BioAg 2021 Product Guide

novozymes®

Rethink Tomorrow

novozymes®

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BioAg solutions to drive your performance

Growers around the world trust our microbial inoculant, biostimulant and biocontrol solutions to drive their crop performance. Our scientific heritage is your guarantee of reliable products.

More than a century ago, we created the BioAg business with our Nitragin® brand, which is still a market leader today. Because we put innovation at the heart of our business, our groundbreaking pipeline will continue to propel agriculture into the future.

Our dynamic portfolio of biological solutions is derived from naturally-occurring microbes and enzymes. Microbial inoculants in our bioyield solutions complement traditional fertilizers. They increase the availability of key nutrients such as nitrogen, phosphorus and potassium. The result is improved crop yields. You know the efficacy claims we make are credible, because we back them up with real data.

Novozymes BioAg: Driving performance

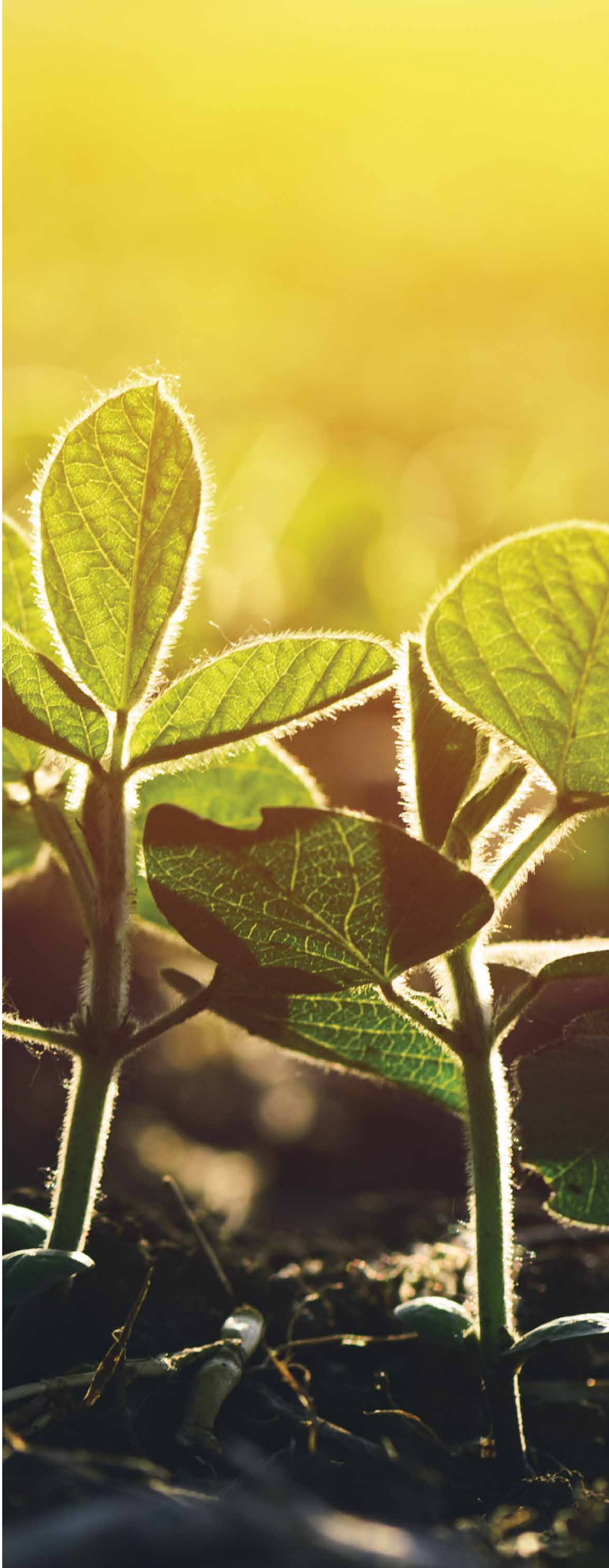
Agriculture today is more than just doing more with less. What if you could do more simply by utilizing nature's own problem solvers – enzymes and microbes. By more we mean: Maximize crop fertility return on investment, maximize soil and fertilizer phosphorus efficiency, and meet crop nutrition requirements through natural processes.

Helping your farm meet its yield potential

It's frustrating when you know your farm is falling short of its yield potential. Our bioyield solutions can help close the yield gap. Whatever crops you're planting; our microbial inoculants and biocontrol solutions will unlock additional profit from every acre.

Our commitment to innovation has helped us develop the world's leading microbial inoculant, biostimulant and biocontrol solutions portfolio. Our innovation is built on:

- Investment, with around 14% of our revenue going towards research and development
- Vertical integration from discovery to production. That leads to close cooperation between our R&D and commercial teams
- A global presence, with fermentation facilities across the globe ensuring that you can trust us to deliver on time
- World-leading formulation technologies that promote homogeneity and stability in our products



Notes

Corn Technologies

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Novozymes QuickRoots® Technology

Protect corn from stress with increased moisture and nutrient availability

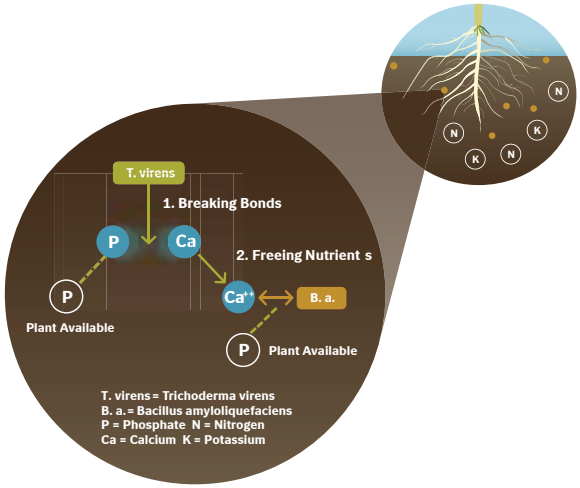
QuickRoots® Technology helps maximize corn yield — especially in fields with limitations in moisture or nutrient availability.

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
- Enables better plant growth and increases yield potential
- Performs in fields with limitations in moisture or nutrient availability

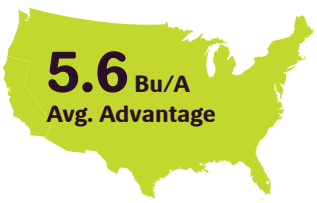
How the technology works

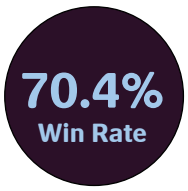
1. The microbes *Bacillus amyloliquefaciens* and *Trichoderma virens* release enzymes that convert organic phosphate, which is not readily available to the plant, to plant available phosphate.
2. Improved phosphate availability can lead to expanded root volume, which enhances moisture, nitrogen and potassium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



Product performance

In 670 independent, replicated small-plot and large-plot trials conducted over 12 years, corn treated with QuickRoots® Technology microbial seed inoculant out-yielded 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® PB Corn Multi-Crop Inoculant

Active ingredients	Packaging	Application rate	Case treats
210 million (2.1 x 10^8) viable cfu/g *Bacillus amyloliquefaciens*	10 x 25 unit	16 g/80,000 seeds (unit)	250 units
50 million (5 x 10^7) cfu/g *Trichoderma virens*	200 units		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*	625 units	7.2 g/80,000 seeds (unit)	625 units

QuickRoots® Technologies are not fungicides and will not replace your current fungicide seed treatment. Always read and follow label directions

Novozymes JumpStart® Wettable Powder Inoculant

Improve phosphate availability to support early vigor in corn.

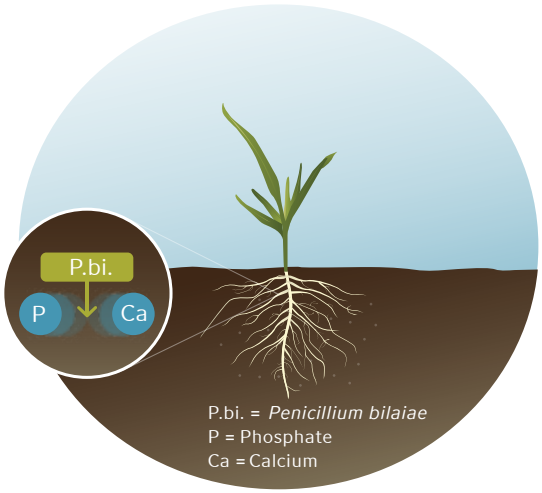
JumpStart® Wettable Powder Inoculant contains the naturally occurring soil fungus *Penicillium bilaiae*. It grows along plant roots releasing nutrients like phosphate bound in the soil, making them more available for the crop to use. *Penicillium bilaiae* does not replace the need for phosphate fertilizer, 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
- 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 (7.2×10^8) cfu/g *Penicillium bilaiae*	4 x 40 bu (2.0 oz)	Varies (see below)	See chart below

Always read and follow label directions

On-Seed Application Rates and Bare Seed Planting Windows 2.0 oz container

Crop	Seed inoculated by 2.0 oz	Approximate water volume	Planting window (bare seed)
Corn	10 units	3.0 quarts	60 days

On-Seed Application Rates and Bare Seed Planting Windows 14.0 oz container

Crop	Seed inoculated by 14.0 oz	Approximate water volume	Planting window (bare seed)
Corn	70 units	20.71 quarts	60 days

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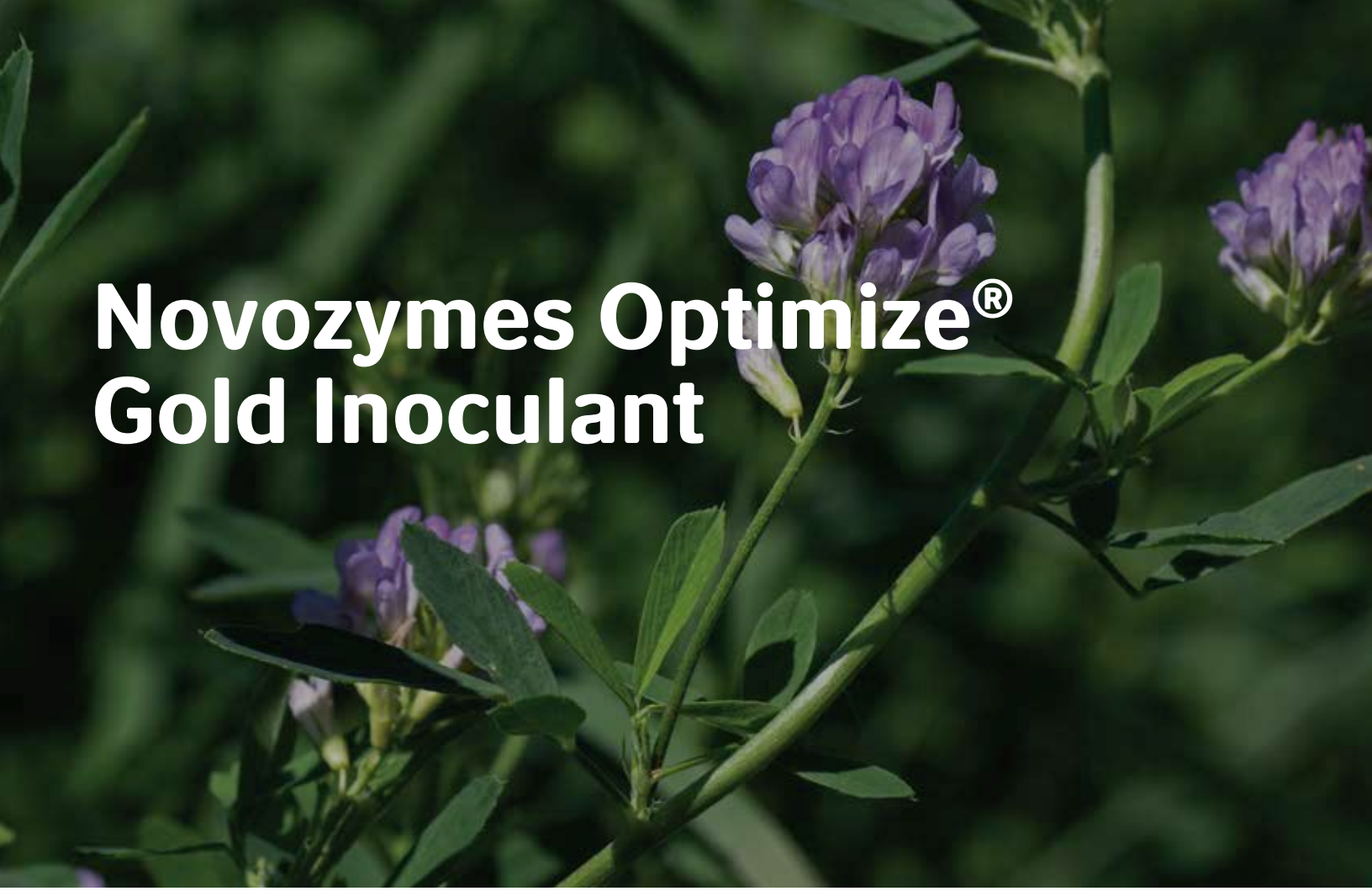


Novozymes Optimize® Gold Inoculant

Breakthrough performance for alfalfa

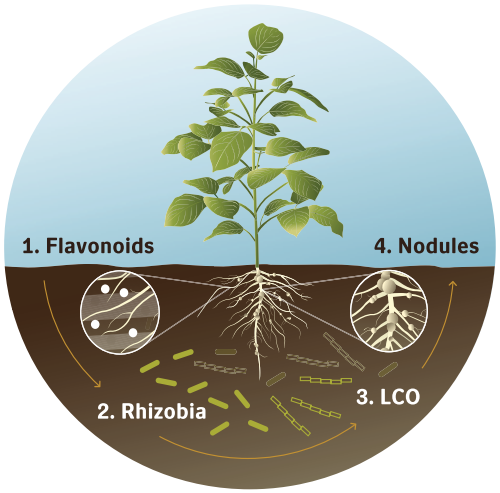
Optimize® Gold Inoculant with LCO technology for alfalfa delivers the benefits of elite inoculant strains of *Sinorhizobium meliloti* along with the LCO (lipo-chitooligosaccharides) technology — helping to improve your crop's potential by enhancing nutrient availability.

Benefits of using Optimize® Gold Inoculant

- When used in conjunction with Nitragin® Gold Technology for alfalfa it can help with effective nodulation
- Increases potential for nitrogen fixation through nodule formation
- Enhances nutrient availability which supports root and shoot growth

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.



Product details

Packaging may vary

Optimize® Gold Inoculant			
Active ingredients	**Packaging**	**Application rate**	**Case treats**
1 million (1 x 10^6) viable cfu/ml *Sinorhizobium meliloti* 1 x 10^{-7} % lipo-chitooligosaccharides	38.3 lb	19.6 fl oz/100 lbs of seed	3,000 lb of seed

Always read and follow label directions

Novozymes Nitragin® Gold Technology

Nitrogen-fixing inoculant for alfalfa, sweet clover and clover

Add value to your seed and for your seed customers by requesting Nitragin® Gold Technology from your processor.

Benefits of using Nitragin® Gold Technology

- **Seed adhesion:** Micron-sized particles can help to provide superior seed adhesion and minimal “dusting off”
- **Ease of application:** Can be used in either a continuous flow or batch treating system
- **Yield:** Specially selected rhizobia strains result in high levels of nitrogen fixation for maximum yield potential
- Nitragin Gold® Technology is compatible with many seed treatment chemistry. See Seed Treatment Compatibility for the most current information at novozymes.com/bioag.
- **OMRI certified:** Products with Nitragin® Gold Technology for alfalfa and sweet clover are OMRI certified (for U.S. and Canada only)

products available OMRI LISTED For Organic Use

Product details

Packaging may vary.

Nitragin® Gold Alfalfa and Sweet Clover Pre-Inoculant

Active ingredients	Packaging	Application rate	Case treats	Crop
300 million (3 X 10^8) viable cfu/g *Sinorhizobium meliloti*	42 lb box	6.67 oz per 50 lbs of seed	5,000 lbs of seed	Alfalfa and sweet clovers (white, yellow, hubam, madrid, bitter and sour clover)
	1,600 lb tote	8.0 oz per 60 lbs or a bushel of seed	192,000 lbs of seed	

Always read and follow label directions

Nitragin® Gold Clover Pre-Inoculant

Active ingredients	Packaging	Application rate	Case treats	Crop
80 million (8 x 10^7) viable cfu/g *Rhizobium leguminosarum*	42 lb box	Red clover — 6.67 oz per 50 lbs of seed White, ladino, alsike clover — 13.3 oz per 50 lbs of seed	Red clover — 5,000 lbs of seed White, ladino, alsike clover — 2,500 lbs of seed	Ladino, alsike, red and white clovers

Always read and follow label directions

Novozymes JumpStart® Wettable Powder Inoculant

Improve phosphate availability to support early vigor in alfalfa and sweet clover.

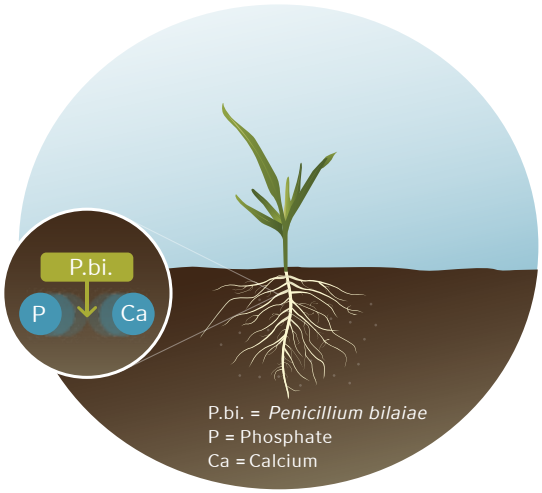
JumpStart® Wettable Powder Inoculant contains the naturally occurring soil fungus *Penicillium bilaiae*. It grows along plant roots releasing nutrients like phosphate bound in the soil, making them more available for the crop to use. *Penicillium bilaiae* does not replace the need for phosphate fertilizer, 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
- 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 (7.2×10^8) cfu/g *Penicillium bilaiae*	4 x 40 bu (2.0 oz)	Varies (see below)	See chart below

Always read and follow label directions

On-Seed Application Rates and Bare Seed Planting Windows 2.0 oz container

Crop	Seed inoculated by 2.0 oz	Approximate water volume	Planting window (bare seed)
Alfalfa/Sweet Clover	150 lbs	1.6 quarts	7 days

On-Seed Application Rates and Bare Seed Planting Windows 14.0 oz container

Crop	Seed inoculated by 14.0 oz	Approximate water volume	Planting window (bare seed)
Alfalfa/Sweet Clover	1,050 lbs	11.5 quarts	7 days

Notes

Peanuts Technologies

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Novozymes Optimize® Inoculant for peanuts

Product overview

Dual-action inoculant for peanut
Optimize® Technology is an inoculant for peanuts that supports your crop's potential by enhancing nutrient availability. With Optimize® Technology, you get the benefits of a specially selected *Bradyrhizobium* sp. *Arachis* inoculant along with LCO (lipo-chitooligosaccharides) technology.

Features & benefits

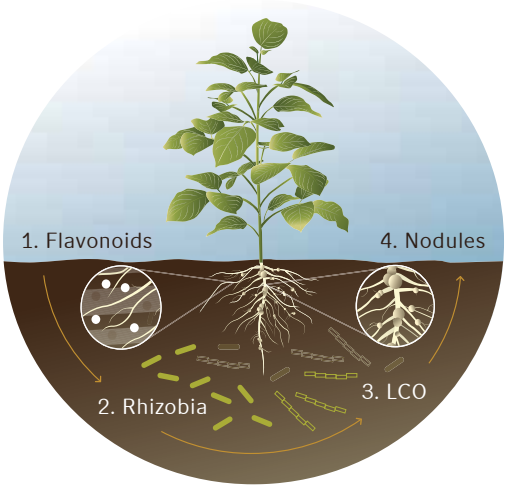
Benefits of using Optimize® Technology:

- Includes an elite strain of *Bradyrhizobium* sp. *Arachis* and LCO to help with effective nodulation
- Increases nitrogen fixation through nodule formation
- Enhances nutrient availability which supports root and shoot growth

How it works

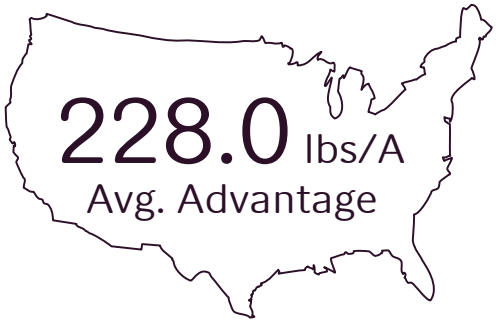
How the technology works:

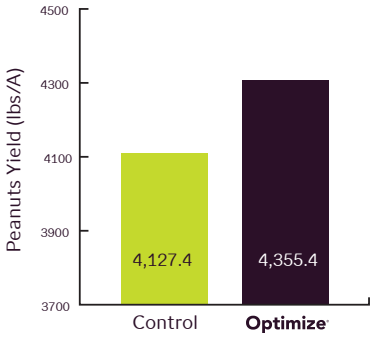
1. Needing nitrogen, the plant releases flavonoids to signal rhizobia.
2. Sensing the flavonoids, the rhizobia signal LCO back to the plant.
3. The plant can respond to the LCO, allowing the rhizobia to infect its roots.
4. This symbiotic relationship creates nodules, which can help fix atmospheric nitrogen.

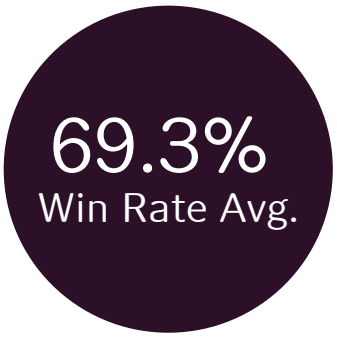


Product performance

In 153 independent, replicated small-plot trials conducted over 13 years, peanuts treated with Optimize® microbial seed inoculant out-yielded peanuts not treated with Optimize® by an average of 228.0 pounds per acre. Data as of January 19, 2018. Individual results may vary.



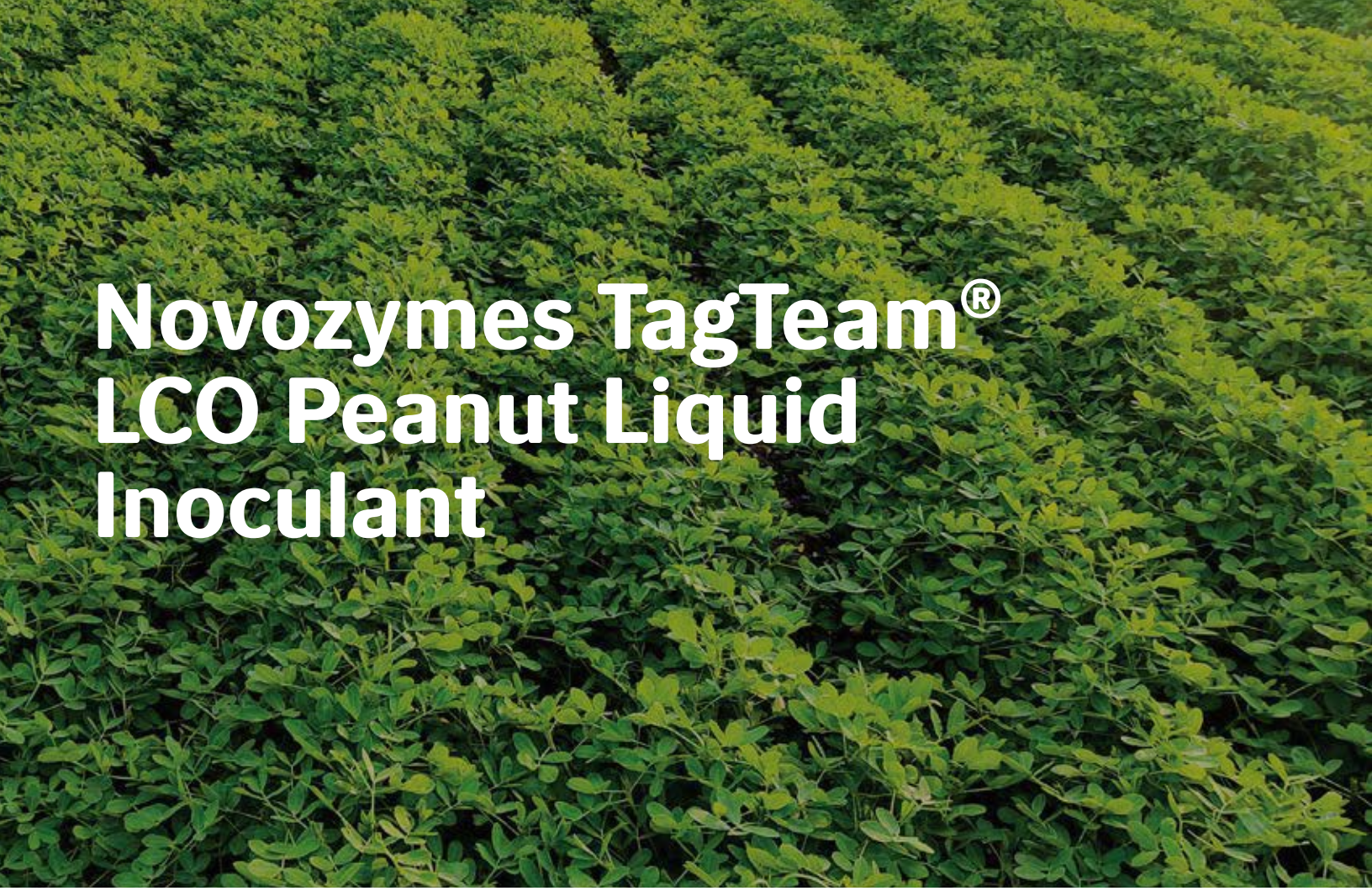




Product performance

Optimize® Peanut Inoculant			
Active ingredients	**Packaging**	**Application rate**	**Case treats**
2 billion (2 x 10^9) viable cfu/ml *Bradyrhizobium* sp. *Arachis* 1 x 10^{-7} % lipo-chitooligosaccharides	4 x 1.1 gal	1.0 oz/1,000 ft of row	Case treats 40 acres. Package treats 10 acres using a 36 inch row spacing.

Always read and follow label directions



Novozymes TagTeam® LCO Peanut Liquid Inoculant

Product overview

Three powerful technologies combined to benefit your peanut crop
TagTeam® LCO Technology for peanuts is a triple-action inoculant that combines a specially selected rhizobia inoculant with the proven performance of the LCO (lipo-chitooligosaccharides) technology and the phosphate-solubilizing benefits of *Penicillium bilaiae*. Together, they can work to help improve your peanut crop's access to nutrients and maximize yield potential.

Features & benefits

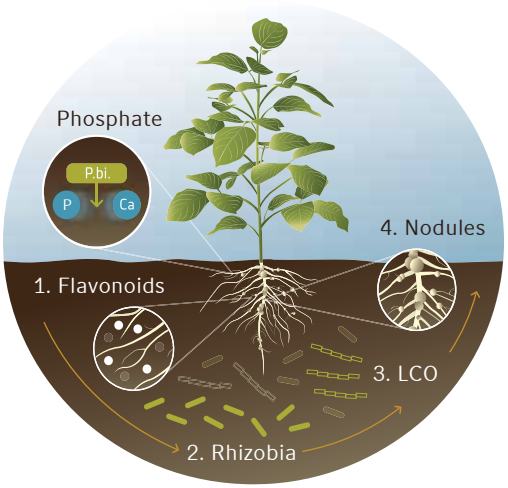
Benefits of using TagTeam® LCO Technology:

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

How it works

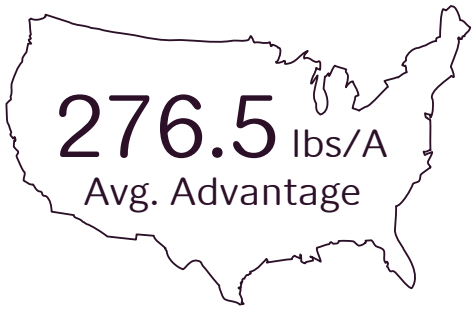
How the technology works:

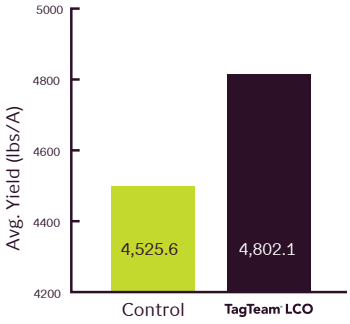
1. Freeing phosphate
   - *Penicillium bilaiae* releases bound mineral forms of soil and fertilizer phosphate, making it more available for the plant to use.
2. More nitrogen
   - Needing nitrogen, the plant releases flavonoids to signal rhizobia.
   - Sensing the flavonoids, the rhizobia signal LCO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

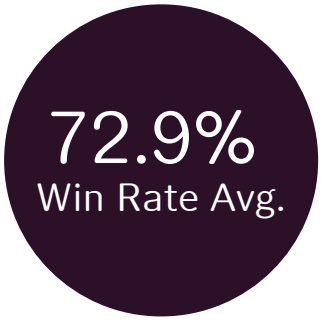


Product performance

In 48 independent, replicated small-plot trials conducted over 4 years, peanuts treated with TagTeam® LCO Technology out-yielded peanuts not treated with TagTeam® LCO by an average of 276.5 pounds per acre. Data as of January 19, 2018. Individual results may vary.







Product details

TagTeam® LCO Peanut Liquid Inoculant			
Active ingredients	**Packaging**	**Application rate**	**Case treats**
2 billion (2 x 10^9) viable cfu/ml *Bradyrhizobium* sp. *Arachis* 1 x 10^{-7} % lipo-chitooligosaccharides 720 million (7.2 x 10^8) cfu/g *Penicillium bilaiae*	4 x 1.1 gal	1.0 fl oz/1,000 ft of row	40 acres at 36 in row spacing

Always read and follow label directions

Novozymes Cell-Tech® Technology

Product features

Nitrogen-fixing inoculant for peanut
Cell-Tech® Technology contains specially selected rhizobia that can provide highly effective nodulation to enhance nitrogen fixation, even in cooler soils, increasing yield potential as planting conditions change.

Features & benefits

Benefits of using Cell-Tech® Granular Technology:

- More nitrogen-fixing bacteria per linear foot than seed applied inoculants
- Convenient application through granular applicator box
- Each bag treats between five and eight acres, depending on row width
- Granular form is advantageous in prolonged hot, dry, or sandy seedbeds

Benefits of using Cell-Tech® Peat:

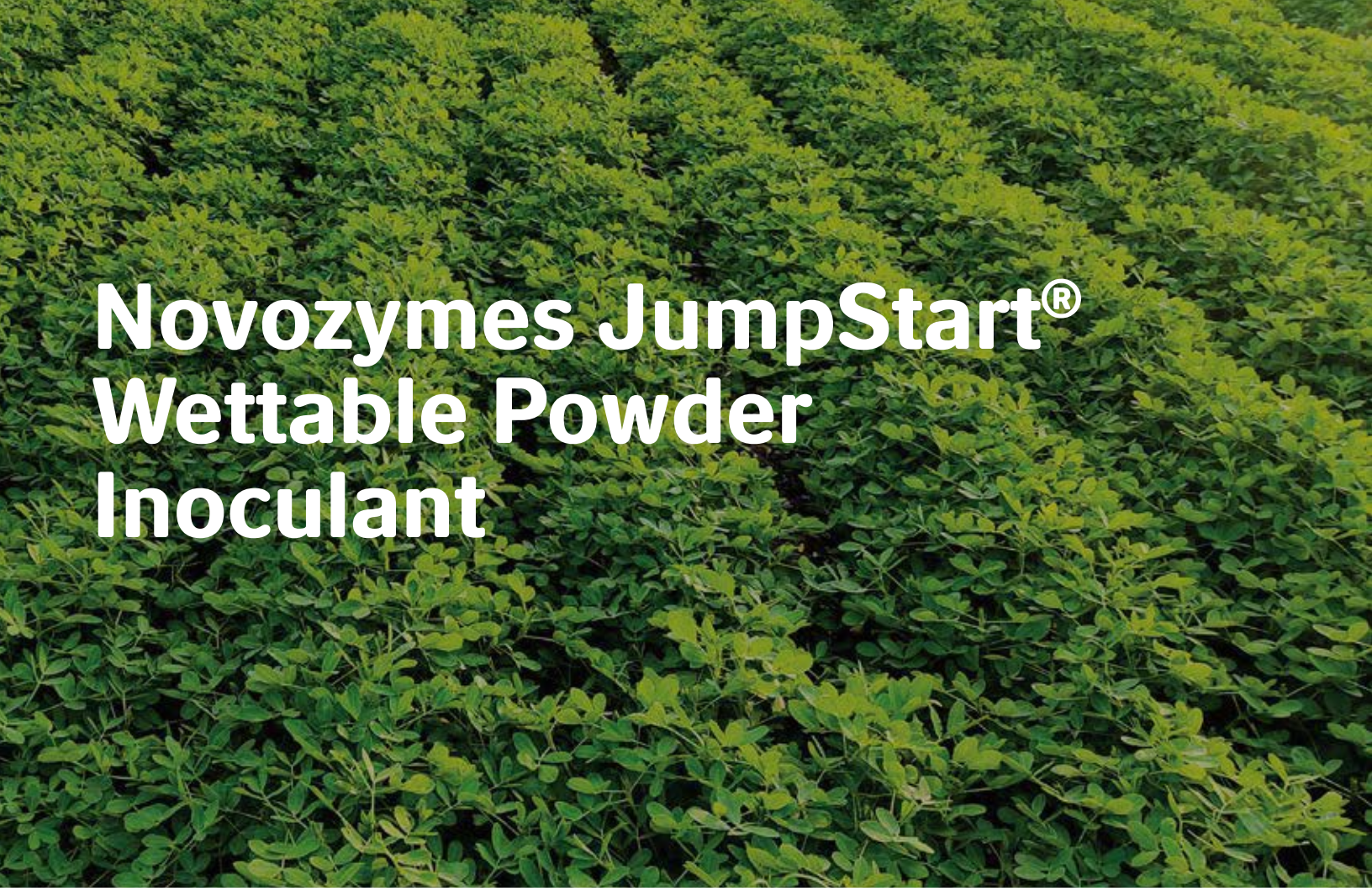
- Each pack can effectively treat 100 pounds of peanut seed
- Dependable, peat-based powder formulation for hopper box application
- Built-in sticker offers seed adhesion, making it compatible with common planting equipment

Product Details

Cell-Tech® Peanut Peat Inoculant			
Active ingredients	**Packaging**	**Application rate**	**Case treats**
100 million (1.0×10^8) viable cfu/g *Bradyrhizobium* sp. *Arachis*	24 x 6.6 oz packages	6.6 oz/100 lbs of seed	2,400 lbs

Cell-Tech® Peanut Granular Inoculant			
Active ingredients	**Packaging**	**Application rate**	**Case treats**
100 million (1.0×10^8) viable cfu/g *Bradyrhizobium* sp. *Arachis*	40 lb bag	6 oz/1,000 feet of row	See Table Below

Application Rates Cell-Tech® Peanut Granular Inoculant						
Row spacing (in)	24	30	32	36	38	40
Application rate (lb/acre)	8.2	6.5	6.1	5.4	5.2	4.9
Area treated per bag (acres)	4.9	6.1	6.5	7.3	7.8	8.2



Novozymes JumpStart® Wettable Powder Inoculant

Product overview

Improve phosphate availability to support early vigor in peanut crops
JumpStart® Technology contains the naturally occuring 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 peanuts access to more nutrients for higher yield potential.

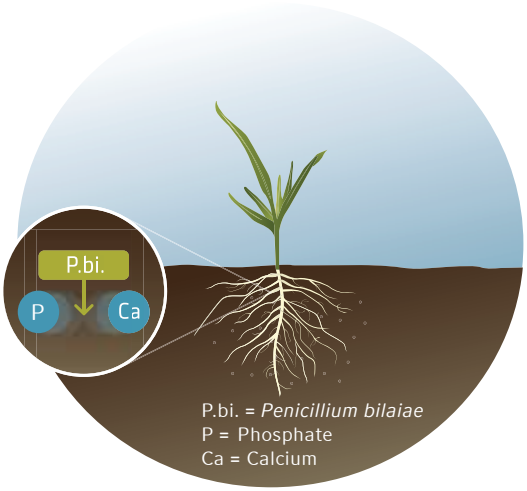
Features & benefits

Benefits of using JumpStart® Technology:

- 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
- Active in cool soil temperatures when phosphate is less available, which can help get the crop off to an early start

How it works

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

JumpStart® Wettable Powder Inoculant

Active ingredients	Packaging
720 million (7.2 x 10^8) cfu/g *Penicillium bilaiae*	4 x 2.0 oz container

In-furrow Application Rates for Peanut

Row width	Recommended JumpStart® Wettable Powder rate	2.0 oz Container treats
30 in		
Single Row	0.166 oz/acre	8.3 acres
Twin Row	0.332 oz/acre	4.2 acres
36 in		
Single Row	0.2 oz/acre	10.0 acres
Twin Row	0.4 oz/acre	5.0 acres

Always read and follow label directions

Notes

Pulses Technologies

Novozymes Cell-Tech® Pulse

Product overview

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

Features & benefits

Benefits of using Cell-Tech® granular technology:

- More nitrogen-fixing bacteria per linear foot than seed applied inoculants
- Convenient application through granular applicator box
- Each bag treats between five and eight acres, depending on row width
- Granular form is advantageous in prolonged hot, dry, or sandy seedbeds

Benefits of using Cell-Tech® peat:

- Dependable, peat-based powder formulation for hopper box application
- Built-in sticker offers seed adhesion, making it compatible with common planting equipment

Benefits of using Cell-Tech® liquid inoculant

- Four-day on-seed guarantee when applied with most common chemical seed treatments. See Seed Treatment Compatibility for the most current information at novozymes.com/bioag
- Flexible — can be applied on-seed or in-furrow
- Convenient liquid formulation for on-farm application

Cell-Tech® Pulse NS Peat

Active ingredients	Packaging	Application rate	Case treats
5 x 10^8 viable cfu/g *Rhizobium leguminosarum* biovar *viciae*	4 x 6.2 lb bag	6.6 oz/100 lbs seed	700 kg (1500 lb, 25 bu) peas or lentils

Cell-Tech® Pulse Granular

Active ingredients	Packaging
100 million (1 x 10^8) viable cfu/g *Rhizobium leguminosarum* bv. *viciae*	40 lb bag

Application rates for Cell-Tech® Pulse Granular

Row spacing	6.0 in	7.0 in	8.0 in	9.0 in	10 in	12 in	15 in
Application rate	7.7 lbs/ac	6.6 lbs/ac	5.8 lbs/ac	5.1 lbs/ac	4.6 lbs/ac	3.8 lbs/ac	3.1 lbs/ac

Cell-Tech® Pulse Liquid

Active ingredients	Packaging	Application rate	Case treats
2 x 10^9 viable cfu/ml [2 x 10^9 viable cfu/g] *Rhizobium leguminosarum*	4 x 101.4 fl oz	2.5 fl oz/60 lb seed (75 ml/27 kg)	2400 lb seed

Novozymes TagTeam® Chickpea Granular Inoculant

Two powerful technologies combined to benefit your chickpeas

TagTeam® Chickpea 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 chickpea crop.

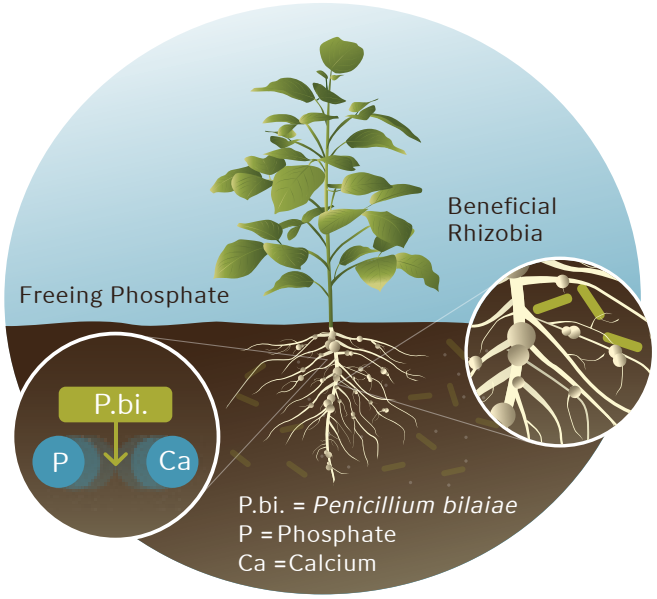
Benefits of using TagTeam® Chickpea Granular Inoculant

- 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® Chickpea Granular Inoculant			
Active ingredients	**Packaging**	**Application rate**	**Case treats**
100 million (1.0 X 10^8) viable cfu/g *Mesorhizobium ciceri* 1 million (1.0 X 10^6) cfu/g *Penicillium bilaiae*	40 lb bag	1.0 oz/1,000 ft of row	See table below

Always read and follow label directions

Application rates for TagTeam® Chickpea Granular Inoculant							
Row spacing	6.0 in	7.0 in	8.0 in	9.0 in	10 in	12 in	15 in
Application rate	5.5 lbs/ac	4.7 lbs/ac	4.1 lbs/ac	3.6 lbs/ac	3.3 lbs/ac	2.7 lbs/ac	2.2 lbs/ac
Area treated per bag	7.3 ac	8.5 ac	9.8 ac	11.1 ac	12.1 ac	14.8 ac	18.2 ac

Novozymes TagTeam® LCO Pea and Lentil Liquid Inoculant

Three powerful technologies combined to benefit your pea and lentil crop

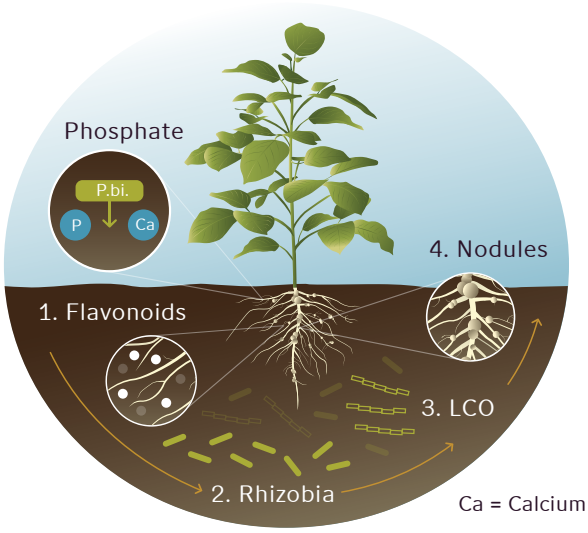
TagTeam® LCO technology for peas and lentils is a triple-action inoculant that combines a specially selected rhizobia inoculant with the proven performance of the LCO (lipo-chitooligosaccharides) technology and the phosphate-solubilizing benefits of *Penicillium bilaiae*. Together, they can work to help improve your crop's access to nutrients and maximize yield potential.

Benefits of using TagTeam® LCO technology

- Greater availability of soil and fertilizer nutrients — including phosphate, which supports root and shoot growth, as well as nitrogen fixation
- 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. **More nitrogen**
   2.1 Needing nitrogen, the plant releases flavonoids to signal rhizobia
   2.2 Sensing the flavonoids, the rhizobia signal LCO back to the plant.
   2.3 The plant can respond to the LCO, allowing the rhizobia to infect its roots.
   2.4 This symbiotic relationship can create nodules, which help fix atmospheric nitrogen



Ca = Calcium

P = Phosphate

P.bi. = *Penicillium bilaiae*

Product details

Packaging may vary.

TagTeam® LCO Pea and Lentil Liquid Inoculant

Active ingredients	Packaging	Application rate with planter, drill or air seeder	Application rate with commercial treater*	Case treats
2 billion (2 X 10^9) viable cfu/g *Rhizobium leguminosarum*	4 x 40 bu	2.5 oz/bu	4.2 oz/100 lbs of seed	160 bu
1 x 10^{-7} % lipo-chitooligosacchrides 720 million (7.2 X 10^8) cfu/g *Penicillium bilaiae*	4 x 40 bu	2.5 oz/bu	4.2 oz/100 lbs of seed	160 bu

Always read and follow label directions

* Do not use the liquid additive

Novozymes QuickRoots® Technology

Protect pulses from stress with increased moisture and nutrient availability

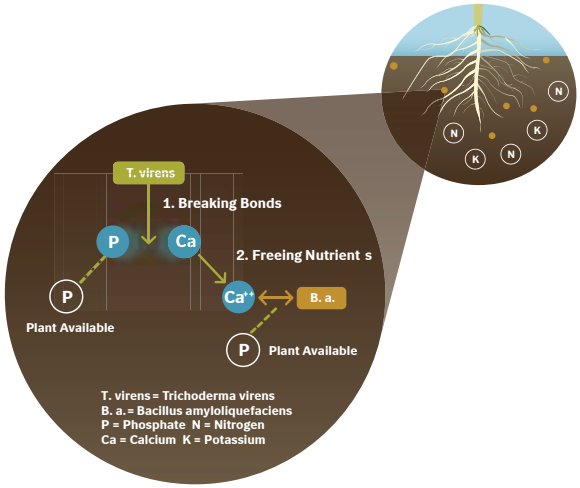
QuickRoots® Technology helps maximize pulse yield — especially in fields with limitations in moisture or nutrient availability.

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
- Enables better plant growth and increases yield potential
- Performs in fields with limitations in moisture or nutrient availability

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 details

Packaging may vary

QuickRoots® Soybean Multi-Crop Inoculant

Active ingredients	Packaging	Application rate	Case treats
3.0 x 10^8 viable cfu/g *Bacillus amyloliquefaciens* 3.0 x 10^7 cfu/g *Trichoderma virens*	10 x 2.0 oz 169 oz pail	Chickpea: 1g/35000 seeds (unit) Dry Bean: 1g/26000 seeds (unit) Field Pea: 1g/60000 seeds (unit) Lentil: 1g/110000 seeds (unit)	Chickpea: 168 million seeds Dry Bean: 124 million seeds Field Pea: 288 million seeds Lentil: 528 million seeds

QuickRoots® Technologies are not fungicides and will not replace your current fungicide seed treatment. Always read and follow label directions

Novozymes JumpStart® Wettable Powder Inoculant

Improve phosphate availability to support early vigor in chickpea, dry bean, lentil and pea.

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.

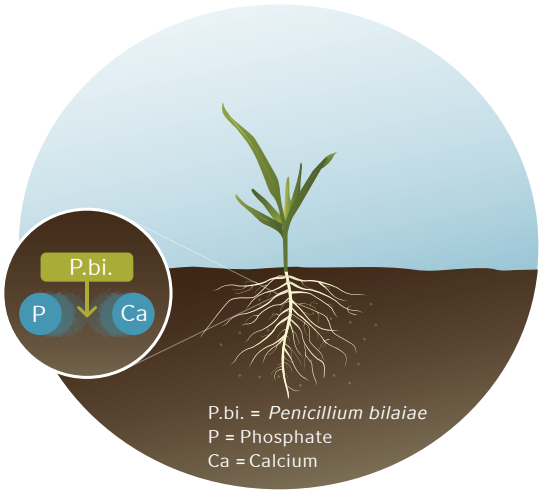
Benefits of using JumpStart® Wettable Powder Inoculant

- 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
- 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 (7.2×10^8) cfu/g *Penicillium bilaiae*	4 x 40 bu (2.0 oz)	Varies (see below)	See chart below

Always read and follow label directions

On-Seed Application Rates and Bare Seed Planting Windows 2.0 oz container

Crop	Seed inoculated by 2.0 oz	Approximate water volume	Planting window (bare seed)
Pea	70 bu = 4,200 lbs	6.1 quarts	30 days
Chickpea	55 bu = 3,300 lbs	4.6 quarts	30 days
Dry Bean[1]	40 bu = 2,400 lbs	3.9 quarts	30 days
Lentil	40 bu = 2,400 lbs	3.9 quarts	30 days

On-Seed Application Rates and Bare Seed Planting Windows 14.0 oz container

Crop	Seed inoculated by 14.0 oz	Approximate water volume	Planting window (bare seed)
Pea	490 bu = 29,400 lbs	43.5 quarts	30 days
Chickpea	385 bu = 23,100 lbs	32.5 quarts	30 days
Dry Bean	280 bu = 16,800 lbs	28.0 quarts	30 days
Lentil	280 bu = 16,800 lbs	28.0 quarts	30 days

Notes

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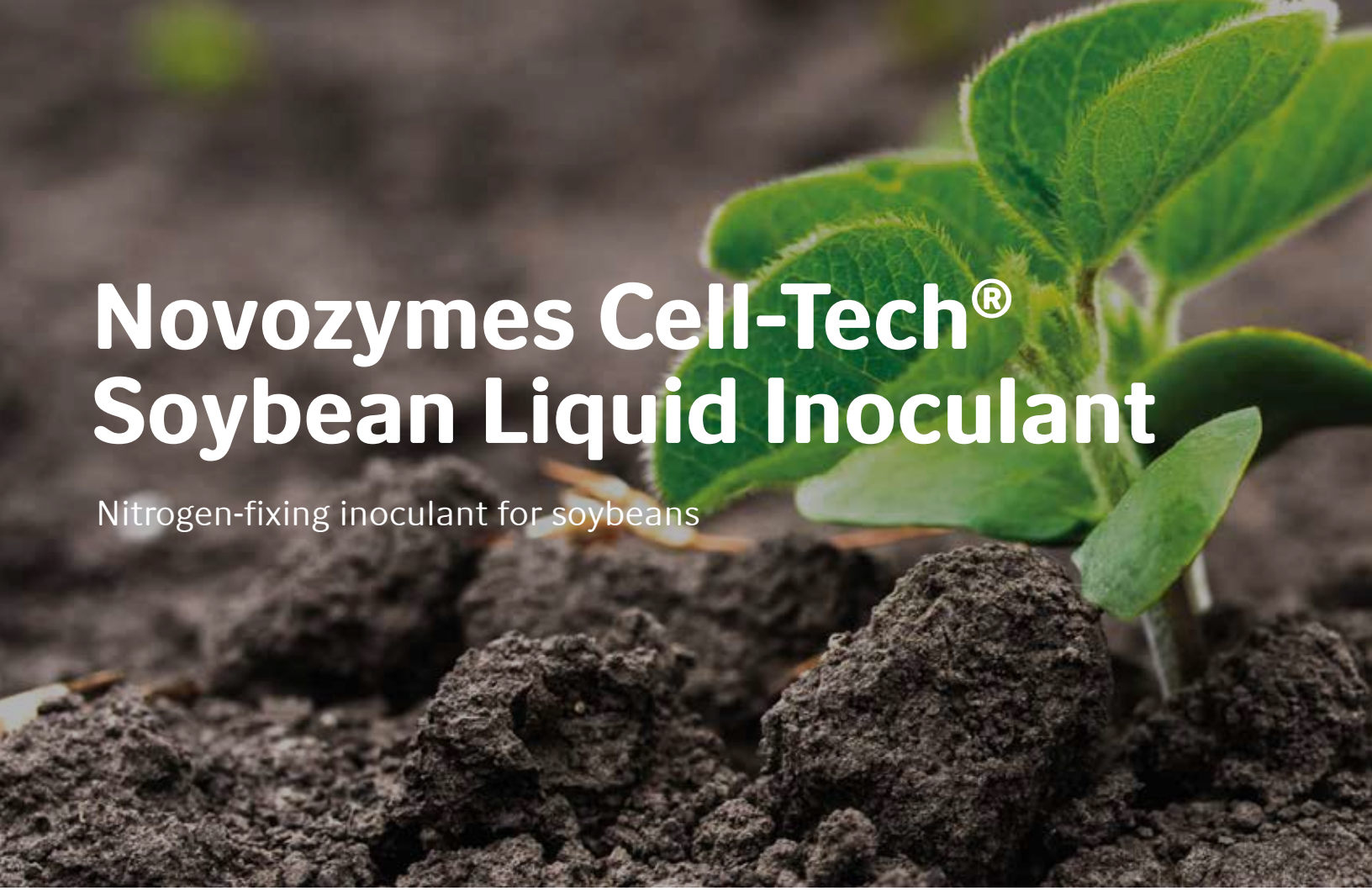
Notes

Soybean Technologies

Rethink Tomorrow

novozymes®



Novozymes Cell-Tech® Soybean Liquid Inoculant

Nitrogen-fixing inoculant for soybeans

Product overview

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

Features & benefits

Benefits of using Cell-Tech® granular technology:

- More nitrogen-fixing bacteria per linear foot than seed applied inoculants
- Convenient application through granular applicator box
- Each bag treats between five and eight acres, depending on row width
- Granular form is advantageous in prolonged hot, dry, or sandy seedbeds

Benefits of using Cell-Tech® peat:

- Dependable, peat-based powder formulation for hopper box application
- Built-in sticker offers seed adhesion, making it compatible with common planting equipment

Benefits of using Cell-Tech® soybean liquid inoculant

- Four-day on-seed guarantee when applied with most common chemical seed treatments. See Seed Treatment Compatibility for the most current information at novozymes.com/bioag
- Flexible — can be applied on-seed or in-furrow
- Convenient liquid formulation for on-farm application

Cell-Tech® Soy NS Peat			
Active ingredients	**Packaging**	**Application rate**	**Case treats**
2.5 x 10^8 viable cfu/g *Bradyrhizobium japonicum*	4 x 6.2 lb bag	6.6 oz/100 lbs seed	1500 lb, 30 units soybeans or 4.2M seeds

Cell-Tech® Soy Granular	
Active ingredients	**Packaging**
100 million (1 x 10^8) viable cfu/g *Bradyrhizobium japonicum*	40 lb bag

Application rates for Cell-Tech® Soy Granular									
Row spacing	6.0 in	7.0 in	8.0 in	9.0 in	10 in	12 in	15 in	24 in	30 in
Application rate low range	7.7 lbs/ac	6.6 lbs/ac	5.8 lbs/ac	5.1 lbs/ac	4.6 lbs/ac	3.8 lbs/ac	3.1 lbs/ac	1.9 lbs/ac	1.5 lbs/ac
Application rate high range	32.7 lbs/ac	28.0 lbs/ac	24.5 lbs/ac	21.8 lbs/ac	19.6 lbs/ac	16.3 lbs/ac	13.1 lbs/ac	8.2 lbs/ac	6.5 lbs/ac

Cell-Tech® Soy Liquid			
Active ingredients	**Packaging**	**Application rate**	**Case treats**
2 billion (2 x 10^9) viable cfu/ml [2 x 10^9 viable cfu/g] *Bradyrhizobium japonicum*	4 x 3.1 L (104.8 US fl oz)	2.1 fl oz/unit (50 lbs of seed)	200 units or 28,000,000 seeds

Novozymes 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.

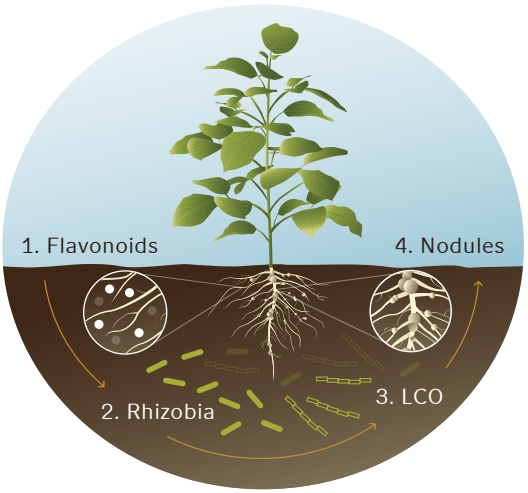
Benefits of using Optimize® XC Inoculant

- 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

*See Seed Treatment Compatibility for the most current information at novozymes.com/bioag

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.



Product details

Packaging may vary.

Optimize® XC Inoculant

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

Always read and follow label directions

Novozymes TagTeam® Soybean Granular Inoculant

Product features

Nitrogen-fixing inoculant for 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.

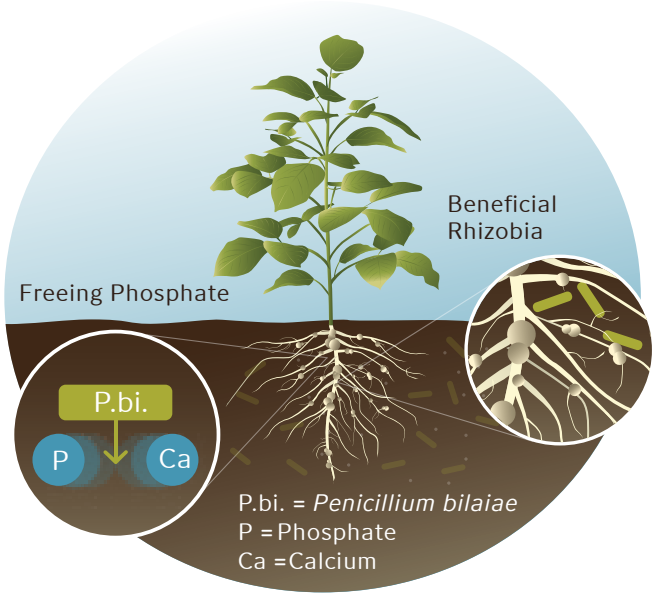
Benefits of using TagTeam® Soybean Granular Inoculant

- 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

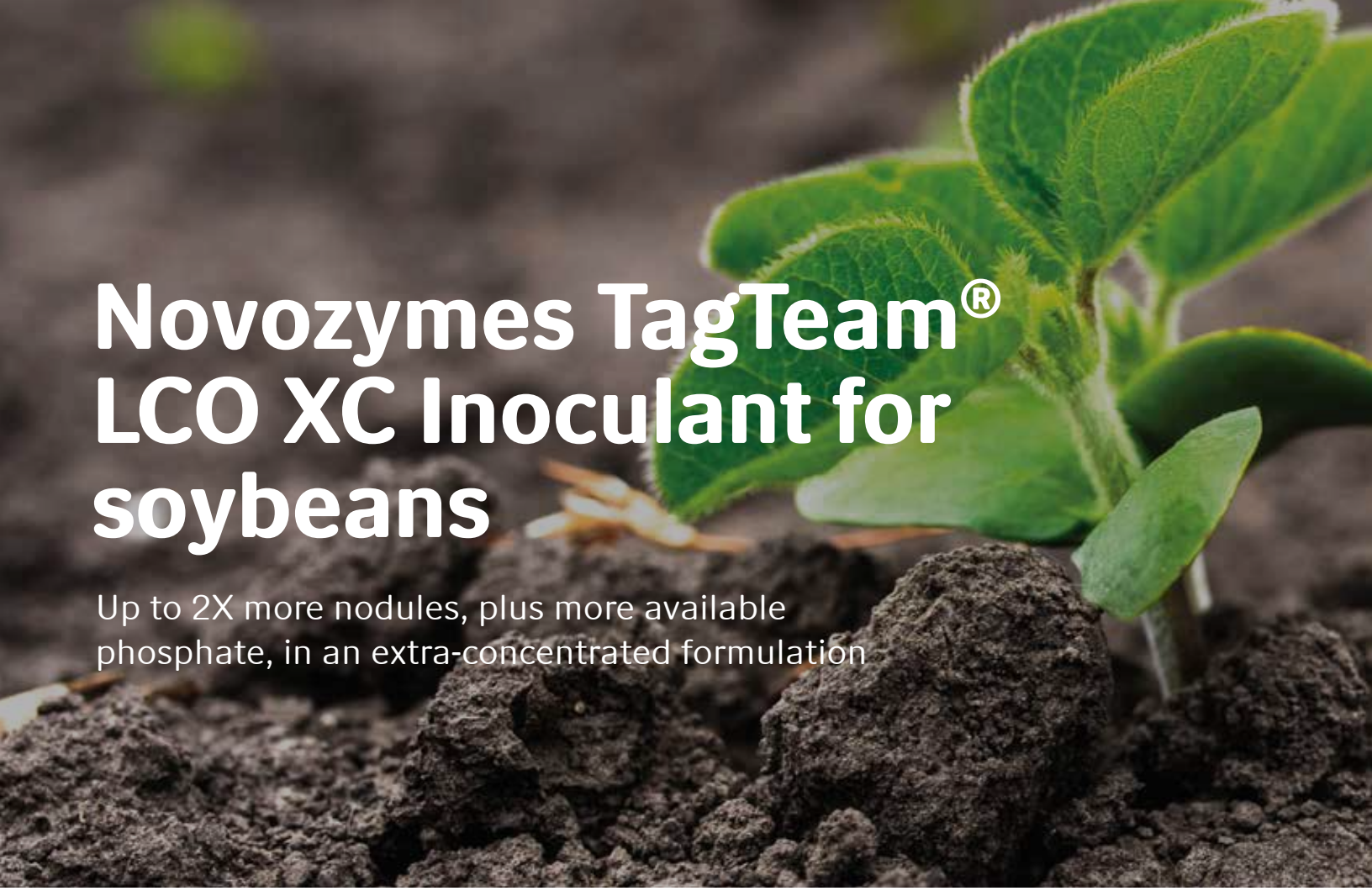
Active ingredients	Packaging	Application rate	Case treats
100 million (1.0 X 10^8) viable cfu/g *Bradyrhizobium japonicum* 100 thousand (1.0 X 10^5) cfu/g *Penicillium bilaiae*	39.7 lbs 582.4 lbs	Varies by row spacing	Varies by row spacing

Always read and follow label directions

Application rates for TagTeam® Soybean Granular Inoculant

Row spacing	6.0 in	7.0 in	8.0 in	9.0 in	10 in	12 in	15 in	24 in	30 in
Application rate	7.1 lbs/ac	6.2 lbs/ac	5.4 lbs/ac	4.7 lbs/ac	4.3 lbs/ac	3.6 lbs/ac	2.9 lbs/ac	1.8 lbs/ac	1.4 lbs/ac
Area treated per 582.4 lb bag	82 ac	93.9 ac	107.9 ac	123.9 ac	135.4 ac	161.8 ac	200.8 ac	323.6 ac	416 ac

Always read and follow label directions



Novozymes TagTeam® LCO XC Inoculant for soybeans

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. See Seed Treatment Compatibility for the most current information at novozymes.com/bioag.
- 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.

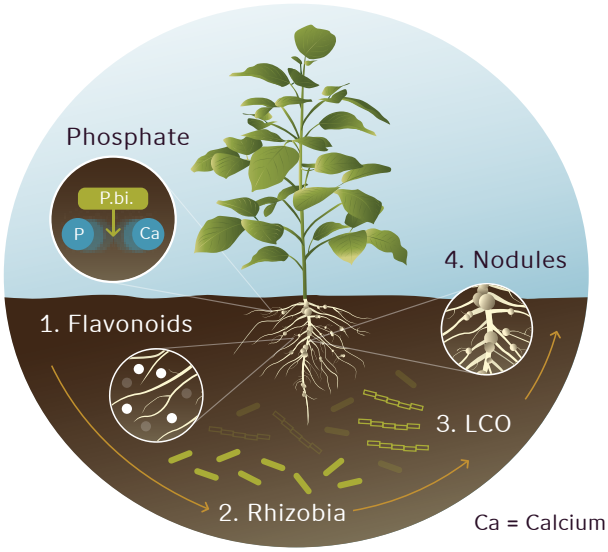
2. More nitrogen

2.1 Needing nitrogen, the plant releases flavonoids to signal rhizobia

2.2 Sensing the flavonoids, the rhizobia signal LCO back to the plant.

2.3 The plant can respond to the LCO, allowing the rhizobia to infect its roots.

2.4 This symbiotic relationship can create nodules, which help fix atmospheric nitrogen. Penicillium bilaiae, the active ingredient in JumpStart®, does not eliminate the need for phosphate fertilizer, but provides crops access to more phosphate for higher yield potential.



Ca = Calcium

P = Phosphate

P.bi. = *Penicillium bilaiae*

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	400 units or 56,000,000 seeds

Always read and follow label directions

Novozymes QuickRoots® Technology

Protect soybeans from stress with increased moisture and nutrient availability

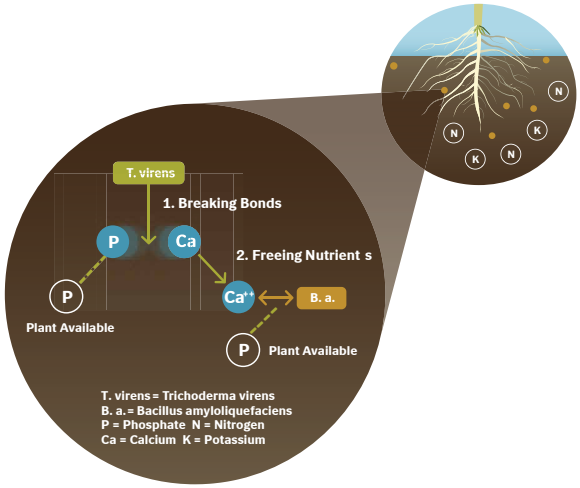
QuickRoots® Technology helps maximize soy yield — especially in fields with limitations in moisture or nutrient availability.

Benefits of using Quickroots® Technology

- Increases phosphate availability and up take, which increases root volume
- Larger root volume helps the plant access more moisture and nutrients, including nitrogen and potassium
- Enables better plant growth and increases yield potential
- Performs in fields with limitations in moisture or nutrient availability

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 details

Packaging may vary

QuickRoots® Soybean Multi-Crop Inoculant

Active ingredients	Packaging	Application rate	Case treats
3.0×10^8 viable cfu/g *Bacillus amyloliquefaciens* 3.0×10^7 cfu/g *Trichoderma virens*	10 x 7oz 169oz pail	4 g/140,000 seeds (unit)	1200 units

QuickRoots® Technologies are not fungicides and will not replace your current fungicide seed treatment. Always read and follow label directions

Novozymes JumpStart® Wettable Powder Inoculant

Improve phosphate availability to support early vigor in soybean.

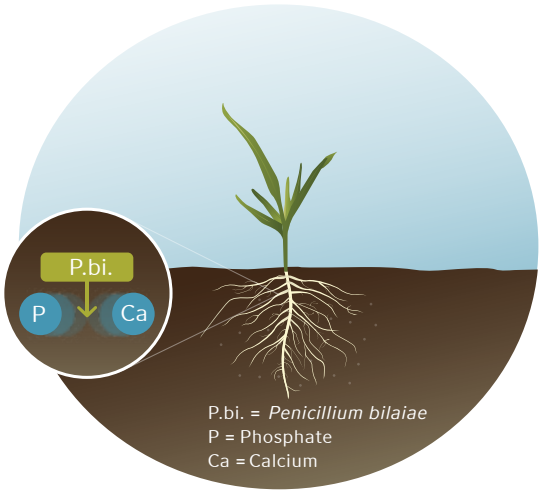
JumpStart® Wettable Powder Inoculant contains the naturally occurring soil fungus *Penicillium bilaiae*. It grows along plant roots releasing nutrients like phosphate bound in the soil, making them more available for the crop to use. *Penicillium bilaiae* does not replace the need for phosphate fertilizer, 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
- 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 (7.2×10^8) cfu/g *Penicillium bilaiae*	4 x 40 bu (2.0 oz)	Varies (see below)	See chart below

Always read and follow label directions

On-Seed Application Rates and Bare Seed Planting Windows 2.0 oz container

Crop	Seed inoculated by 2.0 oz	Approximate water volume	Planting window (bare seed)
Soybean	50 bu = 2,500 lbs	3.9 quarts	30 days

On-Seed Application Rates and Bare Seed Planting Windows 14.0 oz container

Crop	Seed inoculated by 14.0 oz	Approximate water volume	Planting window (bare seed)
Soybean	360 bu = 17,500 lbs	28.0 quarts	30 days

Notes

Wheat & Small Grains Technologies

Novozymes QuickRoots® WP Small Grains Inoculant

Protect wheat from stress with increased moisture and nutrient availability

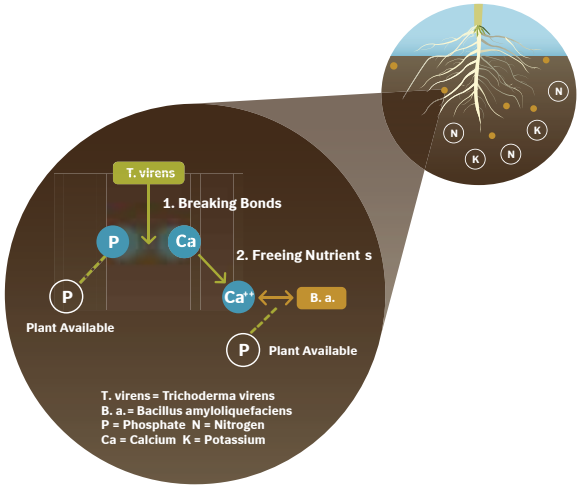
QuickRoots® WP Small Grains Inoculant helps maximize wheat yields — especially in fields with limitations in moisture or nutrient availability.

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
- Enables better plant growth and increases yield potential

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 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

QuickRoots® Technologies are not fungicides and will not replace your current fungicide seed treatment
Always read and follow label directions

Novozymes 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.

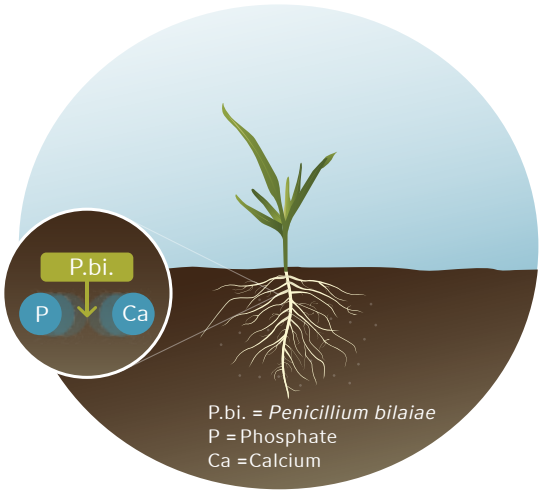
Benefits of using JumpStart® Wettable Powder Inoculant

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)	See below	160 bu = 9,600 lbs of seed

On-Seed Application Rates and Bare Seed Planting Windows

40 bu (2.0 oz)

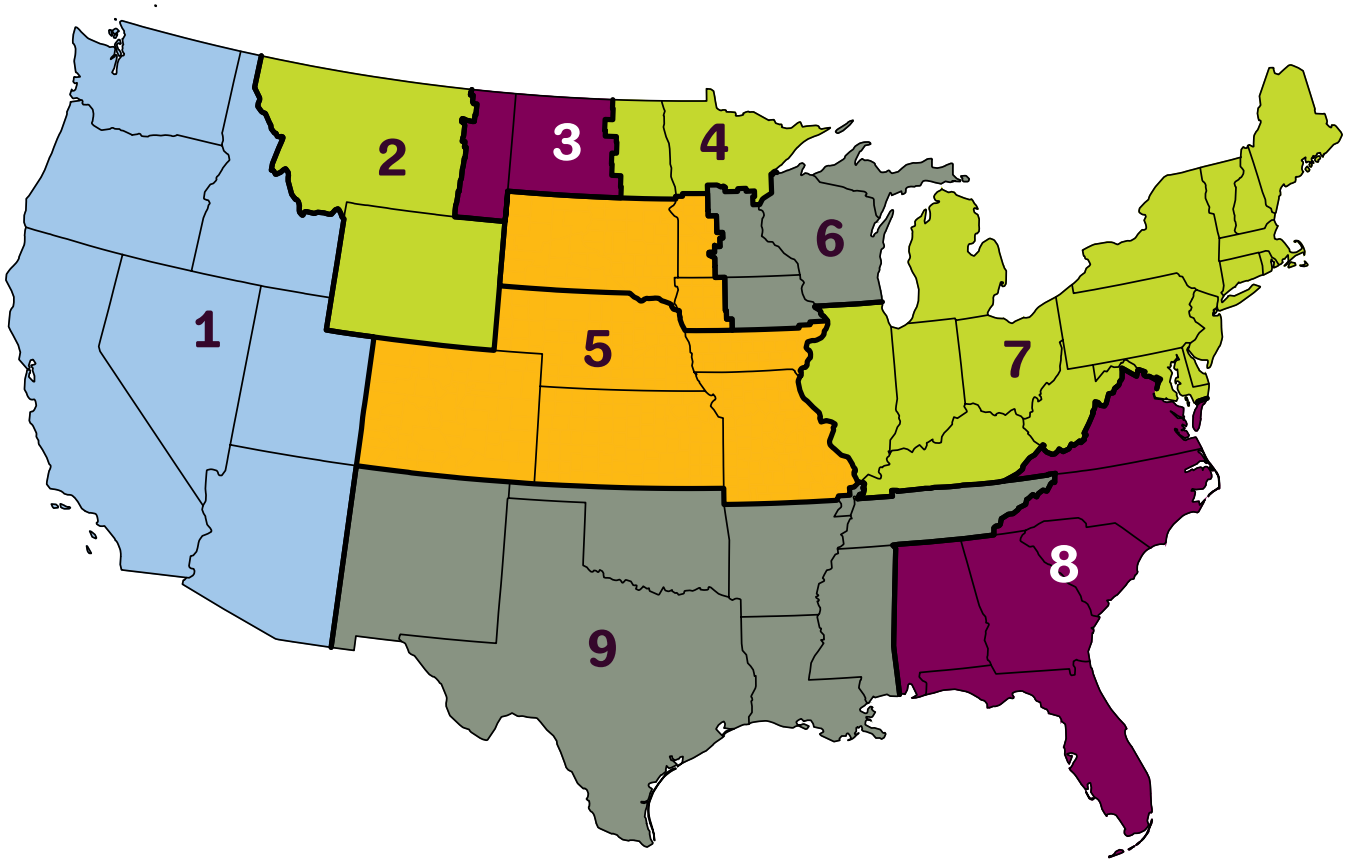
Crop	Seed inoculated by 2.0 oz	Approximate water volume	Planting window (bare seed)
Wheat	40 bu = 2,400 lbs	7.6 quarts	30 days

Notes

Resources

Contacts & Territory Map

Territory Sales Contact Info



Job Title		Name	Phone Number	Email
Territory Sales Manager	1	Tony Severa	(208) 960-4039	tosv@novozymes.com
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North US & Canada Commercial Lead	–	Darrell Wolkowski	(306) 291-0044	dwok@novozymes.com

Contact your local Novozymes representative, or call 800-558-1003 between the hours of 7:30 a.m. to 4:00 pm CST Monday through Friday, or send an email to bioagcs@novozymes.com

novozymes®

Seed treatment compatibility and planting window guide

Rethink Tomorrow

novozymes®

Note to commercial seed treaters
Please use the treatment date and planting window (days on seed) information in this guide to determine the appropriate “not claimed effective after” date to include on the seed bag tag. The planting window is not impacted by the expiration date of the bio-enhancer, as long as the bio-enhancer is applied on or before its expiration or ”treat by” date.

Definitions

Expiration date
Some products have an expiration date on the outside of the product package. This is the "treat by" date that applicators use to determine if they should apply a product. The expiration date does not change the planting window dates for a product. Example: A product has an expiration date of "March 2022". This product may be applied any time before the last day of March 2022 and the product will remain viable on seed for a period of time known as the planting window.

Planting window
The maximum amount of time that can elapse between the date the seed was treated with a bio-enhancer and when it can be planted with an expectation that the bio-enhancer will remain viable.

Simultaneous application
The application of a bio-enhancer and a chemical seed treatment product, commonly fungicides and insecticides, applied at the same time. When using simultaneous application, the products come into contact with each other only at the moment of application to the seeds.

Sequential application
The application of a bio-enhancer to seeds that have been previously treated with a chemical seed treatment product that is allowed to dry prior to the application of the bio-enhancer.

Tank mix application
The application of a mixture of a bio-enhancer and chemical seed treatment product after they are mixed in a common tank. This is the least preferred method because it may result in prolonged exposure of living organisms in the bio-enhancer to the chemical seed treatment product in the mix tank, which can negatively impact the viability of the bio-enhancer.

Seed labels/Seed bag tags
Information that is provided to the end user of seeds treated with a biological product. Seed labels and bag tags contain information required by Federal and state laws and may also contain other information to aid farmers in making decisions. An example of required labeling would be a statement such as "not claimed effective after", followed by a specific date.

For the most up to date information, check our site biosolutions.novozymes.com/en/usa

Corn			
JumpStart®	**Planting Wndow**		
	Sequential	**Simultaneous**	**Tank mix**
Advanced Coating® Zn	30 days	30 days	Not Tested
Advanced Coating® Zn + Flo-Rite 1085	30 days	Not Tested	14 days
Apron XL® LS	30 days	Not Tested	Not Tested
Ascend®	60 days	60 days	Not Tested
Avicta® 500FS	60 days	60 days	Not Tested
Avipel®	3 days	3 days	Not Tested
Concur®	30 days	Not Tested	Not Tested
Cruiser® Extreme® Pak	30 days	Not Tested	Not Tested
Cruiser® 5FS (low)	60 days	Not Tested	Not Tested
Cruiser® 5FS (high)	30 days	Not Tested	Not Tested
Dynasty®	30 days	Not Tested	Not Tested
Graphite	2 days	Not Tested	Not Tested
Kernel Guard® Supreme	30 days	Not Tested	Not Tested
Latitude®	30 days	Not Tested	Not Tested
Macho® 600 ST	20 days	15 days	Not Tested
Maxim® XL	30 days	Not Tested	Not Tested
Maxim® XL & Poncho® 250	30 days	Not Tested	Not Tested
Maxim® XL & Poncho® 1250	30 days	Not Tested	Not Tested
Maxim® XL & Cruiser® 5FS (low)	30 days	Not Tested	Not Tested
Maxim® XL & Cruiser® 5FS (high)	30 days	Not Tested	Not Tested
Maxim® XL & Apron XL® LS	30 days	Not Tested	Not Tested
Nitro Shield®	30 days	Not Tested	Not Tested
Poncho® 250	60 days	Not Tested	Not Tested
Poncho® 500	30 days	Not Tested	Not Tested
Poncho® 1250	30 days	Not Tested	Not Tested
Prevail®	30 days	Not Tested	Not Tested
Regent® TS	30 days	Not Tested	Not Tested
Senator® 600 FS	30 days	30 days	Not Tested
Stamina®	30 days	21 days	Not Tested
Stamina® F3 HL	30 days	30 days	Not Tested
Talc	2 days	Not Tested	Not Tested
Trilex® FL	30 days	Not Tested	Not Tested
Vitaflo® 280	4 days	Not Tested	Not Tested
Bare seed		**60 days**	

Corn			
QuickRoots® Wettable Powder	**Planting window (days after application)**		
	Sequential application	**Simultaneous application**	**Tank mix**
Acceleron™ Seed Applied Solutions for corn (clothianidin rate of 0.25mg / seed)	510 days	510 days	510 days
Acceleron™ Seed Applied Solutions for corn with Poncho®/VOTiVO® (clothianidin rate of 0.50mg / seed)	510 days	510 days	510 days
Acceleron™ Seed Applied Solutions for corn with Poncho®/VOTiVO® 1250 (clothianidin rate of 1.25mg / seed)	540 days	540 days	540 days
CruiserMaxx® Corn 250	400 days	400 days	400 days
Stamina®	350 days	350 days	350 days
Bare seed	**540 days**		

Application of QuickRoots® Wettable Powder

Do not confuse "Planting window" with "Application Window". QuickRoots® Wettable Powder is intended to be applied after it has been mixed with a liquid product, either seed treatment chemistry or water alone. Once the powder has been mixed with a liquid, the mixture must be applied to seeds within two hours after a liquid was introduced to the wettable powder. This is the Application Window. Once the treated seeds have dried, the Planting window days begins.

If mixed slurries containing QuickRoots® Wettable Powder are allowed to remain in a mix tank longer than two hours, the remaining mixture should not be used. It is recommended to mix small batches that can easily be used within the two-hour Application Window.

Corn		
QuickRoots® Dry Planter Box	**Planting window (days after application)**	
	Sequential application	**Simultaneous application**
Acceleron™ Seed Applied Solutions for corn (clothianidin rate of 0.25mg / seed)	540 days	Not Tested
Acceleron™ Seed Applied Solutions for corn with Poncho®/VOTiVO® (clothianidin rate of 0.50mg / seed)	540 days	Not Tested
Acceleron™ Seed Applied Solutions for corn with Poncho®/VOTiVO® 1250 (clothianidin rate of 1.25mg / seed)	540 days	Not Tested
Bare seed	**540 days**	

Peanut	
Optimize®	**Planting window** **Tank mix**
Abound	12 hours
ACA Plus® only	12 hours
Admire® Pro	12 hours
Asset®	12 hours
Asset® NH3	12 hours
Asset® PPS	12 hours
Asset® RS	12 hours
Asset® RTU (1pt – 1qt)	48 hours
Asset® RTU	12 hours
BioMax™ O.C.	48 hours
Black Label® Zn + 10-34-0	8 hours
Energy Max	12 hours
Green Sol GS-48	12 hours
Kickstand® PGR (6oz/ac)	48 hours
Liberate® Ca	12 hours
Loveland Radiant®	48 hours
Radiate®	48 hours
Micro Amp	48 hours
Miller Fertilizer (C.A.F.L.A) 3.0 fl oz	48 hours
Miller Fertilizer (C.A.F.L.A) 6.0 fl oz	Not Recommended
Miller Fertilizer (C.A.F.L.A) 10.0 fl oz	7 hours
NACHURS® imPulse® (10-18-4)	8 hours
NACHURS® 4-13-17-1	48 hours
NACHURS® 6-24-6	48 hours
NACHURS® 9-18-9-1 (0.5 gal)	48 hours
NACHURS® 9-18-9-1 (1.0 gal)	7 hours
NACHURS® 6-22-6-1	48 hours
NutrAsyst® Concentrate only	12 hours
Orthene®	12 hours
PGR IVTM	12 hours
Proline® 480 SC	12 hours
Receptor™ (0.5-1pt/ac)	48 hours
Stimupro	12 hours
Velum® Total	48 hours
Wrangler®	12 hours

Peanut	
TagTeam® LCO Peanut Liquid Inoculant	
Velum® Total	48 hours

Recommendation of compatibility made on the basis of product formulation at the time of testing – user assumes all risk. Water used for dilution of Optimize® or preparation of an Optimize® tank mix must be non-chlorinated. Tank mixes with Optimize® must be used within 12 hours. Do not hold tank-mixed materials for later use. Mix only what will be used within a 12-hour time period. Products listed were tested as individual combinations with Optimize®. Multiple product tank mixes are not recommended. Failure to follow these guidelines will invalidate the Optimize® product warranty. A compatible recommendation indicates that the viability of the rhizobia in Optimize® product will not be affected. Compatibility recommendations are based on dilution with water to a minimum of 5 gallon/acre total liquid application rate. Dilution of Optimize® and in-furrow chemicals to less than a 5 gallon/acre rate can lead to incompatibility, and is not recommended.

Pulse crops - chickpea			
JumpStart®	**Planting window**		
	Sequential	**Simultaneous**	**Tank mix**
ApronMaxx® RTA®	30 days	30 days	30 days
Apron® FL	20 days	20 days	Not Tested
Apron XL® LS	7 days	7 days	Not Tested
Crown® & Apron® FL	3 days	3 days	Not Tested
Maxim® 480 FS	15 days	15 days	Not Tested
Stamina®	30 days	30 days	Not Tested
Trilex® AL	30 days	30 days	Not Tested
Bare seed		**30 days**	

Pulse crops - chickpea			
TagTeam® Peat	**Planting window**		
	Sequential	**Simultaneous**	**Tank mix**
Allegiance® FL	6 hours	6 hours	Not Tested
Allegiance® FL/Crown	6 hours	4 hours	Not Tested
Allegiance® FL/Crown	4 hours	4 hours	Not Tested
ApronMaxx® RFC	6 hours	6 hours	Not Tested
ApronMaxx® RTA®	6 hours	6 hours	Not Tested
ApronMaxx® RTA®	4 hours	4 hours	Not Tested
Apron XL® LS	6 hours	Not recommended	Not Tested
Apron XL® LS	6 hours	4 hours	Not Tested
Crown®	6 hours	6 hours	Not Tested
CruiserMaxx® Beans	6 hours	6 hours	Not Tested
CruiserMaxx® Beans	4 hours	4 hours	Not Tested
Intego® Solo + (CruiserMaxx® Vibrance® Pulses)	6 hours	6 hours	Not recommended
Intego® Solo + (ApronMaxx® RTA®)	6 hours	6 hours	Not recommended
Maxim® 4FS	6 hours	6 hours	Not Tested
Mertect® 340-F	4 hours	4 hours	Not Tested
Stamina®	6 hours	6 hours	Not Tested
Trilex® AL	4 hours	4 hours	Not Tested
Trilex® AL Concentrate	6 hours	6 hours	Not Tested
Bare seed		**60 days**	

Pulse crops - lentil			
Cell-Tech® Liquid	**Planting window**		
	Sequential	**Simultaneous**	**Tank mix**
Allegiance® FL	6 hours	Not Tested	Not Tested
Apron XL® LS	6 hours	6 hours	Not Tested
ApronMaxx® RTA®	4 hours	Not Recommended	Not Tested
Gaucho® 480	6 hours	6 hours	Not Tested
Intego® Solo + CruiserMaxx® Vibrance® Pulses	Not Recommended	15 days	Not Tested
Maxim® 4FS	6 hours	4 hours	Not Tested
Trilex® AL	4 hours	Not Recommended	Not Tested
Bare seed		**6 hours**	

Pulse crops - lentil			
Cell-Tech® NS Peat	**Planting window**		
	Sequential	**Simultaneous**	**Tank mix**
Intego® Solo + ApronMaxx® RTA®	48 hours	48 hours	Not Tested
Intego® Solo + CruiserMaxx ®Vibrance ® Pulses	6 hours	4 hours	Not Tested
Intego® Solo + Trilex® EverGol®	48 hours	48 hours	Not Recommended
Allegiance® FL	48 hours	24 hours	Not Tested
Apron XL® LS	6 hours	Not Recommended	Not Tested
Apron XL® LS & Maxim® 4FS	6 hours	Not Recommended	Not Tested
ApronMaxx® RTA®	6 hours	Not Recommended	Not Tested
Cruiser® 5FS	24 hours	24 hours	Not Tested
Evergol® Energy	24 hours	24 hours	Not Tested
Gaucho® 480	6 hours	Not Recommended	Not Tested
Intego® Solo + CruiserMaxx® Vibrance® Pulses	4 hours	4 hours	Not Tested
Intego® Solo + Trilex® EverGol®	48 hours	48 hours	Not Tested
Maxim® 4FS	24 hours	6 hours	Not Tested
Trilex® AL	24 hours	6 hours	Not Tested
Trilex® AL Concentrate	30 hours	Not Recommended	Not Tested
Vitaflo® 280	48 hours	Not Recommended	Not Tested
Bare seed		**48 hours**	

Pulse crops - lentil			
JumpStart®	**Planting window**		
	Sequential	**Simultaneous**	**Tank mix**
ApronMaxx® RTA®	3 days	3 days	Not Tested
Crown®	24 hours	12 hours	Not Recommended
Nitro Shield®	3 days	3 days	Not Tested
Thiram 75WP	3 days	3 days	Not Tested
Trilex® AL	30 days	30 days	Not Tested
Bare seed		**30 days**	

Pulse crops - lentil			
TagTeam® Peat	**Planting window**		
	Sequential	**Simultaneous**	**Tank mix**
Allegiance® FL	48 hours	24 hours	Not Tested
Apron XL® LS	6 hours	Not Recommended	Not Tested
Apron XL® LS & Maxim® 4FS	6 hours	Not Recommended	Not Tested
ApronMaxx® RFC	6 hours	Not Recommended	Not Tested
ApronMaxx® RTA®	48 hours	Not Recommended	Not Tested
Gaucho® 480	6 hours	6 hours	Not Tested
Intego® Solo + (ApronMaxx® RTA®)	48 hours	Not Recommended	Not Recommended
Intego® Solo + (CruiserMaxx® Vibrance® Pulses)	48 hours	48 hours	Not Recommended
Intego® Solo + (Trilex® EverGol®	48 hours	48 hours	Not Recommended
Macho® 600 ST	24 hours	6 hours	Not Tested
Maxim® 4FS	24 hours	6 hours	Not Tested
Mertect® 340-F	6 hours	4 hours	Not Tested
Trilex® AL	24 hours	6 hours	Not Tested
Trilex® AL Concentrate	30 hours	Not Recommended	Not Tested
Vitaflo® 280	24 hours	Not Recommended	Not Tested
Bare seed		**48 hours**	

Pulse crops - lentil			
QuickRoots® Wettable Powder	Planting window (days after application)		
	Sequential application	Simultaneous application	Tank mix
Insure® Pulse	Not Recommended	Not Recommended	Not Recommended
EverGol® Energy	120 days	120 days	Not Tested
Bare seed		**150 days**	

Pulse crops - pea			
JumpStart®	Planting window		
	Sequential	Simultaneous	Tank mix
Allegiance® FL	15 days	15 days	Not Tested
Apron® FL	5 days	5 days	Not Tested
ApronMaxx® RTA®	20 days	15 days	Not Tested
Apron XL® LS	10 days	7days	Not Tested
Apron XL® LS & Maxim® 480FS	10 days	7 days	5 days
Captan®	24 hours	24 days	Not Recommended
Crown®	24 hours	12 days	Not Recommended
Macho® 600 ST	Not Recommended		
Maxim® 4FS	20 days	15 days	Not Tested
Nitro Shield®	30 days	30 days	Not Tested
Senator® 600 FS	15 days	15 days	Not Tested
Stamina®	28 days	28 days	Not Tested
Thiram 75WP	3 days	3 days	Not Tested
Trilex® AL	2 days	2 days	Not Tested
Vitaflo® 280	7 days	7 days	Not Tested
Bare seed	**30 days**		

Pulse crops - pea			
TagTeam® Peat	**Planting window**		
	Sequential	**Simultaneous**	**Tank mix**
Allegiance® FL	24 hours	12 hours	6 hours
Apron XL® LS	24 hours	Not Recommended	Not Tested
Apron XL® LS & Maxim® 4FS	24 hours	Not Recommended	Not Tested
ApronMaxx® RFC	48 hours	48 hours	Not Tested
ApronMaxx® RTA®	24 hours	6 hours	6 hours
CruiserMaxx® Beans	6 hours	6 hours	Not Tested
Gaucho® 480	6 hours	6 hours	Not Tested
Intego® Solo + ApronMaxx® RTA®	48 hours	48 hours	48 hours
Intego® Solo + CruiserMaxx® Vibrance® Pulses	48 hours	48 hours	48 hours
Intego® Solo + Trilex® EverGol®	48 hours	48 hours	48 hours
Macho® 600 ST	6 hours	6 hours	Not Tested
Maxim® 4FS	24 hours	24 hours	Not Tested
Senator® 600 FS	48 hours	24 hours	Not Tested
Trilex® AL	30 hours	24 hours	Not Recommended
Trilex® AL Concentrate	30 hours	24 hours	Not Tested
Trilex® AL + Sodium Molybdate		Not Recommended	
Vitaflo® 280		Not Recommended	
Bare seed		**48 hours**	

Pulse crops - pea			
Cell-Tech® NS Peat	**Planting window**		
	Sequential	**Simultaneous**	**Tank mix**
Cruiser® 5FS	24 hours	24 hours	Not Tested
EverGol® Energy	24 hours	24 hours	Not Tested
Intego® Solo + ApronMaxx® RTA®	48 hours	48 hours	Not Tested
Intego® Solo + CruiserMaxx® Vibrance® Pulses	48 hours	48 hours	Not Tested
Intego® Solo + Trilex® EverGol®	48 hours	48 hours	Not Recommended
Bare seed		**48 hours**	

Pulse crops - pea			
Cell-Tech® Liquid	**Planting window**		
	Sequential	**Simultaneous**	**Tank mix**
Allegiance® FL		Not Recommended	
Apron XL® LS		Not Recommended	
ApronMaxx® RTA®		Not Recommended	
Intego® Solo + CruiserMaxx® Vibrance® Pulses		Not Recommended	
Gaucho® 480	Not Recommended	4 hours	Not Tested
Maxim® 4FS	8 hours	8 hours	Not Tested
Trilex® AL	24 hours	24 hours	Not Tested
Bare seed		**6 hours**	

Pulse crops - pea			
QuickRoots® Wettable Powder	**Planting window (days after application)**		
	Sequential application	**Simultaneous application**	**Tank mix**
Cruiser® 5FS	120 days	120 days	Not Tested
EverGol® Energy	Not Recommended	Not Recommended	Not Recommended
Intego® Solo + ApronMaxx® RTA®	Not Tested	Not Tested	60 days
Bare seed		**48 hours**	

Soybean			
TagTeam® LCO XC	**Planting window**		
	Sequential	**Simultaneous**	**Tank mix**
Acceleron™ Seed Applied Solutions BASIC	120 days	120 days	Not Recommended
Acceleron™ Seed Applied Solutions BASIC + Poncho®/VOTiVO®	120 days	120 days	Not Recommended
Acceleron™ Seed Applied Solutions STANDARD	120 days	120 days	Not Recommended
ApronMaxx®RTA®	20 days	20 days	Not Recommended
Clariva® Complete Beans	90 days	90 days	Not Recommended
Clariva® Elite Beans	Not Tested	120 days	Not Tested
Clariva® Elite Beans + Saltro®	Not Tested	120 days	Not Tested
Clariva® Elite Beans + Mertect® 340-F	Not Tested	120 days	Not Tested
CruiserMaxx® Advanced with Vibrance®	120 days	120 days	Not Recommended
CruiserMaxx® Vibrance® Beans	120 days	120 days	Not Recommended
CruiserMaxx® Vibrance® Beans + Saltro®	Not Tested	120 days	Not Tested
EverGol® Energy	120 days	120 days	Not Recommended
EverGol® Energy + Stress Shield	120 days	120 days	Not Recommended
ILeVO®	40 days	40 days	Not Recommended
Inovate®	Not Tested	120 days	Not Recommended
Poncho®/ VOTiVO®	Not Tested	120 days	Not Recommended
PPST 2030	Not Tested	120 days	Not Recommended
Seed Shield® Beans	120 days	120 days	Not Recommended
Seed Shield® Max Beans	Not Tested	120 days	Not Tested
Vibrance® Trio	Not Tested	120 days	Not Tested
Bare seed		**120 days**	

Soybean			
Optimize® XC	**Planting window**		
	Sequential	**Simultaneous**	**Tank mix**
Acceleron™ Seed Applied Solutions STANDARD	120 days	120 days	Not Tested
Acceleron™ Seed Applied Solutions BASIC	120 days	120 days	Not Tested
Acceleron™ Seed Applied Solutions BASIC + Poncho®/VOTiVO®	120 days	120 days	Not Recommended
ApronMaxx® RTA®	120 days	120 days	Not Tested
CruiserMaxx Beans + Vibrance®	120 days	Not Tested	Not Tested
CruiserMaxx Vibrance®	120 days	120 days	Not Tested
CruiserMaxx® Advanced with Vibrance®	120 days	120 days	Not Tested
CruiserMaxx® Vibrance® Beans + Saltro®	Not Tested	120 days	Not Tested
Clariva® Complete Beans	90 days	90 days	Not Tested
Clariva® Elite Beans	Not Tested	120 days	Not Tested
Clariva® Elite Beans + Mertect® 340-F	Not Tested	120 days	Not Tested
Clariva® Elite Beans + Saltro®	Not Tested	120 days	Not Tested
Evergol® Energy	120 days	120 days	Not Tested
Evergol® Energy + Gaucho® 600	120 days	Not tested	Not Tested
ILeVO®	40 days	40 days	Not Tested
INOVATE®	120 days	120 days	Not Tested
Intego® Solo	120 days	120 days	Not Tested
Integral®	120 days	120 days	Not Tested
Poncho®/ VOTiVO®	120 days	120 days	Not Tested
PPST 2030	90 days	90 days	Not Tested
Seed Shield® Beans	120 days	120 days	120 days
Seed Shield® Max Beans	Not Tested	120 days	Not Tested
Vibrance® Trio	Not Tested	120 days	Not Tested
Bare seed		**120 days**	

Optimize® treated seed is tested at storage temperatures consistent with the conditions it will encounter in the field. We determine and verify our 120-day compatibility with replicated tests.

Soybean			
Cell-Tech® NS Peat	**Planting window (days after application)**		
	Sequential	**Simultaneous**	**Tank mix**
Acceleron™ Seed Applied Solutions STANDARD	48 hours	48 hours	Not Tested
Acceleron™ Seed Applied Solutions BASIC	48 hours	48 hours	48 hours
Acceleron™ Seed Applied Solutions BASIC + Poncho®/VOTiVO®	48 hours	48 hours	Not Tested
ApronMaxx® RFC	48 hours	48 hours	48 hours
ApronMaxx®RTA®	48 hours	48 hours	48 hours
Avicta® and Avicta® Complete Beans with CruiserMaxx®	48 hours	48 hours	Not Tested
CruiserMaxx® Beans	48 hours	48 hours	48 hours
CruiserMaxx® Advanced	48 hours	48 hours	Not Tested
CruiserMaxx® Pak & Warden® RTA®	48 hours	48 hours	48 hours
INOVATE® System: Rancona® Xxtra + NipSIT Inside® insecticide	48 hours	48 hours	Not Tested
Macho® 600 ST	48 hours	48 hours	Not Tested
Metastar® ST	48 hours	48 hours	Not Tested
Nitro Shield®	48 hours	48 hours	48 hours
Poncho®/VOTiVO®	48 hours	48 hours	Not Tested
Sebring®	48 hours	48 hours	48 hours
Seed Shield®	48 hours	48 hours	48 hours
Senator® 600 FS	48 hours	48 hours	48 hours
Trilex® 2000	48 hours	48 hours	48 hours
Trilex® 6000	48 hours	48 hours	48 hours
Trilex® AL Flowable & Gaucho® SB Flowable	48 hours	48 hours	48 hours
Trilex® Flowable	48 hours	48 hours	48 hours
Trilex® Flowable & Allegiance® FL	48 hours	48 hours	48 hours
Trilex® Flowable & Allegiance® FL & Gaucho® SB Flowable	48 hours	48 hours	48 hours
Warden® RTA®	48 hours	48 hours	48 hours
Bare seed	**48 hours**		

Soybean			
Cell-Tech® Liquid	**Planting window (days after application)**		
	Sequential	**Simultaneous**	**Tank mix**
Acceleron™ Seed Applied Solutions STANDARD	4 days	4 days	Not Tested
Acceleron™ Seed Applied Solutions BASIC	4 days	4 days	Not Tested
Acceleron™ Seed Applied Solutions BASIC + Poncho®/VOTiVO®	4 days	4 days	Not Tested
ApronMaxx® Bean Pak	4 days	4 days	4 days
ApronMaxx® RFC	4 days	4 days	4 days
ApronMaxx® RTA®	4 days	4 days	4 days
Avicta® and Avicta® Complete Beans with CruiserMaxx®	4 days	4 days	Not Tested
CruiserMaxx® Beans	4 days	4 days	4 days
CruiserMaxx® Advanced	4 days	4 days	Not Tested
CruiserMaxx® Pak & Warden® RTA®	4 days	4 days	4 days
ILeVO®	4 days	4 days	Not Tested
INOVATE® System: Rancona® Xxtra + NipSIT Inside® insecticide	4 days	4 days	Not Tested
Intego®	4 days	4 days	4 days
Macho® 600 ST	4 days	4 days	Not Tested
Metastar® ST	4 days	4 days	Not Tested
Nitro Shield®	4 days	4 days	4 days
Poncho®/VOTiVO®	4 days	4 days	Not Tested
Sebring®	4 days	4 days	4 days
Seed Shield®	4 days	4 days	4 days
Senator® 600 FS	4 days	4 days	4 days
Trilex® 2000	4 days	4 days	4 days
Trilex® 6000	4 days	4 days	4 days
Trilex® AL Flowable & Gaucho® SB Flowable	4 days	4 days	4 days
Trilex® Flowable	4 days	4 days	4 days
Trilex® Flowable & Allegiance® FL	4 days	4 days	4 days
Trilex® Flowable & Allegiance® FL & Gaucho® SB Flowable	4 days	4 days	4 days
Warden® RTA	4 days	4 days	4 days
Bare seed		**4 days**	

Soybean	
Cell-Tech® Liquid **When Cell-Tech® is applied in-furrow there will be no adverse effect from seed treatments applied and allowed to dry prior to planting.**	
Asset® PPS	Tank mix compatible*
Tank mix compatible*	
Asset® RS	

*Water used for dilution of Cell-Tech® or preparation of a Cell-Tech® tank mix must be non-chlorinated or de-chlorinated. Do not mix Cell-TechNovozymes (TT) directly with chemical product prior to addition of water. Always add Cell-TechNovozymes (TT) to diluted chemical. Tank mixes must be used within 12 hours. Do not hold tank-mixed materials for later use. Mix only what will be used within a 12-hour time period.

Soybean			
JumpStart®	**Planting window (days after application)**		
	Sequential	**Simultaneous**	**Tank mix**
Acceleron™ Seed Applied Solutions BASIC	120 days	120 days	Not Tested
Acceleron™ Seed Applied Solutions STANDARD	120 days	120 days	Not Tested
Acceleron™ Seed Applied Solutions BASIC + Poncho®/VOTiVO®	120 days	120 days	Not Tested
ApronMaxx® RFCTM	10 days	10 days	Not Tested
ApronMaxx® RTA®	20 days	20 days	Not Tested
Avicta®	120 days	120 days	Not Tested
Avicta® Complete	120 days	120 days	Not Tested
Complete ZMC	120 days	120 days	Not Tested
CruiserMaxx® Advanced	120 days	120 days	120 days
CruiserMaxx® Advanced with Vibrance®	120 days	120 days	120 days
CruiserMaxx® Beans	120 days	120 days	120 days
CruiserMaxx® Beans with Vibrance®	120 days	120 days	120 days
CruiserMaxx® Plus	120 days	120 days	120 days
CruiserMaxx® Plus with Vibrance®	120 days	120 days	120 days
EverGol® Energy	120 days	120 days	60 days
Gaucho® 600 FL	30 days	30 days	Not Tested
Inovate®	120 days	120 days	Not Tested
Macho® 600 ST	30 days	30 days	Not Tested
Nitro Shield®	30 days	30 days	Not Tested
Poncho®/VOTiVO®	120 days	120 days	Not Tested

PPST 2030	120 days	120 days	Not recommended
Prevail® (planter box)	14 days	Not Tested	Not Tested
Protector™ L - Allegiance® (planter box)	24 hours	Not Applicable	
Protector™ L - Allegiance®	Not Tested	2 days	Not Tested
Sebring®	30 days	30 days	Not Tested
Sebring® 318FS	60 days	60 days	Not Tested
Sebring® Max	30 days	30 days	Not Tested
Seed Shield	120 days	120 days	Not Tested
Senator® 600 FS (low rate)	30 days	30 days	Not Tested
Senator® 600 FS (high rate)	21 days	21 days	Not Tested
SoyGreen®	Not Tested	Not Tested	24 Hours
Stiletto®	12 hours	12 hours	Not Tested
Trilex® AL	7 days	7 days	Not Tested
Trilex® 6000	14 days	14 days	Not Tested
Trilex® 2000	7 days	7 days	Not Tested
Vibrance®	120 days	120 days	120 days
Vitaflo® 280	7 days	7 days	Not Tested
Warden® RTA®	30 days	30 days	Not Tested
Bare seed		**120 days**	

Soybean

QuickRoots® Wettable Powder	Planting window (days after application)		
	Sequential application	Simultaneous application	Tank mix
Acceleron™ Seed Applied Solutions STANDARD	300 days	300 days	30,976 mm
Acceleron™ Seed Applied Solutions BASIC	300 days	300 days	220 days
Acceleron™ Seed Applied Solutions STANDARD + ILeVO®	300 days	300 days	260 days
Acceleron™ Seed Applied Solutions BASIC + ILeVO®	300 days	300 days	260 days
Allegiance® FL	Not Tested	240 days	Not Tested
ApronMaxx® RFC	300 days	300 days	Not Tested
ApronMaxx® RTA	300 days	300 days	Not Tested
CruiserMaxx® Advanced + Vibrance®	300 days	300 days	220 days
CruiserMaxx® Vibrance®	300 days	300 days	300 days

EverGol® Energy	300 days	300 days	300 days
EverGol® Energy + Gaucho 600	300 days	300 days	300 days
EverGol® Energy + ILeVO®	300 days	300 days	Not Tested
ILeVO®	300 days	300 days	300 days
Inovate™	300 days	300 days	300 days
Intego® Suite System	300 days	300 days	Not Tested
Integral®	300 days	300 days	Not Tested
Mertect® 340-F	300 days	300 days	300 days
Molybdenum	Not Tested	210 days	210 days
Poncho®/VOTiVO®	300 days	Not Tested	Not Tested
Seed Shield® Beans	300 days	300 days	300 days
Warden® CX	300 days	300 days	300 days
Bare seed	**380 days**		

Application of QuickRoots® Wettable Powder

Do not confuse “Planting window” with “Application Window”. QuickRoots® Wettable Powder is intended to be applied after it has been mixed with a liquid product, either seed treatment chemistry or water alone. Once the powder has been mixed with a liquid, the mixture must be applied to seeds within two hours after a liquid was introduced to the wettable powder. This is the Application Window. Once the treated seeds have dried, the Planting window days begins. If mixed slurries containing QuickRoots® Wettable Powder are allowed to remain in a mix tank longer than two hours, the remaining mixture should not be used. It is recommended to mix small batches that can easily be used within the two-hour Application Window.

Wheat and other cereal crops			
JumpStart® Wettable Powder	**Planting window (days after application)**		
	Sequential application	**Simultaneous application**	**Tank mix**
Warden® Cereals 360	30 days	30 days	30 days
Warden® Cereals WR II	30 days	30 days	30 days
Warden® Cereals HR	30 days	30 days	Not Tested

Wheat and other cereal crops			
QuickRoots® Wettable Powder	**Planting window (days after application)**		
	Sequential application	**Simultaneous application**	**Tank mix**
Cruiser® Vibrance® Quattro	Not Tested	85 days	85 days
CruiserMaxx® Vibrance® Cereals	85 days	85 days	15 days
CruiserMaxx® Vibrance® Cereals + Cruiser® 5FS	60 days	60 days	30 days
Cruiser® Vibrance® Quattro	Not Tested	85 days	85 days
Cruiser® Vibrance® Quattro + Intego® Solo	60 days	60 days	60 days
EverGol® Energy	90 days	90 days	90 days
Insure® Cereal	Not Tested	85 days	85 days
Insure® Cereal FX4	80 days	80 days	80 days
NipsIt™ Suite Cereals	10 days	10 days	10 days
Rancona® Pinnacle	Not Recommended	Not Recommended	Not Recommended
Rancona® Trio	80 days	80 days	80 days
Raxil® PRO MD	65 days	65 days	35 days
Raxil® PRO Shield	60 days	60 days	60 days
Stamina®	85 days	85 days	85 days
Warden® Cereals 360	70 days	70 days	50 days
Warden® Cereals II	100 days	100 days	100 days
Warden® Cereals HR	Not Recommended	Not Recommended	Not Recommended
Warden® Cereals WR II	120 days	120 days	120 days

Alfalfa	
Nitragin® Gold	**Planting window (days after application)**
Allegiance® FL (Over-Treat Application)	18 months
Apron XL® (Over-Treat Application)	18 months
Prontius® (Over-Treat Application)	18 months

Notes

Novozymes BioAg™ best management practices

Rethink Tomorrow

novozymes®

Every batch of every Novozymes 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.

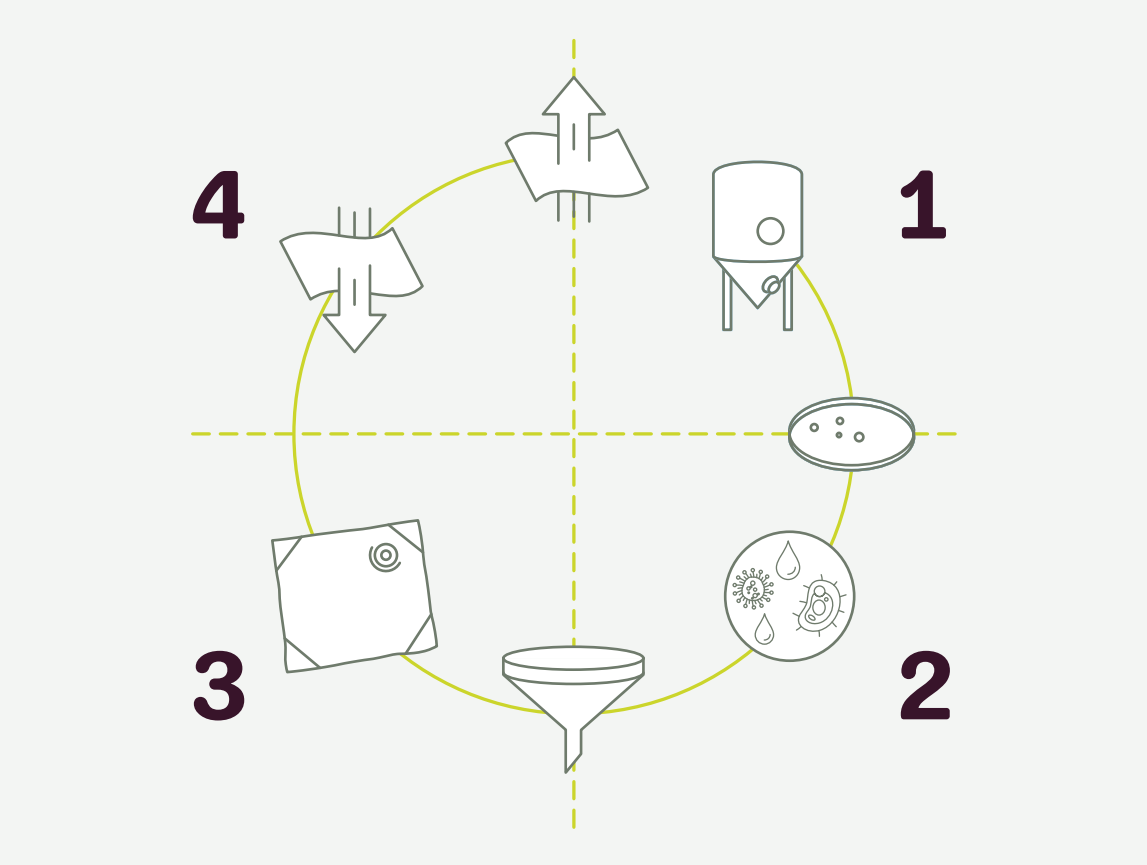
4. Breathable bags and ideal surface area-to-volume ratio

Bradyrhizobia need oxygen, just like you do. Our breathable bags let oxygen in and CO_2 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.



Our approach to innovation

As the innovation leader in the marketplace, Novozymes 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.

Best management practices

Optimize® XC and TagTeam® LCO XC technologies
With these two Novozymes 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 Novozymes 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 seed treatment 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 in to 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 LS2 4 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.

Notes

Quick Reference

Soybean

	Active ingredients	Packaging	Application rates	Case treats
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
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) 582.4 lbs (264 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 u nits 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
Cell-Tech® Soybean Granular Inoculant	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
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
JumpStart Multi-Crop Inoculant	7.2 x 10^{8} cfu/g *Penicillium bilaiae*	4 x 2.0 oz	2.0 oz/50 bu	200 bu
QuickRoots Multi-Crop Inoculant	3 x 10^{8} viable cfu/g *Bacillus amyloliquefaciens* 3 x 10^{7} viable cfu/g *Trichoderma virens*	10 x 7 fl oz 10.6 lb pail	4 g/140,000 seeds (unit)	1200 units

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 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
JumpStart Multi-Crop Inoculant	7.2 x 10^{8} cfu/g *Penicillium bilaiae*	4 x 2.0 oz	2.0 oz/10 units	40 units

Wheat

	Active ingredients	Packaging	Application rate	Case treats
JumpStart® Wettable Powder Inoculant	720 million (7.2×10^8) 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 (7.3×10^8) viable cfu/g *Bacillus amyloliquefaciens* 22 million (2.2×10^7) 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

Pulse

	Active ingredients	Packaging	Application rate	Case treats
TagTeam® Pea and Lentil Peat Inoculant	740 million (7.4×10^8) viable cfu/g *Rhizobium leguminosarum* 3.7 million (3.7×10^6) cfu/g *Penicillium bilaiae*	7 x 4.8 lb bag	Pea – 3,000 lbs of seed (50 bu) Lentil – 1,800 lbs of seed (30 bu)	Pea – 21,000 lbs of seed Lentil – 12,600 lbs of seed
TagTeam® Pea and Lentil Granular Inoculant	130 million (1.3×10^8) viable cfu/g *Rhizobium leguminosarum* 1.3 million (1.3×10^6) cfu/g *Penicillium bilaiae*	40 lb bag 584 lb tote	1 oz/1,000 ft of row 1 oz/1,000 ft of row	Varies
TagTeam® LCO Pea and Lentil Liquid Inoculant	2 billion (2×10^9) viable cfu/g *Rhizobium leguminosarum* 1×10^{-7} % lipo-chitooligosacchrides 720 million (7.2×10^8) cfu/g *Penicillium bilaiae*	4 x 40 bu	2.5 oz/bu 3.0 fl oz/bu	160 bu
TagTeam® Chickpea Granular Inoculant	100 million (1.0×10^8) viable cfu/g *Mesorhizobium ciceri* 1 million (1.0×10^6) cfu/g *Penicillium bilaiae*	40 lb bag	1.0oz/1,000 ft of row	Varies
Cell-Tech® Pulse NS Peat	5×10^8 viable cfu/g *Rhizobium leguminosarum* biovar *viciae*	4 x 6.2 lb bag	6.6 oz/100 lbs seed	700 kg (1500 lb, 25 bu) peas or lentils
Cell-Tech Pulse Granular	100 million (1×10^8) viable cfu/g *Rhizobium leguminosarum* biovar *viciae*	40 lb bag	Varies	Varies
Cell-Tech Pulse Liquid	2×10^9 viable cfu/g *Rhizobium leguminosarum*	4 x 101.4 fl oz	2.5 fl oz/60 lb seed	2400 lb seed
QuickRoots Multi-Crop Inoculant	3×10^8 viable cfu/g *Bacillus amyloliquefaciens* 3×10^7 viable cfu/g *Trichoderma virens*	10 x 7 fl oz 10.6 lb pail	Chickpea: 1g/35000 seeds (unit) Dry Bean: 1g/26000 seeds (unit) Field Pea: 1g/60000 seeds (unit) Lentil: 1g/110000 seeds (unit)	Chickpea: 168 million seeds Dry Bean: 124 million seeds Field Pea: 288 million seeds Lentil: 528 million seeds
JumpStart Wettable Powder	7.2×10^8 viable cfu/g *Penicillium bilaiae*	4 x 2.0 oz	Chickpea: 2 oz/ 55 bu (3,300 lbs) Dry Bean: 2 oz/ 40 bu (2400 lbs) Lentil 2 oz/40 bu (2400 lbs) Pea: 2 oz/70 bu (4,200 lbs)	Chickpea: 13200 lbs Dry Bean: 9600 lbs Lentil: 9600 lbs Pea: 16800 lbs

Peanuts

	Active ingredients	Packaging	Application rate	Case treats
Optimize® for Peanuts	2 billion (2 x 10^9) viable cfu/ml *Bradyrhizobium* sp. *Arachis* 1 x 10-7% lipo-chitooligosaccharides	4 x 1.1 gallon	1 oz/1000 ft of row	40 acres using 36 inch row spacing
TagTeam® LCO for peanuts	7.2 x 10^8 cfu/g *Penicillium bilaiae* 2 x 10^9 viable cfu/ml *Bradyrhizobium* sp. *Arachis* 1 x 10-7% lipo-chitooligosaccharides	4 x 1.1 gallon (4.2L) of liquid inoculants	1 oz/1000 ft of row	40 acres using 36 inch row spacing
Cell-Tech® for peanuts granular	100 million (1 x 10^8) viable cfu/g *Bradyrhizobium* sp. *Arachis*	18kg (40 lb)	4.9 lb/acre using 40 inch row spacing	Varies
Cell-Tech® for peanuts peat	100 million (1 x 10^8) viable cfu/g *Bradyrhizobium* sp. *Arachis*	24x6.6 oz (187grams)	6.6 oz/100lbs seed	2400 lb seed
JumpStart® for peanuts WP	7.2 x 10^8 cfu *Penicillium bilaiae* per gram	4 x 2.0 oz (57grams)	Varies	Varies

Forage

	Active ingredients	Packaging	Application rate	Case treats	Product availability
Nitragin® Gold Alfalfa and Sweet Clover Pre-Inoculant	300 million (3 X 10^8) viable cfu/g *Sinorhizobium meliloti*	42 lb (19 kg) box 1,600 lb tote (725.7 kg)	6.67 oz (189 g) per 50 lbs (22.7 kg) of seed 8.0 oz (226 g) per 60 lbs (27.1 kg) or a bushel of seed	5,000 lbs (2,270 kg) of seed 192,000 lbs (87,020 kg)of seed	Alfalfa and sweet clovers (white, yellow, hubam, madrid, bitter and sour clover)
Nitragin® Gold Clover Pre-Inoculant	80 million (8 x 10^7) viable cfu/g *Rhizobium leguminosarum*	42 lb (19 kg) box	Red clover – 6.67 oz (189 g) per 50 lbs (22.7 kg of seed White, ladino, alsike clover - 13.3 oz (378 g) per 50 lbs (22.7 kg) of seed	Red clover – 5,000 lbs (2,273 kg) of seed White, ladino, alsike clover – 2,500 lbs (1,136 kg) of seed	Ladino, alsike, red and white clovers
Optimize® Gold Inoculant	1 million (1 x 10^6) viable cfu/ml *Sinorhizobium meliloti* 1 x 10-7 % *lipochitooligosaccharides*	38.3 lb (17.4 kg)	19.6 fl oz/100 lbs of seed (580 ml/45.4 kg)	3,000 lb (1,361 kg) of seed	Alfalfa

Agronomic information

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 tandemwith 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 Novozymes® B-300 SAT and BioRise™ 360 ST).

Chlorinated water and biological seed treatments

What you'll learn

- Not all biological seed treatments are bio-enhancers
- Biological seed treatments — including some z bio-enhancers — often 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 often contain living organisms

Biological seed treatments, many of which can be referred to as bio-enhancers, often 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.

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 bioenhancers, 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. 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

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 natural 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 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.

Novozymes BioAg™ products can help

The Novozymes 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 singleaction inoculant Cell-Tech® products support quick and effective nodulation. In conclusion, by using products from Novozymes 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.

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. 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.

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.

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 Novozymes® 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. Contaminants 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.

To learn more visit us at novozymes.com/bioag or call your local retailer.

About Novozymes
Novozymes is the world leader in biological solutions. Together with customers, partners and the global community, we improve industrial performance while preserving the planet's resources and helping to build better lives. As the world's largest provider of enzyme and microbial technologies, our bioinnovation enables higher agricultural yields, low-temperature washing, energy-efficient production, renewable fuel and many other benefits that we rely on today and in the future. We call it Rethink Tomorrow.

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