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root health | alert

JULY 2011

researcher spotlight

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Years ago I started classifying pathogens into two main groups, killers and nibblers. The killers can kill the plant before or shortly after it emerges, thereby affecting harvest population. The nibblers, both fungi and nematodes, reduce the number of small fibrous roots that affect water and nutrient uptake. There may not be any visible symptoms from the nibblers, except a reduction in yield. These are the "hidden" diseases.

When available, genetic resistance is the main choice for disease control. However, for many soilborne diseases there aren't any sources of resistance. A second control strategy is crop rotation, but many pathogens have wide host ranges and affect wheat, corn, soybean and many other crops. One of the most exciting areas for control of soilborne diseases is the new systemic seed treatments. While they do not provide season-long control, they allow the plant to establish a healthy root system.

As the prices of commodities have increased, growers are trying to increase yields. We know the genetic potential of wheat varieties is never achieved, so researchers are trying to determine what is limiting yield. Our research over the past several years has demonstrated that improved root health and less damage by the root nibblers are major factors in limiting crop yields.

Experts focus on understanding roots at Global Root Health Forum

Future yield increases will come from improving root health, but this is an area with great opportunity for research. Dr. David Wright, North Central Soybean Research Program, shared this thought in his keynote address to fellow researchers at the Syngenta Global Root Health Forum. He added that problems with pathogens will increase as farming practices are intensified.

To emphasize the importance of root health and start a conversation on the topic, Syngenta hosted the first Global Root Health Forum in Palm Beach, Fla., in February 2011. Nearly 100 researchers from 15 countries shared their expertise from different regions, climates, crops, diseases and pathogens in a three-day information exchange.

"The goal for bringing together such a wealth of knowledge and experience was to make great strides forward in understanding roots and the rhizosphere in general," said Christian Schlatter, Syngenta global business manager and event host. "We want to keep exchanging information to define and discuss what we are learning about root health, and the Forum was an excellent kick-off."

As one presenter said, maximizing seed yield starts and ends with a healthy root system. To this end, Forum discussions focused on threats to root health; interactions between pathogens like *Rhizoctonia*, *Fusarium* and *Pythium*, crops and the environment; known yield losses to key pests; and understanding plant physiology.

Control of *Rhizoctonia solani* on wheat with seed treatment fungicides (left to right):

1) Untreated, uninoculated
2) Untreated, inoculated
3) Dividend Extreme 22.5 g ai/100 kg
4) Dividend Extreme 22.5 g ai/100 kg + sedaxane 2.5 g ai/100 kg
5) Proceed™ 8 g ai/100 kg

Participants agreed the event was valuable. "The Global Root Health Forum was a really good opportunity to meet people from around the world," said Dr. Tim Paulitz, research plant pathologist with the USDA-Agricultural Research Service. "I learned about parallel work being conducted in Canada and about work being done in Europe. It was also valuable to meet researchers from Australia because they are working in a very similar system to where I work in the Pacific Northwest."

Schlatter added that Syngenta is committed to maintaining the information exchange that started here. "Overall in root health, we are at the beginning of our knowledge, and there is relatively low awareness of the issue among growers," he said. "At Syngenta, we will do our part to grow awareness, support research and develop solutions to protect roots and maximize yields."

Syngenta Crop Protection, Inc.
P.O. Box 18300
Greensboro, NC 27419

Healthy root systems provide increased yield, profit potential

Although it's difficult to execute, several researchers are undertaking the laborious task of exploring how root health ultimately impacts yield potential. Consistently wet weather in recent years, coupled with the upsurge in adoption of reduced tillage programs, has increased the presence of certain yield-robbing, soilborne pathogens, such as *Rhizoctonia*, *Pythium* and *Fusarium*, in critical U.S. wheat-producing regions.

"These root diseases can be referred to as 'root nibblers,' or hidden diseases and can have a huge impact on yield potential," explains Dr. Wayne Pedersen, emeritus plant pathologist, University of Illinois. "Incidence of these soilborne pathogens has increased steadily with evolving production practices, such as no-till, and the cool, wet weather we've experienced the past several spring seasons."

While growers tend to fix their attention to production challenges that pose a significant yield threat, researchers are becoming more attuned to the long-term threat from *Rhizoctonia*, *Pythium* and *Fusarium*, which can "pick away" at yield and profit potential little by little with each passing season. *(Continued on page 2)*

disease profile

Rhizoctonia: Active antagonist of the underground

Above ground, bare patches are scattered through the field. Underground, roots have brown lesions or are shortened with darkened tips. Capable of causing 20 to 40 percent yield loss, this antagonist is called *Rhizoctonia* and is a common soil disease in cereal fields around the world, throughout the United States and particularly in the Pacific Northwest (PNW).

Favorable soil conditions, ideal temperatures and increased use of reduced tillage practices make the PNW a hotspot for soilborne diseases like *Rhizoctonia*. Due to soil erosion and the need for improved soil structure and organic matter, direct seed and no-till practices are common. Unfortunately, no-till often creates a soil environment where *Rhizoctonia* thrives.

According to Dr. Tim Paulitz, research plant pathologist with the USDA-Agricultural Research Service, the fungal pathogen thrives in cool, moist conditions, between 50 and 60 degrees Fahrenheit. Symptoms include brown lesions along roots and shortened roots with darkened tips. It is often recognized by distinct bare patches in fields where wheat or barely was stunted or killed off. To complicate diagnosis, *Rhizoctonia* is commonly mistaken for other soilborne diseases with similar symptoms. Dr. Paulitz recommends sending a sample to a university or research clinic for an accurate diagnosis.

"*Rhizoctonia* infects the entire root system," Dr. Paulitz explains. "The pathogen hides out in dead roots. It forms a thick-walled mycelium, so it sits in the soil, surviving and waiting. When the pathogen senses the root growing, and the soil's moisture level and temperature have become favorable, the mycelium or hyphae will contact the root, stimulate it to grow, and then penetrate. Once the pathogen infiltrates, it kills the root tissue, the root tips, the root cortex – the pathogen invades the entire root system."

The above photo provides an example of *Rhizoctonia* bare patch, where the wheat is extremely stunted and will not yield.
PHOTO BY DR. TIM PAULITZ

In addition to damaging roots, Rhizoctonia attacks young seedlings, impairing their ability to absorb water and nutrients, which reduces emergence and stunts growth.

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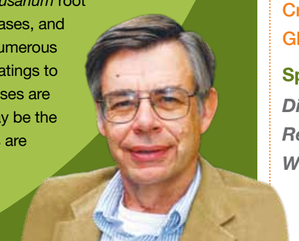
researcher spotlight

By **WAYNE PEDERSEN**
Emeritus Plant Pathologist
University of Illinois

What root health means to me

"Root health" is a term that plant pathologists have used for many years to describe a plant root that has very little disease. Most of the time these studies have focused on specific diseases, such as *Pythium* or *Fusarium* root rot. But, in the field there is always a combination of diseases, and they are affected by the environment. There have been numerous rating systems, but it has been difficult to correlate root ratings to yield. Environment makes a major impact on which diseases are limiting yield. For example, in cool, wet soils, *Pythium* may be the major problem, while in dry, sandy soils, other pathogens are most important. *(Continued on page 4)*



In this issue

Creating strong roots: An intricate balance act

Countless variables factor into our overall health and well-being – balancing the right amounts of vitamins, nutrition, exercise and sleep determines how healthy we are. We can adjust one or more of these, if needed, to ensure our health is at an optimum level, which aids in our ability to fend off sicknesses.

Similarly, wheat growers have the responsibility of ensuring their crops produce a healthy root system that's able to defend against soilborne, yield-robbing diseases. Fertilizers and nutrient management play a vital role in root health, but sometimes we forget the outside factors, such as crop rotation and tillage, that both factor into the health of developing root systems.

A diverse crop rotation can play a key role in reducing root-damaging disease competition by eliminating the "green bridge" effect, in which diseases carry over from season to season due to lack of crop rotation. But, while certain diseases thrive in conditions provided by a continuous cropping system, such as wheat on wheat, others will thrive in any field, regardless of the crop grown, so crop rotation isn't always a workable solution.

"Take-all can be controlled in wheat by rotating with broadleaf crops such as canola or pea, which are resistant to take-all, but *Rhizoctonia solani* AG-8 (cause of *Rhizoctonia* root rot and bare patch) has a broad host range, and crop rotation does not reduce disease levels," explains Dr. Tim Paulitz, research plant pathologist with the USDA-ARS.

In addition, crop rotation isn't always an economically feasible disease management solution, depending on geography. "In other areas of the country, crop rotation is recommended to help minimize disease pressure. However, because of the economic and climatic constraints on cereal growers, crop rotation isn't generally practiced in low-rainfall regions of the Pacific Northwest (PNW)," says Dr. Richard Smiley, professor of plant pathology at Oregon State University.

Because certain diseases have the ability to exist in fields regardless of whether a grower has a continuous wheat rotation or is rotating with other crops, growers need to consider other management options such as seed treatment fungicides.

"Seed treatments are essential components of many growers' operations in the PNW, in part because of the challenges growers encounter with crop rotation options and tillage practices," Smiley explains.

While there are many economic and environmental benefits of direct seeding or no-till in cereal production, the increase in adoption of reduced and zero tillage farming methods has resulted in an increase of potential soilborne and root diseases, as well as insect pressure. Some of the potential pest pressures that coincide with implementing a reduced or zero tillage program and can impact root health include soilborne disease pathogens, such as *Rhizoctonia*, *Pythium* and *Fusarium*.

"I believe no-till is the future of sustainability in cropping systems here in the PNW," Paulitz explains. "However, less than 20 percent of growers in the PNW practice no-till or direct seeding, in part due to the increased potential for some soilborne pathogens, namely *Rhizoctonia* and *Pythium*, which damage root systems and decrease yield potential."

For winter wheat growers in particular, a strong root system is critical to surviving winter dormancy. "A healthy root system is particularly important in no-till operations," Smiley explains. "No-till winter wheat is planted later in the fall than wheat planted in cultivated fields. This means there is less time for the crop to emerge and develop a healthy stand before winter dormancy. It also means cooler temperatures, which are conducive to *Pythium* development."

No-till is a generally more economical and efficient method of farming. But, because reduced tillage systems increase the potential for root-damaging disease pathogens, no-tillers need to ensure seedlings are protected from the beginning with quality seed treatments.

"I've been in this area for about a decade now, and my trials – even those in fields completely infested with *Rhizoctonia* – clearly show that seed treatment fungicides will help protect young seedlings against this and other soilborne diseases," Paulitz says.

By protecting against yield-robbing diseases, seed treatment fungicides enable healthier, stronger root systems to develop, which ultimately means increased yield and profit potential for the grower.

Wheat growers have come to rely on Dividend Extreme® seed treatment fungicide to protect their crop from more than 16 seedborne and soilborne diseases. "Dividend Extreme delivers proven disease protection, which leads to better seedling germination, stronger stands and more heads, because it forms a protective barrier around the roots," explains Kiran Shetty, technical crop manager for Syngenta. "As a result, roots are healthier and able to power the crop to maximize yield. Later this year, Syngenta is set to introduce a new seed treatment fungicide that will deliver a heightened level of disease protection and root health."

Helping crops develop strong root systems is an intricate, often overlooked, component of crop production. Along with proper fertilizer and nutrient management, it's essential to also consider how crop rotation and tillage decisions are affecting the health of developing wheat root systems. Growers who integrate agronomic practices with carefully chosen wheat genetics, seed treatments and crop protection products are better able to harvest the best return on investment.

The photo to the right demonstrates the impact of *Rhizoctonia* on developing wheat plants. All three plants were inoculated with *Rhizoctonia*. A seed treatment fungicide was applied to the center plant before seeding to protect the root system from diseases. The plants to the left and right were untreated and show infection on the stem, less tillers and poor root development. PHOTO BY: DR. KIRAN SHETTY

Healthy root systems

(Continued from page 1)

It's important to ensure cereal crops are protected against these yield-robbing root diseases. "Seed treatment fungicides, like Apron XL®, do a great job of creating a barrier against root diseases like *Pythium*. Dividend Extreme seed treatment fungicide is number one in small grains and provides excellent protection against *Rhizoctonia* and *Fusarium*, as well as other root rots," Pedersen explains.

"An added benefit is that you can apply Cruiser® seed treatment insecticide at the same time, which protects against damaging root feeders, like wireworms, and also helps stimulate plant growth and increase crop vigor, even under stressful conditions. That combination really helps to improve the health of the roots and plants, which ultimately leads to increased yield potential," Pedersen adds.

Keeping developing seedlings free of diseases and insects enables healthier root systems to develop because the root tips more efficiently take up water and nutrients. "Roots are water-absorbers, so increasing root mass, area and number of root tips subsequently increases moisture uptake, which thereby increases the health of the plant," Pedersen explains.

Dr. Pedersen has been using root scanners to assess root health in corn for several years. With root scanners, he can actually quantify the number of root tips produced by each plant and asses the overall health of the root systems. He plans to conduct some of the same research in small grains in the near future.

"Healthier, more robust root systems absolutely help plants better utilize available nutrients and moisture," Pedersen adds. "This helps produce stronger plants that are able to withstand stress brought on by adverse weather conditions, disease and insects. 2010 is a great case in point. We had great early-season moisture and growth, which produced strong, healthy root systems and plant stands. But then Illinois went completely dry and remained that way for a good majority of the summer. The stronger root systems helped carry the plants through the dry spell without compromising yield."

Syngenta researchers are also delving further into research that correlates healthier root systems to increased yield potential. A new experimental fungicide is set to be registered later this year and will offer a new, unmatched level of disease protection through its new mode of action. This results in stronger, more powerful roots that help produce more even emergence, improve nutrient and moisture uptake, and develop stronger plants, which ultimately leads to increased yield and profit potential for growers.

disease profile

Rhizoctonia: Active antagonist of the underground

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Anastomosis Groups (AG-groups) Explained

To better understand this commonly mistaken disease, Syngenta and Dr. Paulitz are collaborating to map the occurrence of *Rhizoctonia* across the United States and identify the different anastomosis groups (AG-groups) present in soils.

AG-groups are classifications that categorize various strains of *Rhizoctonia*. These groups help scientists understand interactions between strains and their potential impact on the crop. How two strains of *Rhizoctonia* interact indicates their compatibility, or ability to exchange genetic information and reproduce.

"Different groups cause different diseases and have different host ranges; they're almost like distinct species," Dr. Paulitz says. "We know that *Rhizoctonia solani* AG-8 is the primary cause of root rot, bare patches and yield loss in direct-seeded wheat. It would be compatible with other AG-8 groups but may not be compatible with an AG2-1 group."

Management Recommendations

It is critical to monitor and observe fields for symptoms of *Rhizoctonia* to manage it the following growing season. Dr. Paulitz stresses understanding the history of the field, maintaining awareness of the disease and implementing both cultural and chemical management tactics.

"Apply some starter fertilizer in the furrow at the time of planting to help the seedling pick up nutrients, even if some of the roots are nibbled away by *Rhizoctonia*," he says. "Seed treatments are important in preventing *Rhizoctonia* and other soilborne pathogens in wheat. It's a relatively small cost compared to other inputs."

While there are no *Rhizoctonia*-resistant cereals varieties available, Dr. Paulitz says planting a fresh, clean, certified seed variety may be better than planting an older variety. The older the seed, the more susceptible it may be to soilborne diseases.

And, while direct-seed and no-till systems may activate the pathogen in the short-term, it may not be an issue forever. "There appears to be a natural suppression of *Rhizoctonia* after a number of years of direct-seeding. We've documented that it appears early in the conversion from conventional to direct-seeding, but then the disease declines," he explains.

Syngenta is also conducting studies to develop effective ways to protect cereal crops from such pathogens. Currently, Syngenta is researching and testing fungicide seed treatment chemistries to help growers better manage soilborne fungal pathogens like *Rhizoctonia*.

"We're excited to partner with Dr. Paulitz on his *Rhizoctonia* mapping project. The results of this important research will help build awareness around this relatively unaddressed challenge in cereals," says Kiran Shetty, Seedcare technical crop manager, Syngenta.

"Syngenta is committed to remaining at the forefront of seed treatment chemistry research by providing the most valuable pest management solutions for growers," Shetty says. "In wheat, barley and other crops, we're currently testing a new seed treatment fungicide to enhance protection already provided by products such as Dividend Extreme seed treatment fungicide, particularly protection against *Rhizoctonia* and true loose smut."

Armed with a deeper understanding of the impact unseen diseases like *Rhizoctonia* can have on a crop, growers can more effectively protect seeds and young seedlings. A stronger defense at the beginning will help generate healthier roots, more vigorous crops and, ultimately, better yield stability in the field.

***Rhizoctonia* damages roots and impairs young seedlings' ability to absorb water and nutrients.**

weather watch

Cold, wet weather

↓

Stunted root systems

↓

Disease

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Limited yield potential

Beyond just keeping growers out of their fields, cold, wet seasons, such as spring 2011, have great potential to limit crop growth and yield. Years of research confirm that weather is the number one factor influencing crop growth, which starts with the roots. At the same time, environmental conditions affect the development of yield-robbing diseases that attack crops.

Limited resources

Cold, wet conditions impose yield limits due to limited resources for growth, as university research explains.

- Cool temperatures translate into fewer Growing Degree Days (GDDs), the accumulation of heat energy that drives plant growth. With less energy to grow, especially early in the season, root growth is stunted, reducing total yield potential.
- Wet or waterlogged soils make critical nutrients, such as nitrogen and phosphorus, less available to roots for uptake into the plant, according to Montana State University research. These and other nutrients are more likely to leach in wet soils, as well.
- Wet soils are more susceptible to compaction, which limits root growth. If wet soils dry out very quickly, they also can harden or crust over, making it difficult for roots to penetrate deeper or for seedlings to emerge.

All these factors are critical to allow cereal crops to produce quality grain. Limits at any point in the growing season can have a permanent yield impact. For example, once the crop heads out, most energy goes into kernel development. The root system to support that development has already been established, and if it was restricted earlier in the season, the ability to gather resources for kernel growth will be limited.

Disease pressure

Cold, wet soils harbor yield-robbing diseases that attack seeds and roots. High-moisture environments favor disease development, and cool temperatures limit growth so plants are more vulnerable to infection. For example, university experts site *Rhizoctonia solani*, decay, wheat mosaic virus (carried by fungal organisms) and *Pythium* as diseases that are more common in these conditions.

Weather does much more than dictate field work timing. It causes physiological responses in the crop that impact yield. And so, experts recommend waiting for warmer temperatures and using seed treatment fungicides in cold, wet environments.

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