

WHAT ARE PLANT PARASITIC NEMATODES?

Plant parasitic nematodes are microscopic roundworms that travel through the soil profile and need a plant host for survival. Nematodes can only travel a short distance per year under their own power; water, tillage, wind, farm workers and animals are most responsible for the spread of nematodes.

WHY SHOULD GROWERS BE CONCERNED ABOUT PLANT PARASITIC NEMATODES?

Nematodes are versatile parasites that move freely between root and soil habitats impacting yields in crops including corn, soybeans, and cotton. UC Davis has estimated that, on average, there is over a 10 percent^[1] yield reduction in each of these crops due to plant parasitic nematodes.

Monsanto has conducted hundreds of trials in the U.S. over four years across corn, soybeans, and cotton that document significantly more yield loss than is currently assumed by many growers. Without effective management of “hidden yield loss,” undetected nematode numbers can increase year to year, reducing yield potential of the current crop as well as other crops in the rotation.

HOW DO NEMATODES DAMAGE THE PLANT?

Nematodes can damage the plant in several different ways depending upon the species. Some species of nematodes will feed on the exterior of the root and are able to move from plant to plant. Other species of nematodes enter the plant through the root and feed on the interior of the plant root. In both cases, they can cause structural damage to the roots, limiting water and nutrient uptake. This root damage can also provide an entry point for pathogens that cause secondary infections.

HOW DO GROWERS KNOW IF THEIR FIELDS HAVE NEMATODE PRESSURE?

Generally, visual signs may include wilting, stunting and yellowing of plants. However, above-ground symptoms of nematodes are often confused with other common sources of injury. For example, in high-pH soils, the yellowing of soybeans due to soybean cyst nematodes is often confused with iron deficiency chlorosis. This confusion can result in nematode injury that goes undetected for several years.

When fields are under high pressure, a grower may observe “hot spots,” or large round patterns of plants showing the above symptoms.

In many instances, there are no visible symptoms above or below ground. However, yield can still be impacted.

WHAT TYPE OF IMPACT CAN NEMATODES HAVE ON YIELD?

The impact of nematodes on yield varies based on populations and environmental conditions, among other things. It is not uncommon for yields to be reduced by 30 percent or more in high-pressure situations.^[2] Often when extreme yield loss is observed it is due not only to nematode damage but also to increased yield loss from environmental factors (drought, nutrient deficiency, disease) that were exacerbated by the nematode damage.

This, along with variables such as the cost and effectiveness of management practices, makes it difficult to set clear economic thresholds based on nematode population alone.

WHAT CAN A GROWER DO TO MANAGE THE IMPACT OF NEMATODES ON THEIR CROP?

There are several historical management practices that growers have used in an attempt to mitigate nematode damage. Some of these practices include:

- Resistant soybean products (SCN)
- Resistant cotton products (RKN)
- Crop rotation
- Use of seed applied products labeled to address nematodes at varying levels of protection based on crop, nematode species and length of control

WHAT IS NEMASTRIKE™ TECHNOLOGY?

NemaStrike™ Technology is a novel mode of action nematicide developed to control plant parasitic nematodes that affect crops including corn, soybeans and cotton. It is characterized by low water solubility and low mobility in the soil, providing up to 75 days of control.

HOW DOES NEMASTRIKE™ TECHNOLOGY WORK?

Products containing NemaStrike™ Technology will be applied directly to the seed as a protective coating before it is planted, rather than sprayed over the crop. The active ingredient, branded as NemaStrike™ Technology, prevents the synthesis (translation) of proteins in the mitochondria, which leads to disruption of the life cycle of the nematode. Preliminary studies in model nematodes indicate that NemaStrike™ Technology interacts with a region of the protein synthesis apparatus that is specific only to nematodes, which is why NemaStrike™ Technology is highly selective for nematodes.

HOW MUCH FIELD TESTING HAS BEEN CONDUCTED USING NEMASTRIKE™ TECHNOLOGY, AND WHAT WERE THE RESULTS?

Over 340 product development field trials were conducted across corn, soybeans and cotton in the U.S. from 2014-2017.

IN CORN, NemaStrike™ Technology provided an average yield protection advantage of 6 Bu/A over Acceleron® Seed Applied Solutions base offering.

IN SOYBEANS, NemaStrike™ Technology provided an average yield protection advantage of 2.2 Bu/A over Acceleron® Seed Applied Solutions base offering.

IN COTTON, NemaStrike™ Technology provided an average yield protection advantage of 80 lb/lint over Acceleron® Seed Applied Solutions base offering with an 86 percent win rate.

Results will vary based on nematode pressure in each field.

WHAT NEMATODE SPECIES DOES NEMASTRIKE™ TECHNOLOGY CONTROL?

NemaStrike™ Technology provides broad spectrum control of plant parasitic nematodes that include, but are not limited to, soybean cyst, root knot, and reniform nematodes in soybeans; lesion, lance, needle, sting and stubby root nematodes in corn; and lance, reniform and root knot nematodes in cotton.

HOW LONG IS NEMASTRIKE™ TECHNOLOGY ACTIVE IN THE FIELD DURING A GROWING SEASON?

NemaStrike™ Technology controls nematodes for up to 75 days after planting.

IS THERE ANY SPECIAL EQUIPMENT NEEDED TO APPLY NEMASTRIKE™ TECHNOLOGY?

Acceleron® NemaStrike™ ST is for use only in commercial seed treatment facilities using fully automated closed transfer and application equipment. Closed transfer application sites that mix products in a mix tank prior to application will need to ensure their transfer lines are plumbed directly to the mix tank.

WHAT ARE THE PPE REQUIREMENTS FOR APPLICATION OF ACCELERON® NEMASTRIKE™ ST?

All mixers, loaders, applicators and other handlers must wear long-sleeved shirts, long pants and shoes plus socks. Workers performing cleaning, maintenance and repair of equipment must wear: coveralls over long-sleeved shirts, long pants, shoes plus socks and chemical-resistant gloves. Refer to the label for specific instructions.

IS THERE A RISK OF NEMATODE POPULATIONS BECOMING RESISTANT TO NEMASTRIKE™ TECHNOLOGY?

Products containing NemaStrike™ Technology are applied as seed treatments and stay localized in and around the root zone; this technology does not wash out of this zone due to low water solubility. This creates essentially a large refuge area in between the rows where nematodes are not exposed to the chemistry, thus lessening the chance for resistance development.

WHAT EFFECTS DOES NEMASTRIKE™ TECHNOLOGY HAVE ON BENEFICIAL NEMATODE POPULATIONS?

NemaStrike™ Technology targets plant parasitic nematodes that feed on the plant roots. Since there is negligible feeding by beneficial nematode species on the plant, we do not expect a material impact on beneficial populations.

WILL NEMATODE POPULATIONS WITHIN A FIELD WHOSE CROP IS TREATED WITH PRODUCTS CONTAINING NEMASTRIKE™ TECHNOLOGY DECREASE OVER TIME?

No. The relative reproductive rate (fecundity) for nematodes is high, with many species having several generations in a growing season. In addition to the reproductive capacity of a population, tillage and a lack of selection pressure also ensure nematodes remain dispersed in the soil profile.

CAN NEMATODE DAMAGE INCREASE THE LIKELIHOOD FOR SUDDEN DEATH SYNDROME IN SOYBEANS?

Openings in root tissues caused by soybean cyst nematode (SCN) feeding expose roots to entry points for many other soil-borne pathogens. Interactions of SCN with other soybean pathogens can amplify the negative effects of both. Sudden death syndrome (SDS) is one example of this interaction. When dealing with interactions of SCN with other pathogens, it is recommended to address the SCN problem first because it will always be present, whereas other diseases may not develop every year. NemaStrike™ Technology controls nematodes, including SCN.

Performance may vary from location to location and from year to year, as local growing, soil and weather conditions may vary. Growers should evaluate data from multiple locations and years whenever possible and should consider the impacts of these conditions on the grower's fields. **Always read and follow pesticide label directions.** The distribution, sale, or use of an unregistered pesticide is a violation of federal and/or state law and is strictly prohibited. Not all products are approved in all states. Please visit <http://acceleronsas.com/stateapprovals> regarding the approval status of products containing NemaStrike™ Technology for application to seeds in your state. Acceleron® and NemaStrike™ are trademarks of Monsanto Technology LLC. ©2018 Monsanto Company All Rights Reserved

*4-Year Average Yield Protection Advantage over control, across all locations and thresholds, N=341 Trials (2014, 2015, 2016, 2017) (AR, GA, IA, IL, IN, KS, KY, LA, MD, MI, MN, MO, MS, NC, ND, NE, OH, SC, SD, TN, TX, VA, WI). Results will vary based on nematode pressure in each field.

1. Nationwide estimated loss. Ferris, Howard. "Nematodes and Plant Damage." University of California, 1 Oct. 2015. Web.

2. Wrather, Allen, and Melissa Mitchum. "Soybean Cyst Nematode: Diagnosis and Management." University of Missouri Extension, Aug. 2010. Web. 7V4S187211