

Lumialza™

NEMATOCIDE SEED TREATMENT

Technical Bulletin





Lumialza™ Key Features

- Seed treatment nematicide that protects yield potential through reduction of nematode injury and increased root biomass
- Creates a living bio-barrier that provides protection against key crop-damaging nematodes for 80+ days
- Robust tool for sustainable farming with minimal impact on beneficial soil microorganisms such as arbuscular mycorrhizal fungi
- Provides protection against key nematode pests of corn, cotton, and soybean
- Protects expansion of upper, middle, and lower root zones
- Proven compatibility with other seed treatment technologies
- Effective nematode control at low use rates
- Safe and effective option for nematode management strategies
- Favorable environmental and seed safety profile

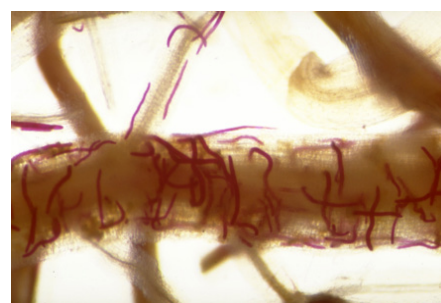


What are nematodes?

Nematodes are an extremely large and diverse family of non-segmented round worms. Estimates indicate the existence of more than one million different species of nematodes that are either free-living or parasitic worms. Free-living nematodes play an important role in soil health and facilitate recycling of nutrients, while parasitic nematodes feed on other organisms, including plants, animals, and other microorganisms for survival. Thus, crop-damaging plant-parasitic nematodes compose a relatively small component of the overall soil nematode population. Lumialza™ is a robust tool for sustainable nematode management of plant-parasitic nematodes with minimal impact on surrounding soil fauna.



Despite being a small subset of the total nematode population, plant-parasitic nematodes are composed of several thousands of different species. Some nematodes, such as the root lesion nematode (*Pratylenchus spp.*) feed on a variety of plant species, which can reduce the impact of crop rotation strategies on nematode infestation. Other species, like the soybean cyst nematode (*Heterodera glycines*), have limited host range. Lumialza seed treatment protects crops in both scenarios by creating a living bio-barrier that provides early season protection from a wide range of nematodes that extends more than 80 days into the growing cycle.



Lance nematodes (*Hoplolaimus geleatus*) feeding on corn root.

Most plant-parasitic nematodes live below ground with a life cycle that typically lasts about 30 days. Juvenile worms hatch from eggs and progress through several larval stages before reaching a reproductive adult stage. This allows plant-parasitic nematodes to quickly reproduce and infest crops with multiple generations within a single growing season. In addition, nematode eggs are able to withstand cold environments to permit overwintering in some geographies. This makes early-season crops particularly vulnerable to nematode damage. As spring soils begin to warm, eggs hatch and juveniles begin feeding on young plant roots. Lumialza provides early season nematode protection at planting with extended protection into the growing season.



Soybean cyst nematode egg (*Heterodera glycines*).
Credit: Becky Dickenson



Lumialza™

NEMATOCIDE SEED TREATMENT

Corteva Agriscience is proud to introduce Lumialza™ nematicide seed treatment. Lumialza is a biological seed treatment that provides protection against plant-parasitic nematodes. Lumialza contains an aggressive root zone-colonizing bacteria, *Bacillus amyloliquefaciens* strain PTA-4838, which creates a biological barrier that shields roots from harmful nematodes for more than 80 days. This mode of nematode protection is not only extremely effective, but is safe to other soil organisms, including arbuscular mycorrhizal fungi. Backed by Corteva's seed application expertise, Lumialza provides excellent protection to vulnerable seedlings.

Plant-parasitic nematodes: unseen pathogens

Nematodes are often overlooked as yield-robbing crop pests due to their small size and patchy distribution patterns. Nematodes are colorless roundworms and are the most abundant multicellular organisms on earth. While most nematodes play a beneficial role by recycling organic matter, some species feed on plant roots and cause significant yield-loss in crops. Nematode damage usually occurs in small patchy patterns that are often confused with other crop stressors such as nutrient deficiency or drought. Yield losses are frequently due to direct mechanical injury of the root system and subsequent loss of nutrient and water uptake. However, nematodes can also facilitate transmission of plant diseases that weaken plants, making them more susceptible to other diseases. In all cases, above ground symptoms such as wilting, chlorosis, and stunted plants are difficult to visually attribute to nematode damage.



Root lesion nematode (*Pratylenchus* spp.)

Nematodes prefer to feed on the new succulent tissues such as young roots. Nematodes are not confined by soil type or geography and can thrive in coarse sandy soils as well as finer textured soils. In 2020, estimated soybean yield loss attributed to nematode damage was more than 2,700 metric tons in the United States. In that same year, 1.9 million metric tons of corn loss was estimated to be due to nematode activity in the United States*. Therefore, nematode management is a top priority for corn and soybean producers to protect yield and return on farming investments.

*cropprotectionnetwork.org/resources





Symptoms of Nematode Damage

Feeding patterns divide plant-parasitic nematodes into 3 different groups of crop-damaging pests. Nematodes such as the dagger nematode (*Xiphinema spp.*) feed from the outside of corn and soybean roots using a specialized mouth part, called a stylet or spear, to penetrate and extract material from plant roots. These nematodes belong to a group called ectoparasites as they feed from outside (ecto meaning "outside") of the host plant and are forced to move along the root system to find new food material. Endoparasites fully penetrate the root and feed within (endo meaning "internal" or "within") the root. Root-knot nematodes (*Meloidogyne spp.*) are prolific endoparasites of many crops and cause galls on the roots of infected plants. In soybeans, soybean cyst nematodes (*Heterodera glycines*) are endoparasites that produce characteristic cysts on soybean roots, which can contain hundreds of eggs per cyst (see figure, upper panels). Lastly, semi-endoparasites, like reniform nematodes (*Rotylenchulus spp.*) feed on the outside and inside portions of the plant root to cause below ground damage.







The feeding damage by all of these groups of nematodes can deprive plants of water, nutrients, and make plants more vulnerable to disease. Therefore, above ground plant symptomology can be quite diverse and difficult to accurately identify in crops, making protection from nematode infestation a key strategy to nematode management. Lumialza provides a physical biological barrier that creates a healthy environment for plant roots and shields them from nematode feeding.



Upper panels – below ground symptoms of soybean cyst nematode on soybean roots. Upper right – magnified view shows development of characteristic small cysts containing nematodes. Lower left – a comparison of a nematode damaged corn plant on the left versus a healthy plant on the right. Below ground symptoms can be more indicative of nematode feeding such as the stubby root nematode damage seen on the lower right.

Nematode Pathogens

Lumialza™ nematicide seed treatment is effective against a wide range of common plant-parasitic nematodes. Because Lumialza creates a living biological barrier, it offers a mode of root protection that grows with the root system and is distinct, yet compatible, with chemical nematicide treatments. This makes Lumialza seed treatment a robust tool for broad spectrum integrated nematode management strategies.

Common Name (Scientific Name)		Feeding and Symptomology
	Root-knot Nematode <i>Meloidogyne spp.</i>	Multiple crop hosts, including corn and soybean Endoparasitic, spending the majority of their life inside roots Form characteristic small galls or knots on roots
	Soybean Cyst Nematode <i>Heterodera glycines</i>	The most important global soybean nematode pest Not considered a threat to corn yield Infests root vascular tissue to produce below ground cysts Soybean fields can suffer more than 50% seasonal yield loss
	Root-lesion Nematode <i>Pratylenchus spp.</i>	Multiple crop hosts, including corn and soybean Make roots prone to fungal and oomycete infection Pruned roots and necrotic roots below ground Stunted and discolored plants above ground
	Stubby-root Nematode <i>Trichodoridae</i>	Prefer corn roots, but will feed on soybean and other crops Cause shortened roots from feeding on growing root tips Damage can resemble herbicide burn (yellowing, stunting)
	Needle Nematode <i>Longidoridae</i>	Prefer corn roots, but will feed on other grassy crops Cause shortened and pruning of finer roots Devastating pest of the North American midwest Migrate deeper into soil as temperature rises
	Dagger Nematode <i>Xiphinema spp.</i>	Multiple crop hosts, including corn and soybean Some species have 1 generation per year, can live for 4-5 years Feeding leads to root damage, stunting, and chlorosis Known viral vectors for mosaic and wilting diseases

* Photo credits: Tim Thoden and Becky Dickenson

Lumialza nematicide seed treatment is also effective against several other corn, cotton, and soybean nematode pests, including sting (*Belonolaimus longicaudatus*), lance (*Hoplolaimus galeatus*), and reniform (*Rotylenchulus reniformis*) nematodes. See product label for full details on spectrum and use rates.



The need for innovative nematode management

There is a widely recognized need for nematode management solutions to protect investment and maximize yield in large acre row crops such as corn and soybean. However, crop-damaging nematodes are ubiquitous soil organisms found in nearly every soil type with a wide range of plant hosts. Considering the enormous soil volume that is home to nematodes, curative measures are not realistic. Preventative measures that protect crops at their most vulnerable stages are key. Lumialza™ nematicide seed treatment provides protection to seeds and seedlings at the earliest stages as well as later into the growing season.

When selecting nematode management solutions, it is important to recognize that plant-parasitic nematodes are a small subset of soil organisms, including beneficial fungi and nematodes, which are critical to nutrient cycling pathways that preserve soil health. Many effective nematicide fumigants have been withdrawn from the market due to their long-term impact on soil health as well as other detractors such as cumbersome and expensive application. Therefore, protection from plant-damaging nematodes while preserving soil fauna is important for sustainable nematode management practices. The bacteria found in Lumialza address this unique challenge by forming a living biological barrier that shields plant roots from parasitic nematodes without disruption of beneficial soil organism activities.

Nematodes are also difficult to manage because of their below-ground location. This presents issues in a few different ways. First, traditional chemical nematicide applications can be hard to deliver to underground environments and may require special farming equipment prior to planting. Once nematicides are delivered below-ground, the mobility of the nematicide will have direct impact on the ability to be retained within the soil or move to deeper root zones. Lumialza seed treatment avoids these challenges by growing with plant roots for more than 80 days after planting.

Nematodes are small translucent roundworms that cannot be seen by the unaided eye. Below ground feeding results in root damage and nutrient loss, but rarely kills the entire plant. Therefore, above ground symptomology, such as stunted growth and discoloration can be easily confused with environmental stress, low fertility, or other pest pressure. Nematode feeding is usually localized and does not affect the entire field, often giving rise to "hot spots" of stunted or discolored plants.

Nematode control challenges

- **Control of all parasitic nematodes is not possible**
- **Nematodes cannot be seen without a microscope**
- **Non-targeted control measures are not sustainable and most have been withdrawn from the market**
- **Most plant-parasitic nematodes spend their lifecycle below ground, making treatment difficult**
- **Maintaining protection throughout the root zone is difficult with chemical nematicides**

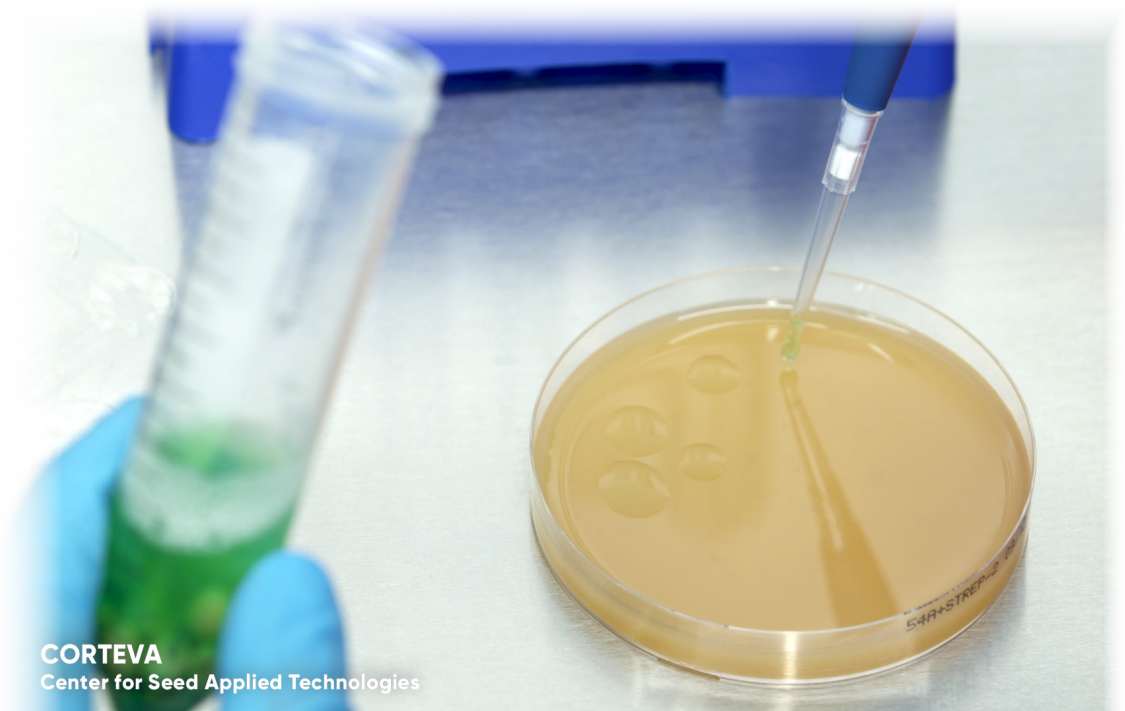


Lumialza™ Description

Corteva Agriscience is proud to bring forward Lumialza nematicide seed treatment. A biological seed treatment that protects early season crops from a wide range of crop-damaging nematodes to improve plant performance and protect crop yield.

The active component in Lumialza nematicide seed treatment is *Bacillus amyloliquefaciens* (PTA-4838), a naturally occurring soil bacteria that aggressively colonizes plant roots to create a living biological barrier that grows with the plant and protects roots from nematode damage to provide an optimal environment for root growth.

Lumialza nematicide seed treatment recipes are developed using the strength and expertise of Corteva field science and seed application technologies to ensure optimal viability and performance of active ingredient as well as compatibility with additional seed treatment recipe components.

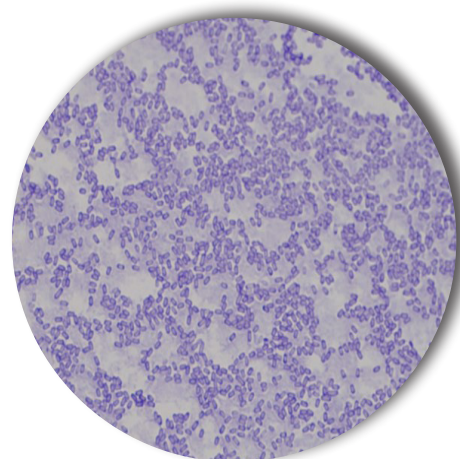


CORTEVA
Center for Seed Applied Technologies

Lumialza™ Mode of Action

A living biological nematode barrier

Lumialza contains *Bacillus amyloliquefaciens*, strain PTA-4838, which is a naturally-occurring gram-positive soil bacterium selected for the ability to form a physical barrier between growing roots and the soil environment. Seeds are coated with active spores that germinate and grow after seed is planted, providing early protection against plant-parasitic nematodes.



B. amyloliquefaciens strain PTA-4838 spores.

Symbiotic growth

Bacillus amyloliquefaciens strain PTA-4838 is a symbiotic rhizobacteria. Rhizobacteria depend on root secretions for survival and form an optimal local environment for root growth by preventing the intrusion of plant parasitic nematodes, while preserving the activities of arbuscular mycorrhizal fungi and other beneficial organisms. In addition, this means Lumialza will not readily move from the root zone and will provide extended protection for at least 80 days of the growing season.



Petri dish assay demonstrating the aggressive symbiotic growth of *B. amyloliquefaciens* bacteria on new roots germinating from a single treated corn seed (red).

Root zone colonization

Bacillus amyloliquefaciens strain PTA-4838 is an aggressive root-colonizing bacteria. This allows for low use rates relative to other seed treatment products. Also, because these bacteria are dependent on active growing roots, Lumialza protection grows with the root system into lower root zones to protect from nematode species that will migrate to deeper soil as temperatures change.



The active ingredient in Lumialza, *B. amyloliquefaciens*, grows with roots deep into the soil profile. This creates a biological barrier that provides nematode protection and an optimal growth environment for plants for more than 80 days into the growing season.



Roots from corn plants infested with root lesion nematode (*Pratylenchus brachyurus*) 42 days after emergence.

Lumialza™ Protection

Plant-pathogenic nematodes have the greatest impact on corn early in the growing season. However, nematodes can attack corn at any time. A wide array of nematodes cause root damage that can limit the plant's uptake of water and nutrients from the soil. This often results in stunted plants that appear stressed or deprived of nutrients. Lumialza creates a living biological barrier that reduces nematode damage below the soil to allow optimal root development and stand establishment. Importantly, Lumialza continues to grow with corn roots late into the season to provide sustained benefit and protection from nematode damage. Above the ground, plants are visually healthier and more likely to reach their productive potential.

Like corn, nematodes can have devastating effects on soybean growth starting at germination. Several different species of nematodes feed on soybean roots from sowing until harvest. Root damage from pathogenic nematodes causes root damage resulting in stunted plants and ultimately decreased yield. Lumialza grows within the root zone and shields root systems throughout the growing cycle, providing protection to roots without disturbing beneficial microorganisms within the surrounding soil environment.



(Left) above ground photos of plants from untreated corn seed infested with *Pratylenchus spp.* 42 DAE, (right) corn plants from seed treated with Lumialza at 10 ml/ha.

Pictures from soy plants in Brazil infested with *Meloidogyne spp.* Left - untreated soybean plants 42 days after emergence (DAE), (right) soybean plants from seed treated with Lumialza at 10 ml/ha. Seed treatment with Lumialza in the presence of *Meloidogyne spp.* results in plants with larger and taller plants above ground.



Formulation

Lumialza™ is a biological seed treatment nematicide product that contains a minimum of 6.1×10^{10} spores of active ingredient, *Bacillus amyloliquefaciens*, bacteria per ml. This is equivalent to more than 60 billion colony-forming units (CFUs) per milliliter. This highly concentrated formulation translates to a low use rate.

Registrations

Corteva Agriscience is seeking registration for Lumialza in several different geographies around the globe for seed treatment of corn, soybean, and other crops as needs are identified.



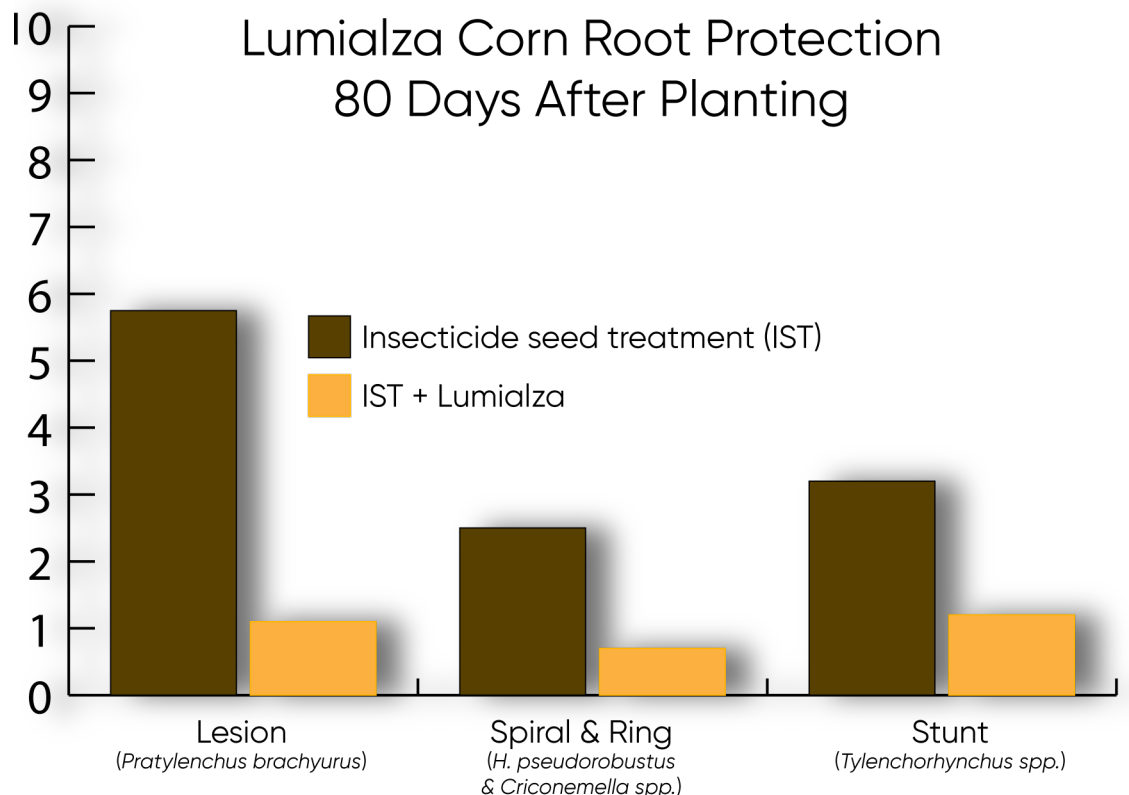


Resistance Management

As of 2021, there are no validated examples of nematode resistance as the primary source of commercial synthetic nematicide failure in field use applications. Challenges seen with traditional nematicides are often due to the low frequency and area of application, the broad plant host range for plant parasitic nematodes, and rapid degradation and elimination from the local soil environment. The active ingredient in Lumialza™ avoids challenges seen with some synthetic nematicides by creating an active growing biological barrier that protects roots for more than 80 days on large acre row crops such as corn, cotton, and soybean.

Lumialza Grows with Roots

The *B. amyloliquefaciens* found in Lumialza grows with roots to provide protection deep into the soil profile. This not only provides an extended zone of protection, but also allows prolonged growth benefits extending late into the soybean and corn growing cycle (>80 days).



* Data provided by Valent BioSciences®

Environmental Safety

- Lumialza™ is a biological nematicide seed treatment that contains *Bacillus amyloliquefaciens* PTA-4838
- *Bacillus amyloliquefaciens* PTA-4838 is a naturally occurring organism that has not been genetically modified in any way
- Lumialza has a favorable environmental profile with limited to no activity on non-target organisms
- Product registrations and use guidelines will differ by country

Stewardship

Seed treated with Lumialza™ nematicide seed treatment must be labeled according to Federal Seed Act (FSA) treated seed labeling requirements. All Lumialza seed treatment application must be done so in accordance with with product label guidelines. This includes the use of proper handling and transport procedures, planting practices, storage, and disposal procedures.



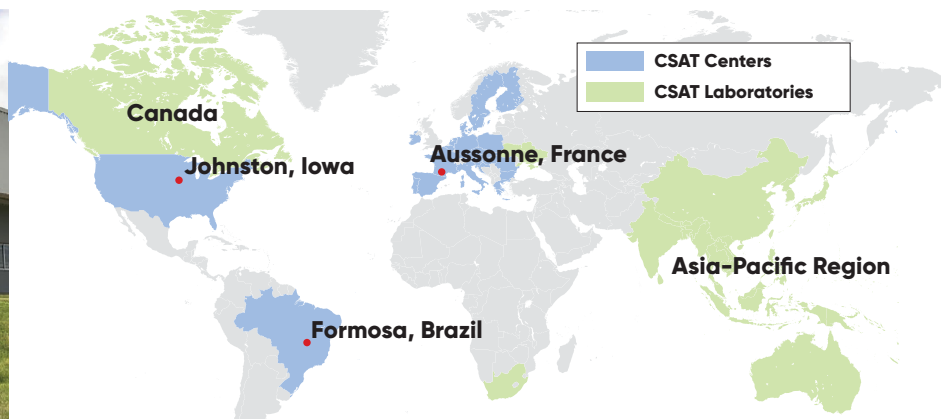
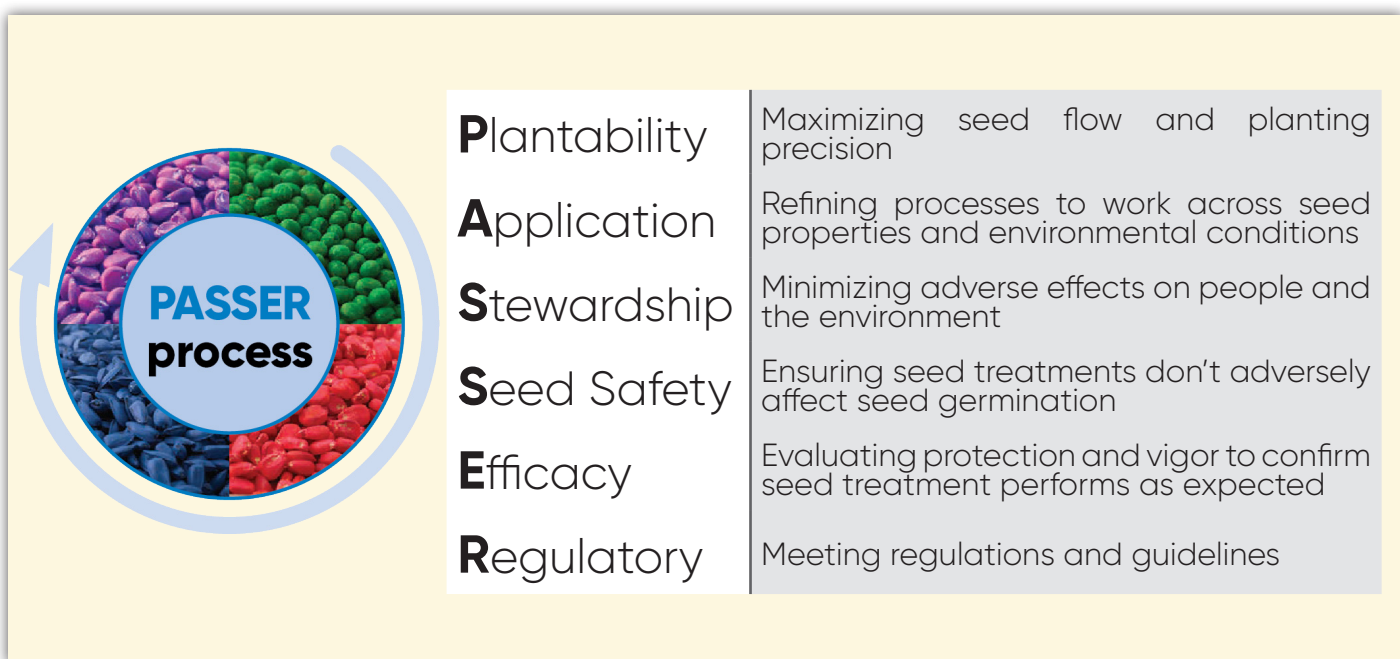


Application Information

- Lumialza™ is supplied as a concentrated solution of *B. amyloliquefaciens* spores at 6.1×10^{10} spores per milliliter.
- Recommended use rates are low compared to similar products. Volume applied will vary slightly by crop. See product label for crop-specific use rate information.
- Lumialza has an extended shelf life and can be stored at ambient temperatures for at least 2 years without loss of viability.

Seed Applied Technology Expertise

- Centers for Seed Applied Technology (CSATs) are worldwide resources for seed treatment expertise
- Expertise in recipe development, application, laboratory testing, and scale-up
- Exclusive PASSER evaluation process delivers customer confidence



Disclaimers

The Lumialza™ Technical Bulletin is provided for reference purposes only and is not a substitute for or an addition to a product label or Material Safety Data Sheet (MSDS). Always read and follow label directions for the country of use for registered pesticides. The information and any recommendations in this bulletin ("information") are presented in good faith; however, Corteva Agriscience makes no representations as to the completeness or accuracy of the information. The information is supplied upon the conditions that the persons receiving it will make their own determinations as to its suitability for their purposes prior to use and consult with their advisors to ensure compliance with all federal, state, and local regulations. In no event will Corteva Agriscience be responsible for damages of any nature whatsoever resulting from the use of or reliance upon the information.

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