors can have a dramatic effect on the intensity, timing and efficiency of nodule development and nitrogen fixation. Taken alone, any one of the following factors can affect nodulation; however, it is common to find more than one factor influencing the extent of nodule formation on soybeans.

SOIL CHEMISTRY AND NUTRIENTS

- As soil pH drops below 6, the conditions can become too acidic for rhizobia to effectively create nod factor and form nodules.[1] Rhizobia survival can also be affected. Important micronutrients, including molybdenum, that are cofactors for nitrogen fixation may become unavailable under low pH conditions.
- Salt content in soil could be naturally occurring or due to irrigation. Introduction of salt can adversely affect nodulation even in concentrations low enough to allow for rhizobial survival and root colonization.
- As carryover nitrogen levels in the soil rise above 40 lbs/acre, nodule formation is negatively affected.[2] If plants have a source of nitrogen readily available, there is no incentive to signal to rhizobia to form nodules and thus the rhizobia do not create nod factor. Once this carryover nitrogen is used up, the plant then may signal to the rhizobia, but the whole nodulation process then becomes delayed or the signaling window can be missed, resulting in little to no nodulation on the soybean plants.

CULTURAL AND PHYSICAL

- Fields that have never been planted with soybeans have little to no rhizobia present, making inoculation/nodulation difficult. In general, the more times a field has been planted with soybeans with successful inoculation/nodulation, the higher the level of indigenous rhizobia. However, naturalized rhizobia may become less infective and/or effective over time and thus a supply of elite rhizobia, selected and fermented for these critical attributes, are needed to ensure effective nodulation.
- Natural differences in soybean products can also affect the intensity of nodulation because soybean plants control the symbiotic nitrogen fixation process, and some soybean products perform this task more efficiently than others. In the absence of supplemental inoculation, there can be vast differences in presence of nodules between two given soybean products. These differences can be lessened by introducing elite strains of rhizobia into the environment to counter those variances.
- Combining LCO with rhizobia increases the rate of early soybean nodulation, resulting in 2X as many nodules compared to rhizobia alone.[3] Both TagTeam® LCO XC and Optimize® XC technologies offer this effective combination.
- Soil texture/organic matter can affect rhizobia populations. In general, the coarser the soil the less rhizobia can survive year to year, negatively affecting rhizobia populations and inoculation/nodulation. Sandy soils can also get extremely dry and hot, which cause the rhizobia populations to desiccate and decrease rapidly.
- No-till conditions can create colder, wetter conditions early in the season, which can increase the stress levels of the plant, negatively affecting the signaling process between the plant and the rhizobia. These same conditions also can decrease the activity of the rhizobia, thus delaying nodulation.

TEMPERATURE AND PRECIPITATION

- The northern range of soybean-growing areas experience more extreme seasonal temperature

Factors Influencing Soybean Nodulation (Cont.)

fluctuations from colder winters to hot and dry summers, making it less likely that rhizobia can survive from year to year. The southern range of soybean-growing areas also can experience extremely high temperatures and dry conditions.

- In addition to creating plant stress, soil moisture can affect rhizobia survival. Hot, dry conditions can cause rhizobia desiccation and death, while flooding can create anaerobic conditions which cause rhizobial death due to low oxygen conditions.
- In addition to creating plant stress, temperature extremes can have an effect on the efficacy of soil rhizobia. In temperatures below 50° F (10° C), rhizobia become mostly inactive and the nodulation signaling process can be interrupted.[4] In high temperatures above 90° F (32° C), especially when combined with dry conditions, rhizobial desiccation and death can occur.[5]

BIOLOGY

- Often times, indigenous or native rhizobia will compete with the elite strains in an inoculant to occupy the infection sites on the soybean root. These native rhizobia may then infect and form nodules, but fix little to no nitrogen, making them parasitic to the soybean plants. The combination of LCO and rhizobia, delivered at the same time, which can be found in TagTeam® LCO XC and Optimize® technologies, can improve early nodulation by up to 2X.
- Any practice that stresses the plant (disease, herbicide injury, nutrient deficiency/poor fertility, compaction, cold early season temperatures) reduces the ability of the plant to signal the rhizobia regarding its need for nitrogen, thus delaying nodulation.
- Compounds applied to the seed and the soil such as incompatible pesticides, fertilizers and nutrients can cause rhizobial death. Care should be used with compounds such as talc (when applied during treating causes rapid rhizobial desiccation) or molybdenum (high toxicity) which can be incompatible with rhizobia. Always refer to published compatibility charts before using any unknown materials with rhizobia inoculants.

Figure 1. *Nodulation generally begins three to four weeks after emergence, and inoculation is the least expensive way to provide nitrogen to soybean plants.*[6]

ACCELERON® BIOAG INOCULANT PRODUCTS CAN HELP

The Acceleron® BioAg line of single-, dual- and triple-action inoculants help enhance the nodulation process. These products make the crucial pieces of the nodulation process available even in cases of environmental stress when they cannot be produced naturally. The unique properties available in products such as TagTeam® LCO, Optimize® XC and Cell-Tech® technologies can help soybean plants mitigate many of the stress factors they face. The nodulation factors delivered in products like TagTeam LCO and Optimize support the nodulation process, overcoming stresses (e.g., low pH conditions, cold, tillage) to support productive nodulation. In cases of flooding and soil toxicity (e.g., salt and pesticide carryover), the supply of healthy rhizobia in these products or our single-action inoculant Cell-Tech products support quick and effective nodulation.

In conclusion, by using an inoculant from Acceleron BioAg, you can maximize opportunities for successful initiation of nitrogen-fixing nodules.

Sources: [1]Pedersen, P. 2015. When do we need to inoculate our soybean seeds? Integrated Crop Management. Iowa State University. Paper 1559. [2]Staton, M. 2014. Identifying and responding to soybean inoculation failures. Michigan State University. [3]Based on a 2016 growth chamber trial. [4]Bohner, H. 2014. Cold temperatures hamper soybean nodulation. Crop Talk. OMAFRA. [5]Yadav, A.S. and Nehra, K. 2013. Selection/isolation of high temperature tolerant strains of Rhizobium for management of high temperature stress on Rhizobium — legume symbiosis. International Journal of Microbial Resource Technology. Vol. 2:47-57. [6]Klein, R. 2013. Check soybean nodulation to determine inoculant efficiency. UNL CropWatch. University of Nebraska, Lincoln.

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Identifying Inoculant Contamination

WHAT YOU'LL LEARN

- Pelleting is a normal occurrence in inoculants
- Contamination, although rare, may happen and cause the inoculant to be ineffective
- Contaminated bladders should not be used

NORMAL PELLETING VS. CONTAMINATION

Pelleting is a normal occurrence and can be more pronounced in concentrated products such as Optimize® XC and Tag Team® LCO XC technologies. Pelleting is the result of bacterial cells, insoluble fermentation ingredients and/or other contributing factors settling out of the solution into masses that can be seen in the bladder lying on the film (Figure 1). Pelleting should not be a reason for concern and the pellets should resuspend back into the solution with very little effort. Following package directions and gently shaking the bladder should be enough to achieve suspension.

Figure 1. *Normal pelleting.*

Even with adhering to the highest operational procedures, contamination may occasionally occur. Contamination may happen in different ways. One example is microscopic holes that may be created at pinch points of the bladder during filling. These holes allow for contaminants to enter the nutrient-rich medium.

Odor and visual cues are two ways to identify a contaminated bladder. A distinct odor is often the first thing noticed. A contaminated inoculant will have a very off smell, it can be rank, smell like ammonia or be very sharp.

Some masses in a contaminated bladder, unlike pelleting, will not easily go back into suspension. The masses may look like sheets or bits of tissue floating in the bladder. If a fungal contamination is to blame, the problem may be more noticeable with large masses of semisolids being present in the bladder (Figure 2).

Figure 2. *Contamination visible as sheeting. Bottom right image is an example of fungal contamination.*

WHAT TO DO IF YOU SUSPECT CONTAMINATION

If contamination is suspected, you should contact the distributor through which you purchased the product. Your distributor will be the most efficient source for replacement product to minimize treatment interruptions. The distributor will work directly with Acceleron® BioAg.

SUMMARY

Pelleting is a normal occurrence in inoculants but floating masses or masses stuck to the bladder film are not. If after following label directions and resuspension methods you are still unsure if contamination may have occurred, refrain from using the product. Contaminates may render the product ineffective and they can block screens in treaters. Upon opening the bladder, if inoculant emits an off smell or rank odor, contamination may have occurred. Contaminated products should not be used. Reach out to your distributor if you believe you have a contaminated product.

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Notes

Notes

Performance may vary from location to location and from year to year, as local growing, soil and weather conditions may vary. Growers should evaluate data from multiple locations and years whenever possible and should consider the impacts of these conditions on the grower's fields.

ACCELERON® BIOAG

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