Novozymes BioAg US

Product Guide 2022



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Introduction

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

Novozymes BioAg: Driving performance

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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

Novozymes' applications for crop production



Bioyield enhancement Fuel your plant's performance.

Improved nutrient uptake, higher crop yields

Our bioyield enhancers are derived from naturally-occurring microbes like bacteria and fungi. These microbial inoculants complement traditional fertilizers and ultimately improve crop yields.



Biocontrol Powerful solutions for insect, disease and weed control.

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Robust biocontrol solutions, healthy crops

Novozymes microbial biocontrol solutions provide robust protection against insects and diseases. The solutions consist of microbes, notably bacteria and fungi, that target damaging pests and keep crops healthy.

Corn & Soybeans







- 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 infection can create nodules, which help fix atmospheric nitrogen.
- 5. The presence of LCO molecules enhances mycorrhizae germination and plant association.

Product details

TagTeam® LCO XC Inoculant for soybeans

Active ingredients	Application rate	Case treats	Packaging
10 billion (1.0 x 1010) viable cfu/ml			
Bradyrhizobium japonicum	1.5 fl oz/	400 units or	400 units
1 x 10 ⁻⁷ % lipo-chitooligosaccharides 720 million (7.2 x 10 ⁸) cfu/g <i>Penicillium bilaiae</i>	100 lbs of seed	56,000,000 seeds	5 x 2 x 40 units

Always read and follow label directions





Balanced nutrition of phosphate and nitrogen is necessary to maximize your crop's yield potential. TagTeam[®] inoculant provides this balanced nutrition by combining the active ingredient from JumpStart[®] inoculant with a nitrogen-fixing bacteria to produce a dualaction inoculant.

The active ingredient in JumpStart[®] is the soil fungus, *Penicillium bilaiae (P. bilaiae)*. This fungus and the rhizobia in TagTeam[®] inoculant work together to create a unique value equation.

The soil fungus is the key to the equation. It grows along the plant roots and makes less-

available forms of phosphate available to the plant. Phosphate is an important component that drives the needed energy for the nitrogen fixation process.

Early-season phosphate availability is difficult when the plant does not have a root mass or the energy to develop a root mass. *Penicillium bilaiae* helps with both of these issues by making phosphate available to the plant to support root and shoot growth.



Product performance

TagTeam® inoculant solves starter fertilizer problems

TagTeam[®] improves phosphate availability, even if starter phosphate fertilizer is used. TagTeam[®] helps the developing primary roots access phosphate early in the growth stages, even before the root reaches the starter fertilizer band. As the primary root develops, TagTeam[®] provides greater availability of soil and fertilizer phosphate, allowing the root to better access phosphate nutrition throughout the rooting zone.

Product details

TagTeam[®] Soybean Granular Inoculant

Active ingredients	Application rate	Case treats	Packaging	
10 billlion (1.0 x 10 ¹⁰) viable cfu/ml <i>Bradyrhizobium japonicum</i> 100 thousand (1.0 x 10 ⁵) cfu/g <i>Penicillium bilaiae</i>	Varies by row spacing	Varies by row spacing	39.7 lbs 582.4 lbs 1000 lbs	

Application rates for TagTeam® Soybean Granular Inoculant

Row spacing (in)	6	7	8	9	10	12	15	24	30
Application rate (lbs/ac)	7.1	6.2	5.4	4.7	4.3	3.6	2.9	1.8	1.4
Area treated (per 39.7 lb bag)	5.6 ac	6.4 ac	7.4 ac	8.4 ac	9.2 ac	11.0 ac	13.7 ac	22.1 ac	28.4 ac
Area treated (per 582.4 lb bag)	82 ac	93.9 ac	107.9 ac	123.9 ac	135.4 ac	161.8	200.8 ac	323.6 ac	416.0 ac

Optimize® XC and Optimize® FXC for soybeans

Optimize[®] FXC

LCO-promoter technology signals to plants that nitrogen-fixing rhizobia are present.

- Fortified LCO allows the *Bradyrhizobia* to start colonizing roots sooner. It does this by providing plants with LCO on seed during treatment. This enhances the natural signaling process plants initiate when they are treated with rhizobia alone.
- 2. The plant can respond to the LCO, allowing the *Bradyrhizobia* to colonize its roots.
- 3. This symbiotic relationship creates nodules, which can help fix atmospheric nitrogen.

How Optimize® 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.
- 5. The presence of LCO molecules enhances mycorrhizae germination and plant association

Optimize [®]	XC	Inocu	lant
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Active ingredients	Application rate	Case treats	Packaging (may vary)
1 billion (1 x 10 ¹⁰) viable cfu/g Bradyrhizobium japonicum 1 x 10 ^{,7} % lipo-chitooligosaccharides	1.5 fl oz/100 lbs of seed	400 units 56,000,000 seeds	400 units 5 x 2 x 40 unit



Inoculant Technologies





Optimize[®] FXC increases yield by 1.4 bushels per acre compared to Optimize[®] XC with a win rate increase of 50 to 70%.

These results are taken from 23 Novozymes internal field trials conducted in 2020 in the United States.

Optimize ®	FXC	Inoculant
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Active ingredients	Application rate	Time on seed	Packaging
1 x 10 ¹⁰ viable cfu/g Bradyrhizobium japonicum 2.6 x 10 ⁵ % lipo-chitooligosaccharides	1.5 oz/100 lb seed	120 days	400 units 5 x 2 x 40 units

Product features

Bradyrhizobia and LCO-promoter technology enhance nodulation and improve mycorrhizal association for healthier soy plants

Optimize® FXC is a *Bradyrhizobia* combined with LCO promoter technology. It enhances nodulation processes and improves mycorrhizal associations. The result is increased biological nitrogen fixation, accessibility to soil nutrients and water absorption for your crops. The result is improved yield expectation. It's a low-volume seed treatment that's highly compatible with on-seed chemistries.

Our LCO-promoter technology just got better: fortified LCO lets the *Bradyrhizobia* get to work faster on helping your crop.

By adding fortified LCO, we give you a headstart on nodulation and formation of key mycorrhizal associations that improve your soybean health. The results are even better yields.

Features & benefits

Benefits of Optimize® FXC

- Enhances nitrogen fixation potential
- Improves yield potential
- Increases root growth and shoot development
- Supports early vigor
- Improves stress tolerance
- Increases mycorrhizal association

How Cell-Tech® works

Nitrogen-Fixing Inoculant: Cell-Tech® inoculant is a single-action product that contains specially selected rhizobia that can provide effective nodulation to enhance nitrogen-fixation, even in cooler soils – increasing yield potential as planting conditions change.

Cell Tech is available in the following formulations:

Сгор	Inoculant species	Cell-Tech formulations available
Soybean	Bradyrhizobium japonicum	Liquid, Granular, Peat

Application

Inoculant Technologies

Please read the label before application for complete use instructions.



Liquid formulations

	Packaging	Application rate	Treats
Soybean	4 x 3.1 L	2.1 fl oz/unit (50 lbs seed)	2500 lb, 50 units soybean

Peat formulations

Cell-Tech[®] peat has its own sticker in the formulation so no additional stickers are required. Apply Cell-Tech[®] dry to pre-moistened seed, or add water while applying Cell-Tech[®], or mix with cool, clean water and apply to seed as a slurry (refer to Table 2). Make sure that inoculated seed is evenly coated.

	Packaging	Application rate	Treats
Soybean	4 x 6.2 lb bag	3.3 oz/unit (50 lbs seed)	1,500 lbs, 30 units

Granular formulations

Row Spacing	Packaging	6"	7"	8"	9"	10"	12"	15"	24"	30"
Cell-Tech Soybean Granular Application Rate	39.7 lbs 1000 lbs	7.1 lb/ ac	6.2 lb/ ac	5.4 lb/ ac	4.7 lb/ ac	4.3 lb/ ac	3.6 lb/ ac	2.9 lb/ ac	1.8 lb/ ac	1.4 lb/ ac

Nutrient Availability Technologies

BioniQ[®] for corn

Trich = Trichoderma virens

- B. a. = Bacillus amyloliquefaciens
- P. bi. = Penicillium bilaiae

Trich ↓ $\mathbf{1}$ Organic Breaking Freeing compounds bonds nutrients Ca N F K РΙ Ca Solubilizes Solubilizes organic nutrients phosphate $\mathbf{1}$ \mathbf{J} К Р P P N Plant available

Product features

Three biological actives join forces for stronger roots, greater nutrient availability and better yield

BioniQ[®] is an inoculant that aids in improved nutrient and moisture uptake and phosphate availability. It also increases yield potential in corn, sorghum, canola, all wheat, oats, mustard, barley, rye and a range of other crops.

The *Penicillium bilaiae* fungus helps release bound mineral forms of soil and fertilizer phosphate, making it more readily available for the plant to use. While, the biologicals *Bacillus amyloliquefaciens* and *Trichoderma virens* help increase availability and uptake of nitrogen, phosphate, and potassium, which supports root and shoot growth.

Features & benefits

Benefits of BioniQ®

- Encourages root growth and shoot development
- Enhances N, P, K availability
- Increases efficiency of P use
- Improves yield potential
- Supports early vigor
- Improves stress tolerance

How BioniQ[®] works

BioniQ[®] employs multiple modes of action to increase crops' access to soil nutrients. It contains three biologicals: *Penicillium bilaiae*, *Bacillus amyloliquefaciens* and *Trichoderma* virens. *Penicillium bilaiae* helps release bound mineral forms of soil and fertilizer phosphate. That makes it more readily available for the plant to use. *Bacillus amyloliquefaciens* and *Trichoderma virens* help increase availability and uptake of nitrogen, phosphate, and potassium. That supports root and shoot growth in corn, sorghum, canola, wheat, oats, mustard, barley, rye and a range of other crops.



Product details

Active ingredients

Powder A: 7.2×10^8 cfu/g Penicillium bilaiae.Powder B: 7.3×10^8 viable cfu/g Bacillus amyloliquefaciens 2.2×10^7 cfu/g Trichoderma virens.

On-seed application rates and bare seed planting windows

783 g co-pack		
Сгор	Seed inoculated by one 783 g co-pack	Planting window (bare seed)
Corn	860 kg (1,900 lb, 34 bu)	60 days

Nutrient

Availability Technologies QuickRoots[®] for corn, and soybeans

How It Works

Two biological actives to increase availability and uptake of nitrogen, phosphate and potassium.

- 1. The biologicals *Bacillus amyloliquefaciens* and *Trichoderma virens* have the ability to release phosphate in the soil not readily available to the plant.
- 2. Improved phosphate availability can lead to expanded root volume, which enhances nitrogen and potassium uptake.
- 3. This ultimately can enable optimal plant growth and increased yield potential.

Product overview

Quickroots[®] inoculant can improve nutrient availability and uptake. The microbial seed inoculant is available and uptake of nitrogen, phosphate and potassium.

Its ability to release nutrients from the soil helps maximize the effectiveness of your inputs and improve your yield potential.





Features and benefits



Improved availability of nitrogen, phosphate and potassium Enhanced nutrient availability, which supports root and

shoot growth.



Performance in a variety of soil conditions and types.

Product performance

By growing directly on your crop's roots, QuickRoots[®] works to improve nutrient availability and uptake. The microbial inoculant performs in a variety of soil conditions and types (including soils low in phosphate availability). This can enable optimal plant growth and increased yield potential.

QuickRoots Products/Technologies – all crops

	Сгор	Case or Pail	Pkgs/case	Package treats
	Corn Multicrop (cor	n, sorghum, canola and cotton)		
QuickRoots® Planter Box	Corn	10 x 25 units	10	25 units
QuickRoots® Planter Box	Corn	200 units	1 pail	200 units
QuickRoots® Wettable Powder	Corn	625 units	1	625 units
	Soybean Multicrop	(soybeans, sunflower, sugarbeet,	pea, lentil, chickpea a	and dry bean)
QuickRoots® Planter Box	Soybean	10 x 50 units	10	50 units
QuickRoots® Wettable Powder	Soybean	10 x 50 units	10	50 units
QuickRoots® Wettable Powder	Soybean	1200 units	1	1200 units
QuickRoots® Planter Box QuickRoots® Wettable Powder QuickRoots® Wettable Powder	Soybean Multicrop Soybean Soybean Soybean	(soybeans, sunflower, sugarbeet, 10 x 50 units 10 x 50 units 1200 units	pea, lentil, chickpea a 10 10 1	50 units 50 units 50 units 1200 units

Jumpstart[®] for soybeans

How Jumpstart® works

Naturally occurring soil fungus to release bound mineral forms of soil and fertilizer phosphate.

Freeing Phosphate

PenIcillium bilalae releases bound mineral forms of soil and fertilizer phosphate, making it more available to the plant to use.

Product overview

Phosphate fertilizer use efficiency

Up to 90% of applied phosphate fertilizer goes unused in the year of application as it gets tied (bound) to soil particles and other elements, making it unavailable to the crop. Some of this is used over subsequent years, but at least 25% never becomes available.¹ It is crucial to make the most efficient use of fertilizer phosphate to maximize yield potential.

Jumpstart[®] inoculant contains the naturally occurring soil fungus *Penicillium bilaiae* (*P. bilaiae*), discovered by Agriculture and Agri-food Canada, which grows along plant roots, releasing phosphate bound in the soil, making it more readily available for the crop to use.

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.

• Jumpstart[®] results are greatest in soils with lower levels of available phosphate and

P. bi. = Penicillium bilaiae



high to medium levels of bound/unavailable phosphate.

- Jumpstart[®] works at low soil temperatures when phosphate availability is normally limited.
- In independent research, Jumpstart[®] resulted in a 22% increase in the proportion of root that contained root hairs and a 33% increase in the mean root-hair length in field pea.²
- Jumpstart[®] can work in soils within a wide pH range. It is the level of available phosphate, not the pH, that determines the benefit of JumpStart[®].³

¹ Source: Better Crops Vol. 86 (2002, No. 4), International Plant Nutrition Institute (formerly: Potash and Phosphate institute).
² Source: Penicillium bilaiae inoculation increases root-hair production in field pea. Robert H. Gulden and J. Kevin Vessey. May 17, 2000.

³ Source: Phosphorous for Agriculture, International Plant Nutrition Institute (Formerly: Potash and Phosphate Institute).

Nutrient Availability Technologies



Benefits to better phosphate

Uptake with JumpStart®

JumpStart[®] Inoculant promotes greater phosphate availability, which results in early vigor, greater stress tolerance and earlier, more even maturity. JumpStart[®] improves phosphate availability to plants at the most vulnerable stages and reduces the need to speed-place high rates of phosphate fertilizer with sensitive seed like canola, pea, lentil and soybean.

Early vigor

Cool soils, common under direct seeding or early seeding conditions, mean phosphate is less available to plants. If early-season phosphate availability is limited, It can reduce early-season growth and, ultimately, crop yield. Early spring conditions, including cool soils, are difficult on plants, especially when phosphate is not available. Because JumpStart[®] is active under these conditions, phosphate availability is improved when the plant needs it.

Greater stress tolerance

Plants with larger healthy root systems have the ability to better withstand a variety of stresses such as drought and weed pressure. Healthy root systems help plants access moisture and nutrients more efficiently.

JumpStart[®] increases phosphate availability in all areas of the soil that the root explores, not just around the fertilizer band, which helps promote more root growth.

Seed treatment/package	2 oz bottle	Case (4 x 2 oz bottles)
Soybean	2,500 lbs	10,000 lbs

Plant signal compound for soybean



What is Cue®?

Cue[®] (isoflavinoids) is a plant signal compound for soybeans.

How Cue® works?

Cue® triggers beneficial fungi in the root zone before the plant can activate them naturally. Cue® triggers beneficial soil fungi (mycorrhizae) in the soil profile enhancing nutrient uptake, which in turn leads to lateral root development and increased stress tolerance. This improves the nutrient, water and phosphorus uptake to overcome environmental stress. Cue® helps soybean varieties reach their true genetic potential.

Features and benefits:

- Increases root surface area
- Improved nutrient and water uptake
- Enhances phosphorus uptake
- Increases stress tolerance
- A new patented technology for soybeans that allows seed companies to differentiate seed genetics and traits providing consistent yield increases of 1-2 bushels in all yield ranges
- Cue[®] is a low rate technology designed to be applied at processing time by the seed company with excellent seed safety

Signaling Technologies



Average yield response (bu/acre)



Years = 3, N = 55. Control included a base fungicide and/or insecticide package. Cue[®] was added to the base package.

Product details

Shelf life	Package treats	Application	Seed Treatment Rate	Packaging
2 years	3,200 units (4.6 gal) or 10,000 units (14.38 gal)	Seed	0.368 fl oz/cwt	4.6 gallon container or 14.38 gallon shuttle

Available May 2022

Novozymes Ratche

Signaling Technologies

LCO promoter technology for foliar applications



Above ground:

- 1. Increased photosynthesis
- 2. Increased chlorophyll content
- 3. Increased carbohydrate synthesis
- 4. Early and increased flowering
- 5. Increased grain yield
- 6. Mitigated water deficit/drought stress

Roots:

- 1. Lateral root development
- 2. Increased root biomass
- 3. Longer main roots
- 4. Increase water and nutrient uptake

Introducing Ratchet[®] for corn and soybean:

Foliar applied LCO promoter technology

Ratchet is Novozymes' patented, foliar applied LCO Promoter Technology for corn and soybean. Formulated for ease of use and compatibility with post-emergence applications, Ratchet supports the growth and yield potential of the crop.

Benefits received from the enhanced nutritional capabilities include:

- Increased photosynthetic capacity which enhances plant growth
- Earlier canopy closure to conserve soil moisture and reduce weed pressure
- A healthier plant for improved stress tolerance and yield performance

Easy and convenient to use- apply with your post-emergence application

Ratchet is compatible with post-emergence pesticides and foliar fertilizer applications, including glyphosate herbicides. No additional passes are required to get the benefits of LCO Promoter Technology working in your corn and soybean fields.

What is LCO Promoter Technology?

LCO (lipo-chitooligosaccharide) Promoter Technology is a unique molecule that enhances the plant's nutritional capabilities which drives the natural growth processes such as root and shoot development, immediately and independently of variety, soil, and environmental conditions.

When applied to the foliar surface, this patented technology provides an increase in photosynthesis and sugar production, and in turn advances plant growth improving overall crop performance.

Soybean: multi-year, proven performance with Ratchet[®]



Product details

Compatibility	Application	Use rate	Area treated	Packaging
Compatible with most tank mix partners	Apply post emergence with a tank mix partner	4 oz per acre	80 acres/jug	2 x 2.5 gallon jug

Novozymes BioAg Ratchet® trial results: Corn



Available May 2022

Novozymes Torque

Signaling Technologies LCO promoter technology for corn and soy



Roots:

- 1. Lateral root development
- 2. Increased root biomass
- 3. Longer main roots
- 4. Increase water and nutrient uptake
- 5. Increased mycorrhizal association

Multi-year, proven historical performance with Torque®

Stronger, healthier crops from the roots up

Torque[®] with LCO Promoter Technology[®] enables your crop to achieve its full genetic potential by enhancing nutritional capabilities that drive natural growth processes, maximizing plant health, and crop performance. Specially formulated for easy, flexible application with pop-up or liquid start fertilizers, Torque[®] takes the genetic potential of your crop to a new level.

Benefits received from enhanced nutritional capabilities include:

- Enhanced root and shoot development for improved nutrient and water uptake
- Improved plant health enabled plants to better handle environmental pressures
- Consistent yield increases

What is LCO Promoter Technology?

LCO (Lipo-chitooligosaccharide) Promoter Technology is a unique molecule that stimulates mycorrhizal association in your crop. LCO triggers cell division and cell elongation in the root. Both processes enhance your plant's nutritional capabilities which drives the natural growth processes such as root and shoot development, immediately and independently of variety, soil and environmental conditions. The natural growth processes are advanced for a healthier start for plants, translating into higher yields and better returns at the end of the season.



Product details

Compatibility	Application rate	2 x 2.5 jug treats	Packaging
Compatible with most popup and start fertilizers	1 oz/acre (for in furrow or 2 x 2)	240 acres	2 x 2.5 gallon jugs

Novozymes BioAg Torque® trial results: Corn





Inoculant **Technologies**

TagTeam BioniQ® for peat and granular inoculants for pea, lentil, and chickpea



Features & benefits

yield potential.

Benefits of TagTeam® BioniQ®

- Enhances N, P, K availability
- Increases efficiency of P use
- Enhances nitrogen fixation potential
- Improves yield potential
- Encourages root growth and shoot development
- Supports early vigor
- Improves stress tolerance

How TagTeam[®] BioniQ[®] works

TagTeam[®] BioniQ[®] for pea and lentil combines four biologically active ingredients for powerful in-field performance. It improves availability of NPK, allows a great opportunity for earlier nodulation and increased nitrogen fixation. increasing access to nutrients and water.

BioAdvantage Trial



Source: Results were collected from 13 farmer conducted, large-scale, side-by-side BioAdvantage Trials in Western Canada from 2017-2020.

Application rates

Source: Results were collected from 69 farmer conducted,

large-scale, side-by-side BioAdvantage Trials in Western Canada from 2017-2020.

Peat formulations

Product performance

Active ingredients	Packaging
Penicillium bilaiae, Rhizobium leguminosarum, Bacillus amyloliquefaciens and Trichoderma virens.	7 x 2.2 kg (4.8 lbs)

Application rates and kerning seed planting windows

Сгор	Seed inoculated by one bag	Approx. water volume	Planting window (bare seed)
Pea	1,360 kg (3,000 lb, 50 bu}	4.0 litres (4.2 US quarts)	48 hours
Lentil	820 kg (1,800 lb, 30 bu}	2.5 litres (2.7 US quarts)	48 hours
Chickpea	1,360 kg (3,000 lb, 50 bu}	4.0 litres (4.2 US quarts)	6 hours

Granular fomulations

Product performance

	A	Destanta	-
Active ingredients	Application rate	Раскадіпд	_
Penicillium bilaiae, Rhizobium leguminosarum, Bacillus amyloliquefaciens, Trichoderma virens	Varies	Granular 18 kg bag	

Application rates for TagTeam® BloniQ® Pro Granular Inoculant for pea and lentil

Row spacing (cm)	14.2	17.8	20.3	22.9	25.4	30.5	38.1
Row spacing (In)	(6.0)	(7.0)	(8.0)	(9.0)	(10.0)	(12.0)	(15.0)
Application rates (kg/ha)	6.1	5.3	4.6	4.0	3.7	3.1	2.4
Application rates (lb/ac)	(5.5)	(4.7)	(4.1)	(3.6)	(3.3)	(2.7)	(2.2)

Application rates for TagTeam® BioniQ® Granular Inoculant for chickpea							
Row spacing (cm)	14.2	17.8	20.3	22.9	25.4	30.5	38.1
Row spacing (ln)	(6.0)	(7.0)	(8.0)	(9.0)	(10.0)	(12.0)	(15.0)
Application rates (kg/ha)	6.1	5.3	4.6	4.0	3.7	3.1	2.4
Application rates (lb/ac)	(5.5)	(4.7)	(4.1)	(3.6)	(3.3)	(2.7)	(2.2)



How TagTeam[®] LCO works

Freeing phosphate

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

More Nitrogen

- 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 infection can create nodules, which help fix atmospheric nitrogen.

Inoculant Technologies

Higher yield potential

Source: Results were collected from 7 farmer conducted, large-scale, side-by-side BioAdvantage Trials conducted in Saskatchewan in 2018.

Lentil

Source: Results were collected from 5 farmer conducted, large-scale, side-by-side BioAdvantage Trials conducted in Saskatchewan in 2018.

Product details

Application rates and bare seed planting windows

Сгор	Seed inoculated by one bag	Planting Window Bare Seed
Pea	700 kg (1,500 lb, 25 bu)	24 hours
Lentil	700 kg (1,500 lb, 25 bu)	24 hours

Always read and follow label directions

Inoculant Technologies

Product Overview

Balanced nutrition

Balanced nutrition of phosphate and nitrogen is necessary to maximize your crop's yield potential. TagTeam[®] inoculant provides this balanced nutrition by combining the active ingredient from JumpStart® inoculant with a nitrogen-fixing bacteria to produce a dualaction inoculant.

The active ingredient in JumpStart[®] is the soil fungus, Penicillium bilaiae (P. bilaiae). This fungus and the rhizobia in TagTeam[®] inoculant work together to create a unique value equation.

The soil fungus is the key to the equation. It grows along the plant roots and makes lessavailable forms of phosphate available to the plant. Phosphate is an important component that drives the needed energy for the nitrogen fixation process.

Early-season phosphate availability is difficult when the plant does not have a root mass or the energy to develop a root mass. Penicillium bilaiae helps with both of these issues by making phosphate available to the plant to support root and shoot growth.

Product performance

TagTeam® inoculant solves starter fertilizer problems

TagTeam[®] improves phosphate availability, even if starter phosphate fertilizer is used. TagTeam® helps the developing primary roots access phosphate early in the growth stages, even before the root reaches the starter fertilizer band. As the primary root develops, TagTeam® provides greater availability of soil and fertilizer phosphate, allowing the root to better access phosphate nutrition throughout the rooting zone.

Product details

TagTeam [®] Pea and Lenti	l Granular Inc	oculant					
Active ingredients 1.3 x 10 ¹⁰ cfu/g Penicillium bilaiae 1.3 x 10 ¹⁰ viable cfu/g Rhizobium leguminosarum		Appl	ication rate	Case treat	ts	Packaging	
		1.0 oz/1,000 ft of row		See table below		39.7 lbs 582 lb 1000 lbs	
Application rates for Tag	gTeam® Pea a	nd Lentil Gr	anular Inocula	nt			
Row spacing (in)	6	7	8	9	10	12	15
Application rate (lbs/ac)	5.5	4.7	4.1	3.6	3.3	2.7	2.2
Area treated (per 39.7 lb bag)	7.3 ac	8.5 ac	9.8 ac	11.1 ac	12.1 ac	14.8 ac	18.2 ac
						Always read an	d follow label directions
TagTeam [®] Granular for c	hickpea						
Active ingredients		Application rate		Case treat	ts	Packaging	
1.0 x 10 ⁶ cfu/g <i>Penicillium bilaia</i> 1.0 x 10 ⁸ viable cfu/g <i>Mesorhizo</i>	e bium cicero	Varies by row spacing		Varies by row spacing		39.7 lb	
Application rates for Tag	gTeam® Granu	lar for chic	kpea				
Row spacing (in)	6	7	8	9	10	12	15
Application rate (lbs/ac)	5.5	4.7	4.1	3.6	3.3	2.7	2.2
Note: The bulk density for TagTear	. The hulk density for TarTeam [®] Granular for Chicknes averages 0.6 g/cm ³ (371b/ft ³)					Always read an	d follow label directions

Note: The bulk density for TagTeam[®] Granular for Chickpea averages 0.6 g/cm³ (37lb/ft³).

Always read and follow label directions

TagTeam[®] Chickpea Peat Inoculant

Active ingredients	Application rate	Case treats	Packaging
6.9 x 10 ⁶ cfu/g <i>Penicillium bilaiae</i> 6.9 x 10 ⁸ viable cfu/g <i>Mesorhizobium cicer</i> o	2.5 oz/100 lb of seed	3000 lb seeds	4.8 lb bag

TagTeam® Pea and Lentil Peat Inoculant

Active ingredients	Application rate	Case treats	Packaging
3.7 x 10° cfu/g Penicillium bilaiae	Pea: 2.5 oz/100 lb of seed	3000 lb pea seeds	4.8 lb bag
7.4 x 10° viable cfu/g Rhizobium leguminosarum	Lentil: 4.3 oz/100 lb of seed	1800 lb lentil seeds	

Always read and follow label directions

Cell-Tech[®] for pea and lentil

How Cell-Tech® works

Nitrogen-Fixing Inoculant: Cell-Tech® inoculant is a single-action product that contains specially selected rhizobia that can provide effective nodulation to enhance nitrogen-fixation, even in cooler soils – increasing yield potential as planting conditions change.

Cell Tech is available in the following formulations:

Сгор	Inoculant species	Cell-Tech formulations available
Pea, Lentil	Rhizobium leguminosarum	Liquid, Granular, Peat

Application

Inoculant Technologies

Please read the label before application for complete use instructions.

Liquid formulations

	Packaging	Application rate	Treats
Pea & Lentil	4 x 3 L	2.5 fl oz/60 lb (bu)	9,600 lbs, 160 bu

Peat formulations

Cell-Tech[®] peat has its own sticker in the formulation so no additional stickers are required. Apply Cell-Tech[®] dry to pre-moistened seed, or add water while applying Cell-Tech[®], or mix with cool, clean water and apply to seed as a slurry. Make sure that inoculated seed is evenly coated.

	Packaging	Application rate	Treats
Pea & Lentil	4 x 6.2 lb bag	3.6 fl oz/55 lb (bu)	1,500 lbs, 25 bu

Granular formulations

Row Spacing	Packaging	6"	7"	8"	9"	10"	12"	15"	24"	30"
Cell-Tech Pea/Lentil Granular Application Rate	40 lbs 1000 lbs	7.7 lb/ac	6.6 lb/ac	5.8 lb/ac	5.1 lb/ac	4.6 lb/ac	3.8 lb/ac	3.1 lb/ac	-	-

Nutrient

Availability

Technologies

Jumpstart[®] for chickpea, dry bean and pea

How Jumpstart® works

Naturally occurring soil fungus to release bound mineral forms of soil and fertilizer phosphate.

Freeing Phosphate

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

Product overview

Phosphate fertilizer use efficiency

Up to 90% of applied phosphate fertilizer goes unused in the year of application as it gets tied (bound) to soil particles and other elements, making it unavailable to the crop. Some of this is used over subsequent years, but at least 25% never becomes available.¹ It is crucial to make the most efficient use of fertilizer phosphate to maximize yield potential.

Jumpstart[®] inoculant contains the naturally occurring soil fungus *Penicillium bilaiae (P. bilaiae)*, discovered by Agriculture and Agri-food Canada, which grows along plant roots, releasing phosphate bound in the soil, making it more readily available for the crop to use.

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.

• Jumpstart[®] results are greatest in soils with lower levels of available phosphate and

bi. = Penicillium bilaiae

high to medium levels of bound/unavailable phosphate.

- Jumpstart[®] works at low soil temperatures when phosphate availability is normally limited.
- In independent research, Jumpstart[®] resulted in a 22% increase in the proportion of root that contained root hairs and a 33% increase in the mean root-hair length in field pea.²
- Jumpstart[®] can work in soils within a wide pH range. It is the level of available phosphate, not the pH, that determines the benefit of JumpStart[®].³

 ¹ Source: Better Crops Vol. 86 (2002, No. 4), International Plant Nutrition Institute (formerly: Potash and Phosphate institute).
 ² Source: Penicillium bilaiae inoculation increases root-hair production in field pea. Robert H. Gulden and J. Kevin Vessey. May 17, 2000.

³ Source: Phosphorous for Agriculture, International Plant Nutrition Institute (Formerly: Potash and Phosphate Institute).

Benefits to better phosphate

Uptake with JumpStart®

JumpStart[®] inoculant promotes greater phosphate availability, which results in early vigor, greater stress tolerance and earlier, more even maturity. JumpStart[®] improves phosphate availability to plants at the most vulnerable stages and reduces the need to speed-place high rates of phosphate fertilizer with sensitive seed like canola, pea, lentil and soybean.

Early vigor

Cool soils, common under direct seeding or early seeding conditions, mean phosphate is less available to plants. If early-season phosphate availability is limited, It can reduce early-season growth and, ultimately, crop yield. Early spring conditions, including cool soils, are difficult on plants, especially when phosphate is not available. Because JumpStart[®] is active under these conditions, phosphate availability is improved when the plant needs it.

Greater stress tolerance

Plants with larger healthy root systems have the ability to better withstand a variety of stresses such as drought and weed pressure. Healthy root systems help plants access moisture and nutrients more efficiently.

JumpStart[®] increases phosphate availability in all areas of the soil that the root explores, not just around the fertilizer band, which helps promote more root growth.

Seed treatment/package	2 oz bottle	Case (4 x 2 oz bottles)
Chickpea	3,300 lbs	13,200 lbs
Dry bean	2,400 lbs	9,600 lbs
Lentil	2,400 lbs	9,600 lbs
Pea	4,200 lbs	16,800 bs

Nutrient Availability Technologies

QuickRoots[®] for pea, lentil, chickpea, and dry bean

How It Works

Two biological actives to increase availability and uptake of nitrogen, phosphate and potassium.

- 1. The biologicals *Bacillus amyloliquefaciens* and *Trichoderma virens* have the ability to release phosphate in the soil not readily available to the plant.
- 2. Improved phosphate availability can lead to expanded root volume, which enhances nitrogen and potassium uptake.
- 3. This ultimately can enable optimal plant growth and increased yield potential.

Product overview

Quickroots[®] inoculant can improve nutrient availability and uptake. The microbial seed inoculant is available and uptake of nitrogen, phosphate and potassium.

Its ability to release nutrients from the soil helps maximize the effectiveness of your inputs and improve your yield potential.

Features and benefits

availability of nitrogen, phosphate and potassium

Enhanced nutrient availability, which supports root and shoot growth.

Performance in a variety of soil conditions and types.

Product performance

By growing directly on your crop's roots, QuickRoots[®] works to improve nutrient availability and uptake. The microbial inoculant performs in a variety of soil conditions and types (including soils low in phosphate availability). This can enable optimal plant growth and increased yield potential.

QuickRoots Products/Technologies – all crops

	Сгор	Case or Pail	Pkgs/case	Package treats
	Soybean Multicrop (soybeans, sunflower, sugarbeet,	pea, lentil, chickpea a	and dry bean)
QuickRoots® Wettable Powder	Pea	60,000 lbs	10 x 200 g	6000 lbs
	Lentil	22,000 lbs		2200 lbs
	Chickpea	46,640 lbs		4664 lbs
	Dry bean	28,800 lbs		2880 lbs
QuickRoots [®] Wettable Powder	Pea	144,000 lbs	1 x 4.8 kg	144,000 lbs
	Lentil	52,800 lbs		52,800 lbs
	Chickpea	111,936 lbs		111,936 lbs
	Dry bean	69,312 lbs		69,312 lbs

- 1. Needing nitrogen, the plant releases
- 2. Sensing the flavonoids, the rhizobia
- 3. The plant can respond to the LCO, allowing the rhizobia to infect its roots.
- 4. This infection can create nodules, which help fix atmospheric nitrogen.
- 5. The presence of LCO molecules enhances mycorrhizae germination and plant association

TagTeam[®] LCO Peanut Liquid Inoculant

Active ingredients	Application rate	Case treats	Packaging
2 billion (2 x 10°) viable cfu/ml <i>Bradyrhizobium</i> sp. <i>Arachis</i> 1 x 10 ⁻⁷ % lipo-chitooligosaccharides 720 million (7.2 x 10°) cfu/g <i>Penicillium bilaiae</i>	1.0 fl oz/ 1,000 ft of row	40 acres at 36 in row spacing	4 x 1.1 gal

Inoculant **Technologies**

Product performance

How Optimize® 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.
- 5. The presence of LCO molecules enhances mycorrhizae germination and plant association

Optimize® Peanut Inoculant

Active ingredients	Application rate	Case treats	Packaging
2 billion (2 x 10³) viable cfu/ml Bradyrhizobium sp. Arachis I x 10 ^{,7} % lipo-chitooligosaccharides	1.0 fl oz/1,000 ft of row	Case treats 40 acres. Package treats 10 acres using a 36 inch row spacing.	4 x 1.1 gəl

Inoculant **Technologies**

Product performance

Rhizobium

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How Cell-Tech® works

The active ingredient in Cell-Tech® liquid nitrogenfixing inoculant for peanut is the bacterium Bradyrhizobium sp. Arachis. Bradyrhizobium sp. Arachis forms root nodules which convert, or fix, nitrogen in the air into forms the plant can use.

Nitrogen-Fixing Inoculant: Cell-Tech® inoculant is a single-action product that contains specially selected rhizobia that can provide effective nodulation to enhance nitrogen-fixation, even in cooler soils - increasing yield potential as planting conditions change.

Cell Tech is available in the following formulations:

Сгор	Inoculant species	Cell-Tech formulations available
Peanut	Bradyrhizobium sp. Arachis	Liquid, Granular, Peat

Application

Inoculant **Technologies**

Please read the label before application for complete use instructions.

Liquid formulations

	Packaging	Application rate	Case treats
Peanuts	4 x 1.1 gal	1 fl oz/1,000 ft of row	40 acres (36" rows)

Peat formulations

Cell-Tech[®] peat has its own sticker in the formulation so no additional stickers are required. Apply Cell-Tech[®] dry to pre-moistened seed, or add water while applying Cell-Tech[®], or mix with cool, clean water and apply to seed as a slurry (refer to Table 2). Make sure that inoculated seed is evenly coated.

	Packaging	Application rate	Treats
Peanuts	24 x 6.6 oz	6.6 oz/100 lbs of seed	100 lbs seed

Granular formulations

Row Spacing	Packaging	24"	30"	32"	36"	38"	40"
Cell-Tech Peanuts Granular Application Rate	40 lbs	8.2 lb/ac	6.5 lb/ac	6.1 lb/ac	5.4 lb/ac	5.2 lb/ac	4.9 lb/ac

Nutrient

Availability

Technologies

Jumpstart[®] for peanuts

How Jumpstart[®] works

Naturally occurring soil fungus to release bound mineral forms of soil and fertilizer phosphate.

Freeing Phosphate

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

Product overview

Phosphate fertilizer use efficiency

Up to 90% of applied phosphate fertilizer goes unused in the year of application as it gets tied (bound) to soil particles and other elements, making it unavailable to the crop. Some of this is used over subsequent years, but at least 25% never becomes available.¹ It is crucial to make the most efficient use of fertilizer phosphate to maximize yield potential.

Jumpstart[®] inoculant contains the naturally occurring soil fungus Penicillium bilaiae (p. bilaiae), discovered by Agriculture and Agri-food Canada, which grows along plant roots, releasing phosphate bound in the soil, making it more readily available for the crop to use.

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.

 Jumpstart[®] results are greatest in soils with lower levels of available phosphate and

high to medium levels of bound/unavailable phosphate.

P. bi. = Penicillium bilaiae

 Jumpstart[®] works at low soil temperatures when phosphate availability is normally limited.

Organic

compounds

Stabilizes

phosphate

Plant available

- In independent research, Jumpstart[®] resulted in a 22% increase in the proportion of root that contained root hairs and a 33% increase in the mean root-hair length in field pea.²
- Jumpstart[®] can work in soils within a wide pH range. It is the level of available phosphate, not the pH, that determines the benefit of JumpStart[®].³

¹ Source: Better Crops Vol. 86 (2002, No. 4), International Plant Nutrition Institute (formerly: Potash and Phosphate institute). ² Source: Penicillium bilaiae inoculation increases root-hair production in field pea. Robert H. Gulden and J. Kevin Vessey. May 17, 2000.

³ Source: Phosphorous for Agriculture, International Plant Nutrition Institute (Formerly: Potash and Phosphate Institute).

Benefits to better phosphate

Uptake with JumpStart®

JumpStart[®] inoculant promotes greater phosphate availability, which results in early vigor, greater stress tolerance and earlier, more even maturity. JumpStart[®] improves phosphate availability to plants at the most vulnerable stages and reduces the need to speed-place high rates of phosphate fertilizer with sensitive seed like canola, pea, lentil and soybean.

Early vigor

Cool soils, common under direct seeding or early seeding conditions, mean phosphate is less available to plants. If early-season phosphate availability is limited, It can reduce early-season growth and, ultimately, crop yield. Early spring conditions, including cool soils, are difficult on plants, especially when phosphate is not available. Because JumpStart[®] is active under these conditions, phosphate availability is improved when the plant needs it.

Greater stress tolerance

Plants with larger healthy root systems have the ability to better withstand a variety of stresses such as drought and weed pressure. Healthy root systems help plants access moisture and nutrients more efficiently.

JumpStart[®] increases phosphate availability in all areas of the soil that the root explores, not just around the fertilizer band, which helps promote more root growth.

Products details

Seed treatment/package	2 oz bottle	Case treats (4 x 2 oz bottles)	
Peanut	12 acres	48 acres	

Wheat Small Grains

BioniQ[®] for corn, sorghum, canola, all wheat, oats, mustard, barley, and rye

Product features

Three biological actives join forces for stronger roots, greater nutrient availability and better yield

BioniQ[®] is an inoculant that aids in improved nutrient and moisture uptake and phosphate availability. It also increases yield potential in corn, sorghum, canola, all wheat, oats, mustard, barley, rye and a range of other crops.

The *Penicillium bilaiae* fungus helps release bound mineral forms of soil and fertilizer phosphate, making it more readily available for the plant to use. While, the biologicals *Bacillus amyloliquefaciens* and *Trichoderma virens* help increase availability and uptake of nitrogen, phosphate, and potassium, which supports root and shoot growth.

Features & benefits

Benefits of BioniQ®

- Encourages root growth and shoot development
- Enhances N, P, K availability
- Increases efficiency of P use
- Improves yield potential
- Supports early vigor
- Improves stress tolerance

How BioniQ[®] works

BioniQ[®] employs multiple modes of action to increase crops' access to soil nutrients. It contains three biologicals: *Penicillium bilaiae*,

Bacillus amyloliquefaciens and Trichoderma virens. Penicillium bilaiae helps release bound mineral forms of soil and fertilizer phosphate. That makes it more readily available for the plant to use. Bacillus amyloliquefaciens and Trichoderma virens help increase availability and uptake of nitrogen, phosphate, and potassium. That supports root and shoot growth in corn, sorghum, canola, wheat, oats, mustard, barley, rye and a range of other crops.

Product performance

The performance of BioniQ[®] was tested under real farm growing conditions, using real farm practices in the BioAdvantage[®] Trial (BAT) program of on-farm trials. This summary data represents trials on 35 locations in Western Canada from 2017 to 2020.

Inoculant Technologies

BioAdvantage Trial

Active ingredients

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Powder A: 7.2 x 10<sup>8</sup> cfu/g Penicillium bilaiae.
Powder B: 7.3 x 10<sup>8</sup> viable cfu/g Bacillus amyloliquefaciens and 2.2 x 10<sup>7</sup> cfu/g Trichoderma virens.
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On-seed application rates and bare seed planting windows

783 g	CO-	pack
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Сгор	Seed inoculated by one 783 g co-pack	Approx. water volume	Planting window (bare seed)
Barley	5,445 kg (12,000 lb, 250 bu)	42 litres (9.0 US gal)	60 days
Canola/mustard	227 kg (500 lb, 10 bu)	5 litres (1.3 US gal)	60 days
Oats	3,857 kg (8,500 lb, 250 bu)	24 litres (6.3 US gal)	60 days
Rye	6,352 kg (14,000 lb, 250 bu)	39 litres (10.3 US gal)	60 days
Wheat	6,818 kg (15.000 lb. 250 bu}	42 litres (11.1 US gal)	60 days
Sorghum	790 kg (1,750 lb, 31 bu)	10 litres (2.6 US gal)	60 days
Corn	860 kg (1,900 lb, 34 bu)	12 litres (3.2 US gal)	60 days
Corn	860 kg (1,900 lb, 34 bu)	12 litres (3.2 US gal)	60 days

Jumpstart[®] for wheat, canola, and sorghum

How Jumpstart® works

Naturally occurring soil fungus to release bound mineral forms of soil and fertilizer phosphate.

Freeing Phosphate

PenIcillium bilalae releases bound mineral forms of soil and fertilizer phosphate, making it more available to the plant to use.

Product overview

Phosphate fertilizer use efficiency

Up to 90% of applied phosphate fertilizer goes unused in the year of application as it gets tied (bound) to soil particles and other elements, making it unavailable to the crop. Some of this is used over subsequent years, but at least 25% never becomes available. ¹ It is crucial to make the most efficient use of fertilizer phosphate to maximize yield potential.

Jumpstart[®] inoculant contains the naturally occurring soil fungus *Penicillium bilaiae (P. bilaiae)*, discovered by Agriculture and Agri-food Canada, which grows along plant roots, releasing phosphate bound in the soil, making it more readily available for the crop to use.

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.

• Jumpstart[®] results are greatest in soils with lower levels of available phosphate and

P. bi. = Penicillium bilaiae

high to medium levels of bound/unavailable phosphate.

- Jumpstart[®] works at low soil temperatures when phosphate availability is normally limited.
- In independent research, Jumpstart[®] resulted in a 22% increase in the proportion of root that contained root hairs and a 33% increase in the mean root-hair length in field pea.²
- Jumpstart[®] can work in soils within a wide pH range. It is the level of available phosphate, not the pH, that determines the benefit of JumpStart[®].

 ¹ Source: Better Crops Vol. 86 (2002, No. 4), International Plant Nutrition Institute (formerly: Potash and Phosphate institute).
 ² Source: Penicillium bilaiae inoculation increases root-hair production in field pea. Robert H. Gulden and J. Kevin Vessey. May 17, 2000.

³ Source: Phosphorous for Agriculture, International Plant Nutrition Institute (Formerly: Potash and Phosphate Institute).

Inoculant Technologies

Benefits to better phosphate

Uptake with JumpStart®

JumpStart[®] Inoculant promotes greater phosphate availability, which results in early vigor, greater stress tolerance and earlier, more even maturity. JumpStart[®] improves phosphate availability to plants at the most vulnerable stages and reduces the need to speed-place high rates of phosphate fertilizer with sensitive seed.

Early vigor

Cool soils, common under direct seeding or early seeding conditions, mean phosphate is less available to plants. If early-season phosphate availability is limited, It can reduce early-season growth and, ultimately, crop yield. Early spring conditions, including cool soils, are difficult on plants, especially when phosphate is not available. Because JumpStart[®] is active under these conditions, phosphate availability is improved when the plant needs it.

Greater stress tolerance

Plants with larger healthy root systems have the ability to better withstand a variety of stresses such as drought and weed pressure. Healthy root systems help plants access moisture and nutrients more efficiently.

JumpStart[®] increases phosphate availability in all areas of the soil that the root explores, not just around the fertilizer band, which helps promote more root growth.

Seed treatment/package	2 oz bottle	Case (4 x 2 oz bottles)
Wheat	2,400 lbs	9,600 lbs
Canola	140 lbs	560 lbs
Sorghum	300 lbs	1200 lbs

Inoculant Technologies

QuickRoots[®] for wheat, barley, oats, rye, and spelt seed

How It Works

Two biological actives to increase availability and uptake of nitrogen, phosphate and potassium.

- 1. The biologicals *Bacillus amyloliquefaciens* and *Trichoderma virens* have the ability to release phosphate in the soil not readily available to the plant.
- 2. Improved phosphate availability can lead to expanded root volume, which enhances nitrogen and potassium uptake.
- 3. This ultimately can enable optimal plant growth and increased yield potential.

Product overview

Quickroots[®] inoculant can improve nutrient availability and uptake. The microbial seed inoculant is available and uptake of nitrogen, phosphate and potassium.

Its ability to release nutrients from the soil helps maximize the effectiveness of your inputs and improve your yield potential.

Features and benefits

Product performance

By growing directly on your crop's roots, QuickRoots[®] works to improve nutrient availability and uptake. The microbial inoculant performs in a variety of soil conditions and types (including soils low in phosphate availability). This can enable optimal plant growth and increased yield potential.

QuickRoots Products/Technologies – all crops

	Сгор	Case or Pail	Pkgs/case	Package treats	
	Small grains (wheat, barley, oats, rye and spelt seed)				
QuickRoots® Wettable Powder	Small grains	10 x 100 bu	10 x 180 g	100 bu	
QuickRoots® Wettable Powder	Small grains	2,500 bu	1 x 4.8 kg	2,500 bu	

(A.

- 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.

Inoculant Technologies

Optimize[®] Gold Active ingredients Application rate Case treats Packaging

Active ingredients	Application rate	Case licals	Fackaging
100 million (1 x 10 ⁸) viable cfu/ml <i>Sinorhizobium meliloti</i> 1 x 10 ⁷ % lipo-chitooligosaccharides	19.6 ft oz/100 lbs of seed	3,000 lb of seed	38.3 lb

Nitragin® Alfalfa, Clover, and Sweet Clover

Leguminous plant

Nitrogen fixing bacteria like rhizobium fixes atmospheric nitrogen into nitrogenous compounds.

Nodules

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)

Sinorhizobium meliloti fixes nitrogen

Inoculant Technologies

Product details

Nitragin® Gold Alfalfa and Sweet Clover Pre-Inoculant

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

Always read and follow label directions

Nitragin[®] Gold Clover Pre-Inoculant

Active ingredients	Packaging	Application rate	Case treats	Сгор
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	White, ladino, alsike red and clovers

Always read and follow label directions

Jovozymes Jumpstar

Nutrient Avazidaubialintty Technologies

Alfalfa/sweet clover

How Jumpstart[®] works

Naturally occurring soil fungus to release bound mineral forms of soil and fertilizer phosphate.

Freeing Phosphate

PenIcillium bilalae releases bound mineral forms of soil and fertilizer phosphate, making it more available to the plant to use.

Product overview

Phosphate fertilizer use efficiency

Up to 90% of applied phosphate fertilizer goes unused in the year of application as it gets tied (bound) to soil particles and other elements, making it unavailable to the crop. Some of this is used over subsequent years, but at least 25% never becomes available. ¹ It is crucial to make the most efficient use of fertilizer phosphate to maximize yield potential.

Jumpstart[®] inoculant contains the naturally occurring soil fungus *Penicillium bilaiae (P. bilaiae)*, discovered by Agriculture and Agri-food Canada, which grows along plant roots, releasing phosphate bound in the soil, making it more readily available for the crop to use.

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.

• Jumpstart[®] results are greatest in soils with lower levels of available phosphate and high

to medium levels of bound/unavailable phosphate.

- Jumpstart[®] works at low soil temperatures when phosphate availability is normally limited.
- In independent research, Jumpstart[®] resulted in a 22% increase in the proportion of root that contained root hairs and a 33% increase in the mean root-hair length in field pea.²
- Jumpstart[®] can work in soils within a wide pH range. It is the level of available phosphate, not the pH, that determines the benefit of JumpStart[®].

³ Source: Phosphorous for Agriculture, International Plant Nutrition Institute (Formerly: Potash and Phosphate Institute).

¹ Source: Better Crops Vol. 86 (2002, No. 4), International Plant Nutrition Institute (formerly: Potash and Phosphate institute). ² Source: Penicillium bilaiae inoculation increases root-hair production in field pea. Robert H. Gulden and J. Kevin Vessey. May 17, 2000.

phosphate availability

soil temps helping to enhance earlyseason vigour

Earlier, more uniform maturity

Benefits to better phosphate

Uptake with JumpStart®

JumpStart[®] Inoculant promotes greater phosphate availability, which results in early vigor, greater stress tolerance and earlier, more even maturity.

Early vigor

Cool soils, common under direct seeding or early seeding conditions, mean phosphate is less available to plants. If early-season phosphate availability is limited, It can reduce early-season growth and, ultimately, crop yield. Early spring conditions, including cool soils, are difficult on plants, especially when phosphate is not available. Because JumpStart[®] is active under these conditions, phosphate availability is improved when the plant needs it.

Greater stress tolerance

Plants with larger healthy root systems have the ability to better withstand a variety of stresses such as drought and weed pressure. Healthy root systems help plants access moisture and nutrients more efficiently.

JumpStart[®] increases phosphate availability in all areas of the soil that the root explores, not just around the fertilizer band, which helps promote more root growth.

Seed treatment/package	2 oz bottle	Case (4 x 2 oz bottles)
Alfalfa/Sweet Clover	150 lbs	600 lbs

Rethink tomorrow

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 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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