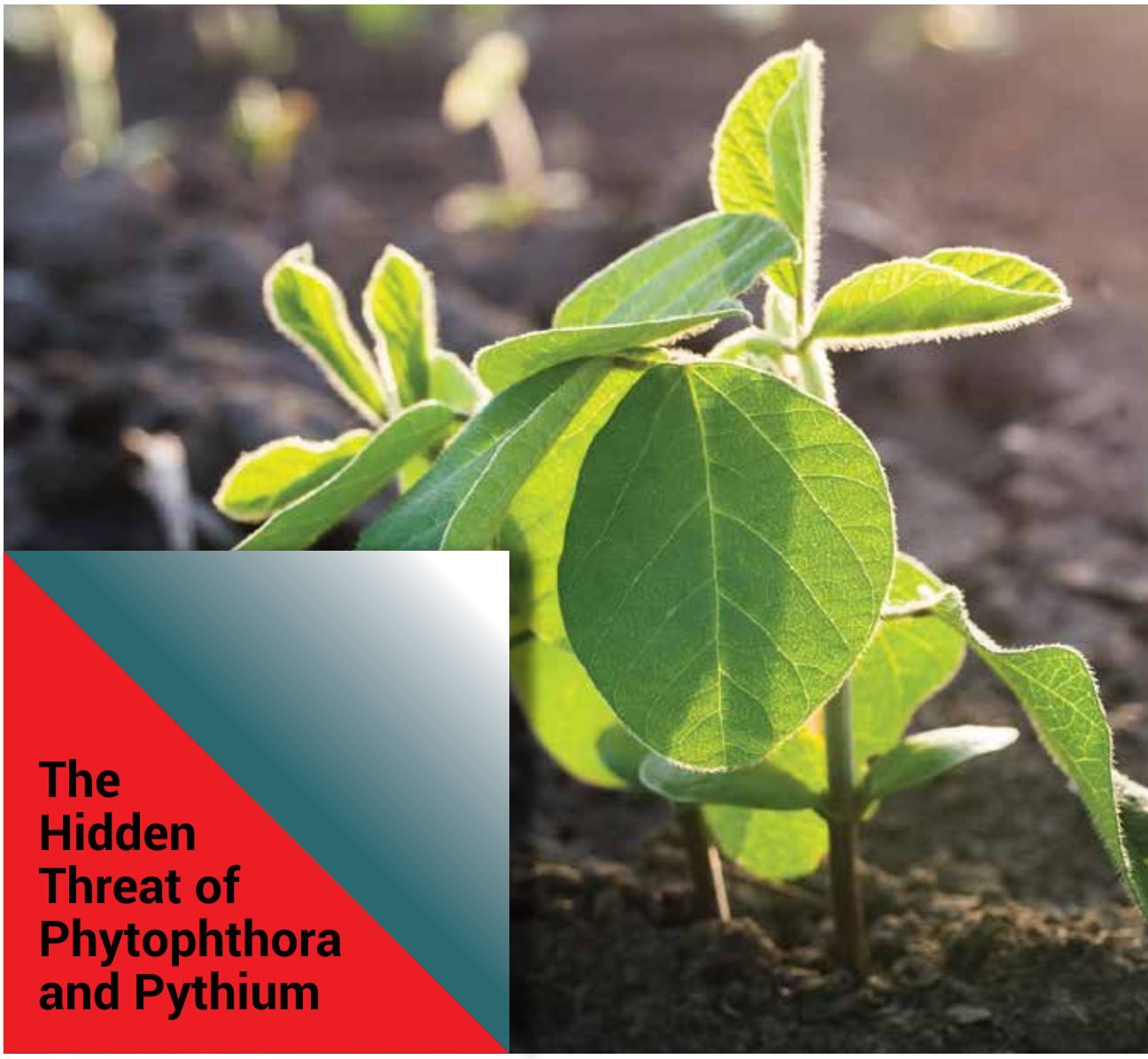


# The Hidden Threat of Phytophthora and Pythium

# Introduction

*Phytophthora* first gained notoriety in mid-nineteenth century Europe when the destructive plant pathogen caused the Irish potato famine and hardships for millions.[1] Today, *Phytophthora sojae* remains a top threat for growers to manage worldwide and is the No. 1 disease that impacts soybean yields. Over the last 11 years, *Phytophthora* has suppressed U.S. soybean yields resulting in an estimated loss of 500 million bushels.[2]

Over **500M soybean bushels suppressed** by *Phytophthora* over 11 years.[2]

*Pythium* and *Phytophthora* live in the soil, waiting for the right **moisture and temperature** to activate.

Species diversity of *Pythium* exists in **both warm and cool soils.**

*Pythium* and *Phytophthora* act fast to attack the soybean seed. *Pythium* can strike **within 90 minutes** of planting.

Similarly, crop disease caused by *Pythium* spp. has caused serious economic losses, with scientific literature documentation dating back to the early 1900s.[3]

*Pythium* and *Phytophthora* are classified as oomycetes, also known as "water molds," and are among the most devastating plant pathogens year in and year out.[4] The group is taxonomically distinct from other important plant pathogens like *Fusarium* and *Rhizoctonia*. Consequently, management of oomycetes generally requires different chemistries than what will protect against *Fusarium* and *Rhizoctonia*.

One of the biggest threats for growers is the rapid speed at which *Pythium* attacks the soybean seed. The disease pathogens live in the soil, waiting for the right moisture and temperature conditions to activate. *Pythium* can strike seedlings within 90 minutes of planting.[5]

In the planting-to-harvest cycle, seed protection is an important process in setting the seed up for health. The solid foundation provided by a healthy, protected seedling maximizes the yield potential.[6]

Recent research from Iowa State University explains that seedling diseases are primarily managed with fungicide seed treatments. Yet seedling disease remains a tricky issue for growers, especially when seed is planted in cold, wet soils with high clay content.[7]

The fast-changing economic environment has driven up the costs associated with resulting stand losses of *Pythium* and *Phytophthora*. The costs associated with forced replanting include lost yield potential, increased fuel, labor and seed

costs. Soybean seed prices per bushel have doubled in the past 15 years, thus every seed planted needs to be a productive plant.

Seed treatment use—especially insecticide and fungicide treatments—may help avoid replanting, according to new research from University of Wisconsin-Madison. The paper entitled "Think Twice Before Replanting Soybeans" explains that seed treatments are a best practice for increasing initial plant stands by an average of 20 percent.[8]

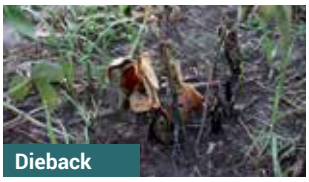
This document seeks to drive awareness of *Pythium* and *Phytophthora* by highlighting some of the key findings from recent university research in areas where the endemic pathogens are most prevalent and to help readers better understand the magnitude of the problem. The whitepaper will discuss the prime conditions in which *Pythium* and *Phytophthora* thrive, how the pathogens are growing in resistance to the traditional chemical treatments metalaxyl and mefenoxam, and will recommend strategies for growers in combatting further proliferation.

### *Hidden Endemic Pathogens*

Ways that *Phytophthora* and *Pythium* can destroy soybean yields.


Stand Stunt


Seed Rot


Dieback

# Weather implications and distribution

Like the weather, *Pythium* and *Phytophthora* are another unpredictable force for soybean growers to take into account with their crop management programs. Because *Pythium* and *Phytophthora* live in the soil almost indefinitely, these pathogens can withstand changes in soil moisture and temperature every year. For growers, this means if the weather is not conducive to disease in one year, the pathogens stand ready to strike the next year under different, optimal conditions.[9]

Midwest growers have reported that *Pythium* and *Phytophthora* are found in many of their fields, with damage most pronounced under cool and wet conditions. However, new research has confirmed that diversity of *Pythium* spp. also exists in warmer soils, and the problem is growing.

## *Pythium and Phytophthora At-A-Glance*

| ***Pythium* spp.** | ***Phytophthora sojae*** |
|---|---|
| Remains dormant in the soil across nearly all soybean geographies in the U.S. | Prevalent in wet, heavy clay soils with poor drainage |
| Active in soils 32° to 86° F | Symptoms often appear first in compacted areas of the field, such as entrances |
| Causes seedling and root rot, leading to preemergence and postemergence damping off | Periodic rainfall ideal for severe disease |
| Infected seedlings have water-soaked lesions on the hypocotyl or cotyledons that develop into brown, soft rot | Warm soil temperatures of up to 85° F are optimum for infection |
| May start attacking the soybean seed within 90 minutes after planting | Often mistaken for herbicide damage |

Soybean roots infected with *Phytophthora sansomeana* and *Pythium* spp. displaying root lesions.


*Photo credit: Anette Phibbs, DATCP*

There are now at least 30 identified *Pythium* spp. in Minnesota soils alone, far beyond what was previously thought by researchers. That dramatic increase in *Pythium* incidences is a detriment to Minnesota soybean growers, who now have to focus on more than one species to control. In his recent article "Once Forgotten, Pythium Back on the Radar," Jim Kurle with the University of Minnesota Department of Plant Pathology said that four of these *Pythium* spp. infect both soybeans and corn, making it challenging to manage with crop rotation.[10]

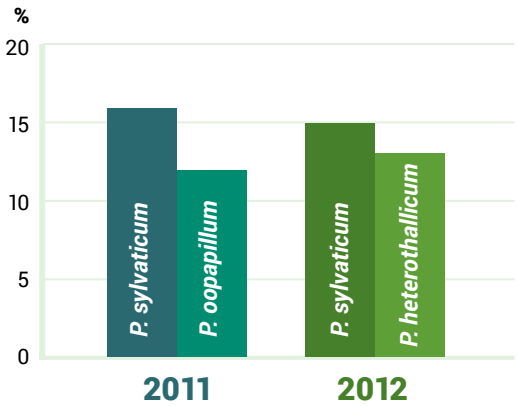
Kurle's study supports that *Pythium* thrives at different temperatures. The study analyzed *Pythium* at a range of temperatures and found that many species are actually pathogenic and more active in warmer temperatures. These findings provide some answers to growers and researchers who have seen root rot stand establishment occur under warmer conditions.

*Pythium* also flourishes at different temperatures and is not just a cold weather program in Iowa. Although *Pythium* is a perennial problem, there is little known regarding the pathogenicity of individual *Pythium* spp. in Iowa, so effectively managing corn and soybean seedling diseases can be difficult.[7] Community composition and temperature at planting play a major role in disease severity. The link between the two factors is just being clarified.[10]

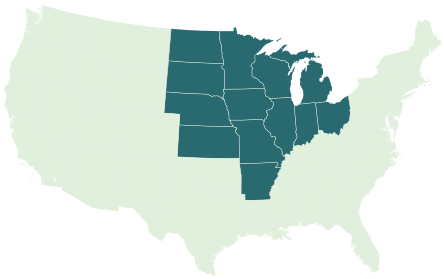
Conversely, a new species of *Phytophthora* is creeping up in the Midwest. *P. sansomeana* was detected for the first time in Wisconsin soybeans in 2012, resulting in root rot. The paper entitled "New *Phytophthora* spp. causing root rot in soybean in Wisconsin" explains that this species has been reported on corn in Ohio and soybeans in Indiana. The paper also stresses that growers "use soybean cultivators with good resistance to the known *P. sojae* races in the field" and that "fungicide seed treatments can also reduce the incidence of *Phytophthora* rot on soybean."[11]

## 2011–2012 USDA–NIFA Oomycete Survey

Top Pythium spp. (%)




**3600** samples processed
**82** different Pythium species
**7** different Phytophthora species



# Metalaxyl insensitivity on the rise

Fungicides have long transformed the way crops are grown as well as growers' expectations of performance. When first launched in the 1970s, products with the active ingredient metalaxyl changed expectations for control of oomycete diseases including *Pythium* and *Phythophthora*. Metalayxl rapidly grew in widespread popularity because of its impressive properties: high potency; both curative and protectant activity; exceptional redistribution and protection of new growth; control of all members of the order *Peronosporales* (including *Pythium*); and flexible application methods including seed treatment.[12] Due to its systemic activity against this important group of pathogens, metalaxyl is used worldwide on a variety of crops today, including soybeans. In 1996, mefenoxam was introduced to the marketplace. Mefenoxam is a chirally-pure form of metalaxyl and shares it physical properties, efficacy and known insensitivity issues.[13]

For U.S. corn, soybeans and wheat, every seed treatment package contains either metalaxyl or mefenoxam to combat *Pythium*. This practice means that a high percentage of production acres for corn, soybeans and wheat rely on the same chemistry for *Pythium* management. Resistance progressed in areas where metalaxyl was used alone, as a curative application, multiple times in a season, and in scenarios with high disease pressure.[13]

In Ohio, *Pythium* spp. unaffected by seed treatment products containing metalaxyl are being reported. In an effort to determine if *Pythium* was sensitive to metalaxyl, new research from Anne Dorrance at The Ohio State University found that the traditional way of treating seed with one mode of action (MOA) against a diverse range of *Pythium* spp. will not suffice. A total of nine varieties of *Pythium* spp. found that the same problem fields were highly insensitive to metalaxyl, indicating that tackling today's *Pythium* community calls for a wide combination of active ingredients.[14]

> "Seed treatment with only one active ingredient for *Pythium* spp. will not provide protection for the wide range of diversity that is now contributing to this disease complex."
>
> —Anne Dorrance, "Cold Spring Rains Brought Perfect Conditions for *Pythium* in Ohio and a Few More Surprises."

## *Pythium Resistance—Ohio*

Summary of *Pythium* spp. recovered from symptomatic soybean seedlings collected in Ohio during the spring of 2014.

| *Pythium spp.* | No. of Locations | Insensitive to Metalaxyl | Sensitive to Metalaxyl |
|---|---|---|---|
| *conidiophorum* | 1 | 1 | 0 |
| *dissotocum* | 3 | 3 | 0 |
| *heterothallicum* | 1 | 1 | 0 |
| *inflatum* | 1 | 1 | 0 |
| *perplexum* | 3 | 3 | 0 |
| *slyvaticum* | 3 | 3 | 1* |
| *torulosum* | 3 | 3 | 0 |
| *ultimum var ultimum* | 2 | 2 | 1 |
| *vexans* | 1 | 1 | 0 |

**Two isolates from one location, one grew at 100 ppm, the other no.*

| Oomycete | Metalaxyl | INTEGO™ SUITE |
|---|---|---|
| *Pythium sylvaticum* | ○ | ● |
| *Pythium irregulare* | ○ | ● |
| *Phytophthora sojae* | ○ | ● |
| *Pythium dissoticum* | ○ | ● |
| *Pythium torulosum* | ○ | ● |

○ partially controlled ● superior performance

*Valent interpretation of Dorrance AE, Ellis M, and Berry SA (2010 July). Trials with additional species ongoing.*

In her newsletter "Cold Spring Rains Brought Perfect Conditions for *Pythium* in Ohio and a Few More Surprises," Dorrance states:

***"Seed treatment with only one active ingredient for* Pythium *spp. will not provide protection for the wide range of diversity that is now contributing to this disease complex.*** For the 2015 season, for those fields with a history of replant and stand establishment issues should focus on treatment that has a wide combination of active ingredients."

# Opportunity with new chemistries

Research trials validate that combining an active ingredient like metalaxyl with the new MOA of ethaboxam offers better protection against the spectrum of *Pythium* spp. and *Phytopthora.*

The diversity of *Pythium* spp. means *Pythium* can cause stand loss and damping off under a variety of environmental conditions. According to trial data, adding ethaboxam to metalaxyl improved performance on several *Pythium* spp. including *sylvaticum, irregulare, P. dissotocum, P. torulosum* and *Phytopthora sojae.*[15]

The combination of ethaboxam and metalaxyl delivers superior seed protection because only it provides consistent protection against the broadest spectrum of *Phytopthora* and *Pythium* spp., including metalaxyl insensitive *Pythium* spp. under a wide range of environmental conditions. This is good news for soybean growers looking to optimize yields.

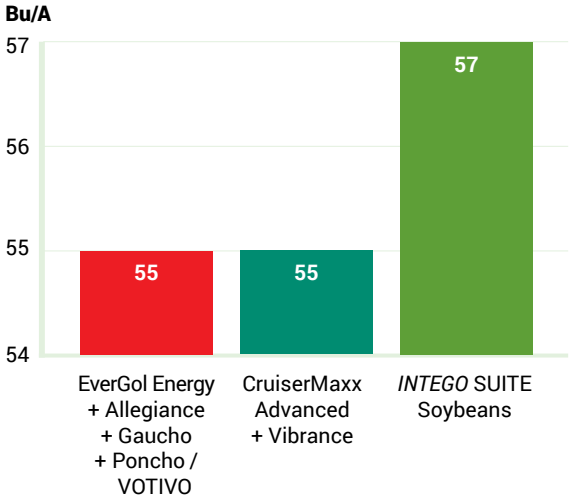
## *INTEGO™ SUITE Soybeans offers more complete protection than CruiserMaxx® Advanced and Acceleron®*

Plot location: Ohio, 2015
Extreme *Phytophthora* and *Pythium* Pressure

*INTEGO* SUITE Soybeans | CruiserMaxx Advanced | Acceleron

## INTEGO *SUITE Soybeans Increases Yield by 1.5 bu/A Over the Competition*

2013 Independent Professional Seed Association Soybean Treatment Yield Study



In a 2013-2014 Independent Professional Seed Association "Soybean Seed Treatment Yield Study," including trials at 22 Midwest and Mid-South sites with two varieties each, INTEGO™ SUITE Soybeans increased yield over the untreated check 75 percent of the time. A commonly used package with a single active ingredient for *Pythium* increased yield over the check 59 percent of the time.[16] *INTEGO* SUITE Soybeans is also the only seed treatment with ethaboxam, a new MOA against *Pythium* and *Phytophthora*.

# Conclusion

*Pythium* and *Phytophthora* are important pathogens to protect against to ensure establishment of a healthy stand early in the soybean season. Factors for the best yield potential—early planting, moisture and temperature—are also best for the pathogens.

With shifting cultural practices, new *Pythium* and *Phytophthora* spp. being found and insensitivity to current fungicides increasing, it is becoming apparent that additional tools are needed. Seed protection utilizing the best combination of products will protect against the broadest spectrum of *Pythium* spp. and *Phythophthora* and will maximize stand and yield potential.

To learn more about *Pythium* and *Phytophthora*, visit **fightsoybeandisease.com**.

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