Pythium Management to Maintain Stands and Vigor in Sweet Corn and Snap Beans

Delaware Ag Week: Processing Vegetable Session 2024

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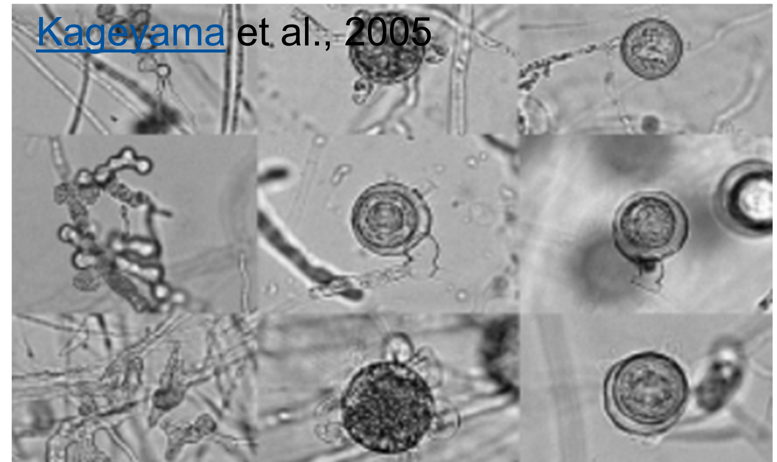
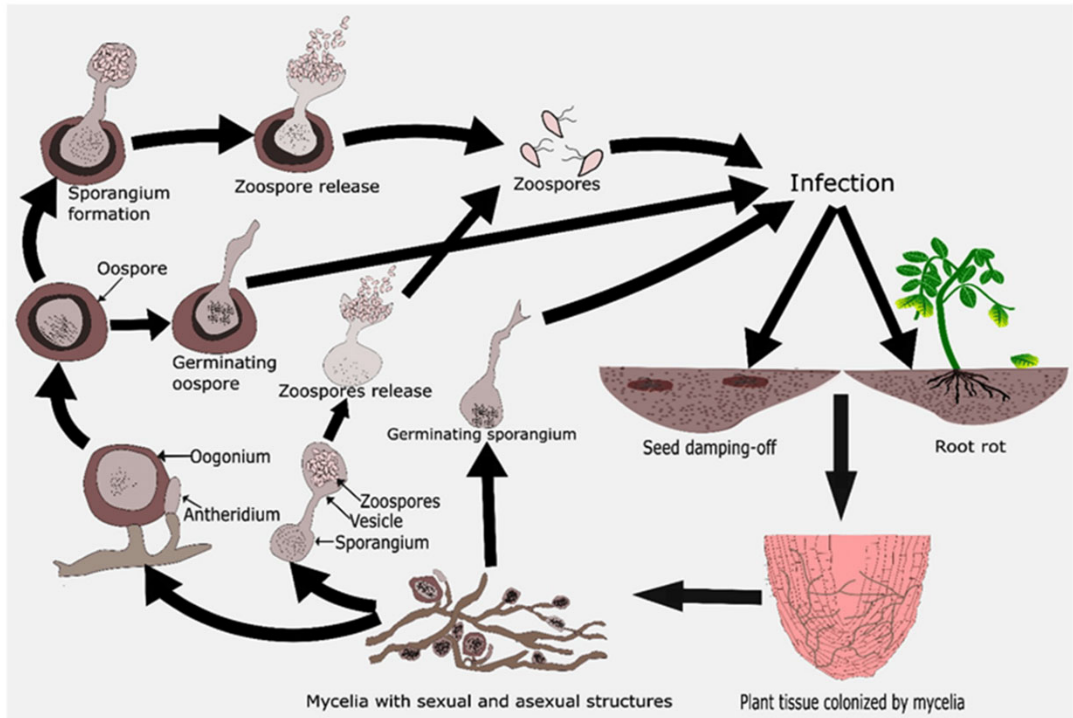
What is *Pythium*

- Oomycete pathogen
  - Water mold, not a fungus
- Wide host range
- Root rot, damping off, seedling death
- Symptoms of chlorosis and stunting
- Fruit rot



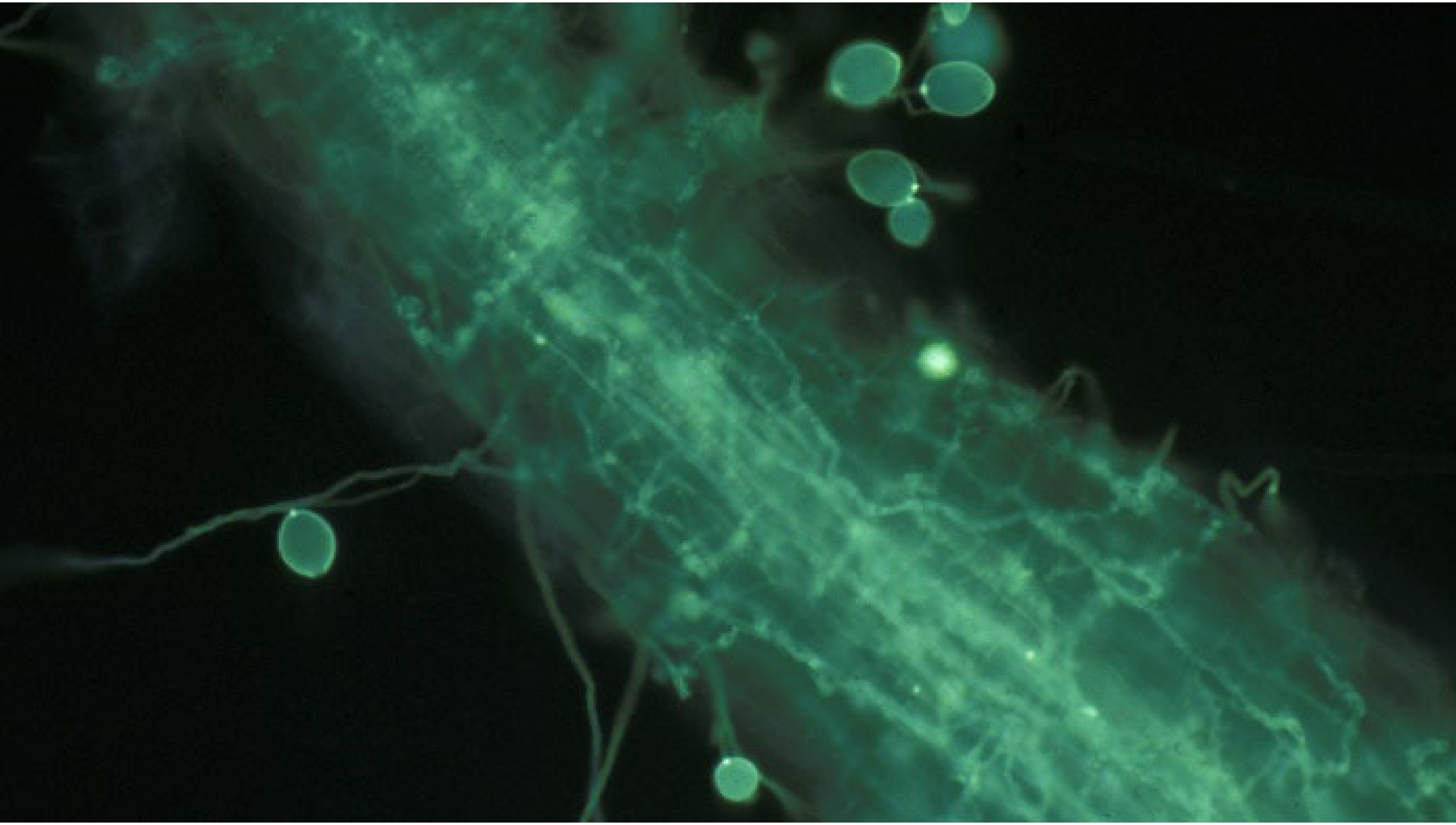
How *Pythium* Works

- Soilborne pathogen
- Hyphae – Sporangium – Zoospores (spread in saturated soils)
- 1 generation zoospore to zoospore in 18 hours or less
- Oospores (thick walled, allow for longer survival)



https://www.mdpi.com/2076-2607/9/4/823

Zoospores

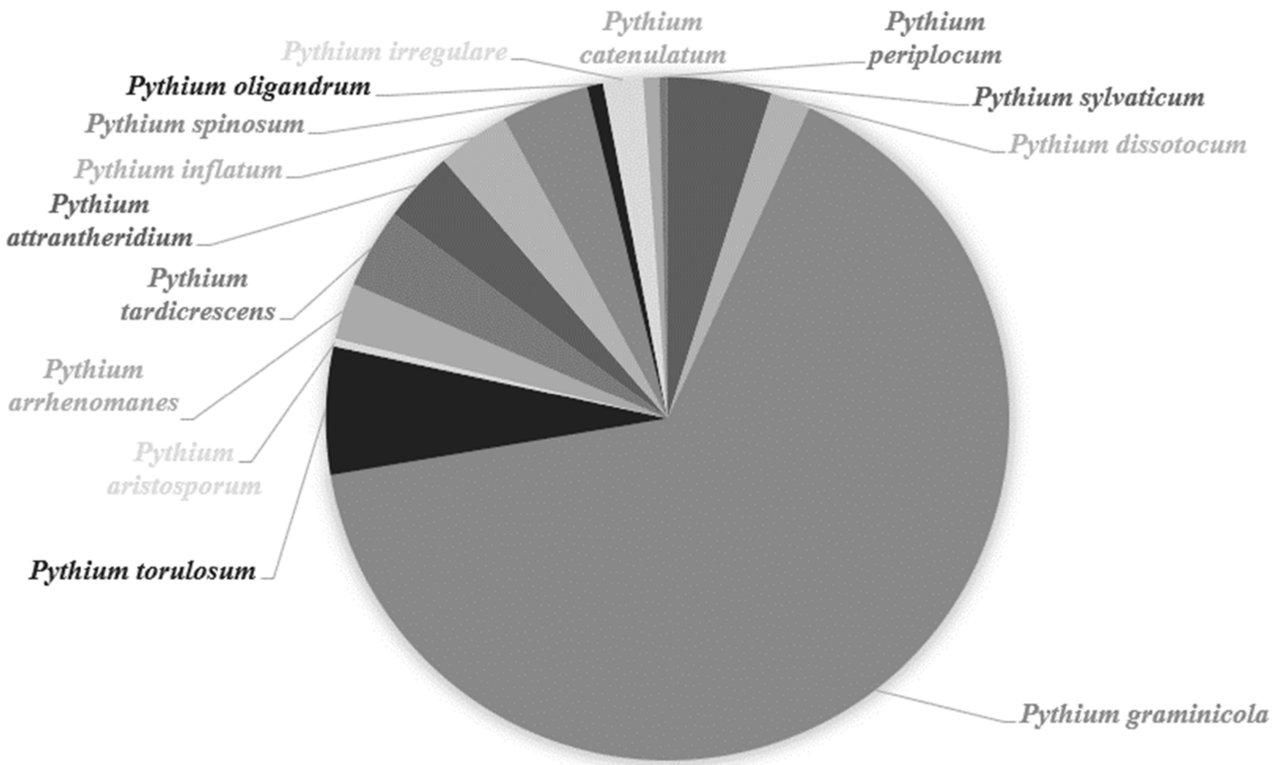


Survival of *Pythium*

- Zoospores – swim for 20 to 30 hours and can move around 3 inches
- Sporangia can survive several months to a year
- Sporangia and zoospores do not survive in air or dry soil for very long
- Oospores have been shown to survive >10 years (often survive in old crop debris)

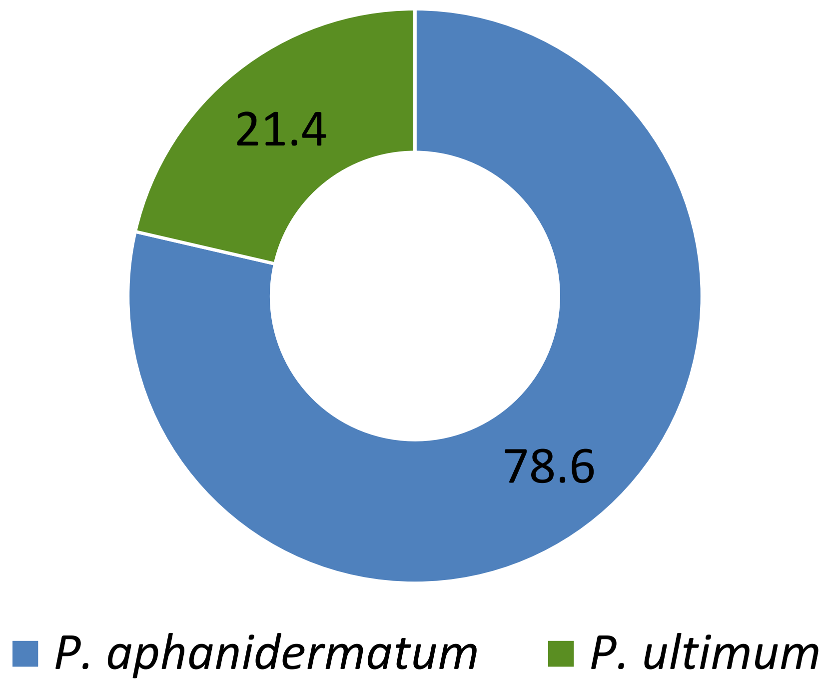
https://www.invasive.org/browse/detail.cfm?imgnum=5389662

Field Corn Survey



Survey of *Pythium* species in the Mid-Atlantic (2019-2020)

2023 Survey of *Pythium* spp. in Snap Bean



Pythium species in DE Veg Production

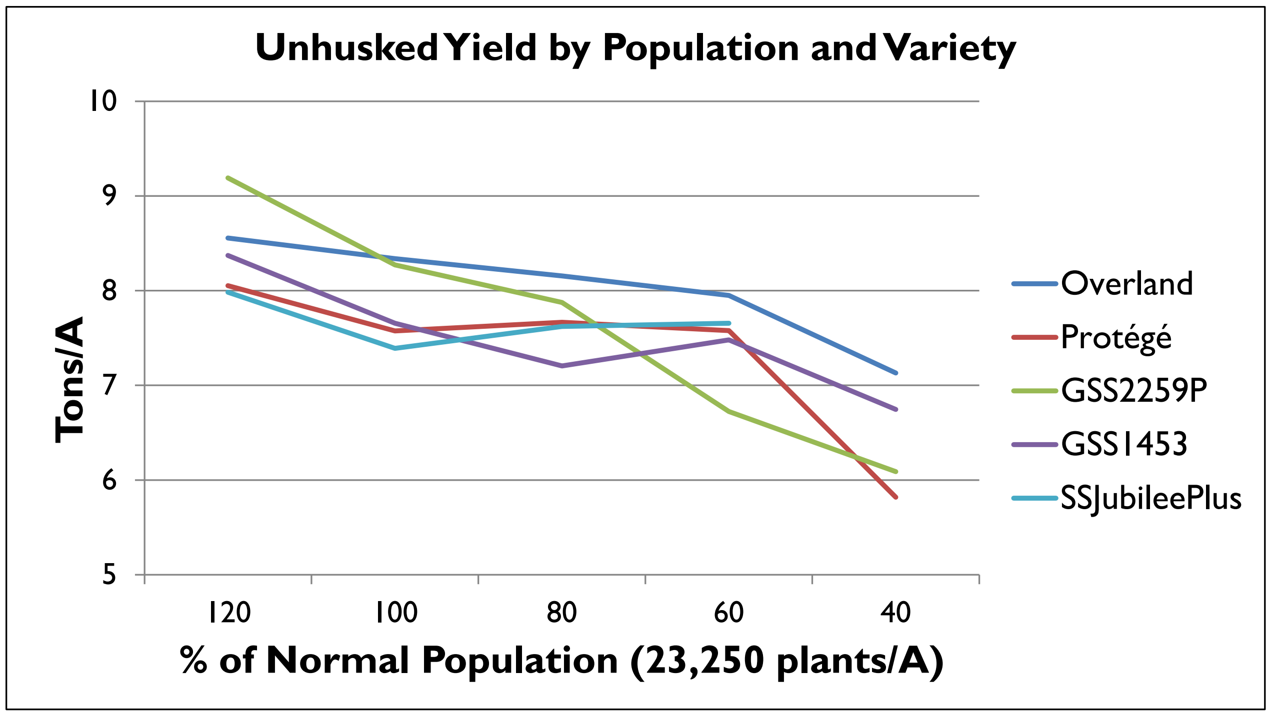
- *P. graminicola* – most commonly isolated from corn
- *P . aphanidermatum* – favored by heat
- *P. ultimum* – favored by cooler weather
- Hot or dry, warm or cold…there is probably a *Pythium* waiting

Under Attack

- *Pythium* targets young tissue - germinating seedings or root tips
- As the soil dries, warms up, etc., new roots may be produced, and the plant may recover
- In wet conditions or heavy infection, the plant may collapse and die
- Some plants recover better than others
- Some crops are better at compensating for stand loss than others

Stand Reduction Impact on Processing Vegetable Yield

Processing sweet corn compensates well for stand loss (up to 40% loss), especially Overland.



Research by Dr. Emmalea Ernest in 2012 and 2013.

Lima beans compensate well for stand loss (up to 50% loss)

Research done by Wally Pill, Tom Evans, Michael Olszewski, Bob Mulrooney and Ed Kee in 2003-2004.

HortScience 40(7):2024–2025. 2005.

The ‘Maffei 15’ Lima Bean Compensates for Reduced Plant Stand

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Additional index words. *Phaseolus lunatus*, population, population density

Abstract. **‘Maffei 15’ baby lima bean seeds were sown every 6 cm in rows 76 cm apart to yield a nominal stand of 215,000 plants/ha at two locations in Delaware over 2 years. Seedlings were thinned within 2 weeks of planting to provide 0%, 16.7%, 33.3%, and 50.0% stand reduction at two in-row spacing patterns to determine subsequent effects on vegetative and reproductive growth. Shoot fresh weight per square meter was decreased only in 2003 by 21% and bean fresh weight per square meter was decreased only in 2004 by 13.8% when plant stand decreased to 50%. This disproportional vegetative and reproductive growth response to stand reduction resulted from a compensatory linear increase in shoot fresh weight, usable pod number, and bean fresh weight of individual plants. Thus, ‘Maffei 15’ lima bean tolerates a considerable loss of plant stand with little or no effect on yield.**

The green lima bean is a major processing crop in the mid-Atlantic region with 7200 ha planted annually (Tarburton et al., 2000) and Delaware producing about 40% of the lima beans sold in the United States. The effects of stand reduction on economic yield of baby lima beans have not been examined. Lima bean stands in Delaware can be reduced significantly by infection primarily from *Rhizoctonia solani* (Mulrooney et al., 2004). Stands of lima bean and other warm-season crops also can be reduced by imbibitional injury (Pollock, 1969; Pill and Kabilan, 1999) when seeds of low initial seed moisture rapidly imbibe causing an accumulation of intercotyledonary water that hinders oxygen transfer to the embryo axis. Other reasons for reduced stand could include planter malfunction, herbicide injury or soil crusting.

Smith (1980) showed that economic yield of ‘Fodhook 242’ lima bean, a large-seeded type, was unaffected as plants decreased from 16 to 11 per m of row. Although there are no known reports of the effects of baby lima bean stand reduction on crop growth and yield, the effects of plant population density have been reported. A positive correlation between seed yield of individual lima bean plants and their shoot dry matter production is documented (Fisher and Weaver, 1974; Lambeth, 1950; Rappaport and Carolus, 1956; Smittle, 1986). An inverse relationship between plant population density and lima bean economic yield has occurred with closer in-row spacing (Lachman and Snyder, 1943; Larson and Peng-Fi, 1948; Matthews, 1933), and closer row spacing (Larson and Peng-Fi, 1948). Presumably, the higher population density was unable to compensate for the reduced yield from the smaller plants. Sirait et al. (1994) noted that narrower rows increased economic yield of ‘Maffei 15’ lima beans, but only with irrigation, which increased leaf area index and shoot dry matter production per unit land area.

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Yield reductions were not proportional to percent stand reductions in soybean (*Glycine max* L. Merr.) because of the compensating ability of the remaining plants to develop more branches and pods (Johnson and Harris, 1967; Stivers and Swearingin, 1980). In fact, Torii et al. (1987) reported that a 25% reduction in plant stand reduced soybean yield by only 10%, and Vasilas et al. (1990) reported that a 66% stand reduction, imposed uniformly, and as gaps, reduced soybean yields by only 7 and 27%, respectively. Yield loss associated with replanting was greater than yield loss associated with a stand reduction of up to 66% (Vasilas et al., 1990).

The objective of our study was to determine the effects of stand reduction on vegetative and reproductive responses of ‘Maffei 15’ baby lima beans.

Materials and Methods

The study was conducted during June to September on Kalmia loamy sand (fine loamy silicaceous, thermic Typic Hapludult) near Georgetown, Del. (lat. 38.7° N, long. 75.3° W) in 2003, and on Matapeake silt loam (fine silty, mixed mesic Typic Hapludult) in Newark, Del. (lat. 37.3°N, long. 75.5°W) in 2004. Seeds of ‘Maffei 15’ lima bean were machine planted every 6 cm in rows 76 cm apart to provide a nominal stand of 215,000 seeds/ha. Plant population densities were created by hand removal of plants within 2 weeks of planting. In addition to the full stand (0% stand reduction), three percentages of stand reduction were created at two in-row spacings (gaps) by removing plants. The percentages and gaps were 16.7% (one plant out of every consecutive six, or two consecutive plants out of every twelve); 33.0% (one plant out of every consecutive three, or two consecutive plants out of every six); and 50% (every other plant, or two consecutive plants out of every four). Each treatment consisted of four 6-m-long rows.

The 4 (stand reduction) × 2 (gaps) factorial experiment was arranged in randomized block design with four replications. Blocks consisted of four 6-m-long rows per treatment with two border rows on each side. Plots received 90 kg N/ha from 14N–3P–12K (14–7–14) on the day of planting. Imazethapur herbicide was incorporated preplant at 36g a.i./ha. Manual cultivation subsequently controlled weeds. Other pest control measures followed Univ. of Delaware (2003) recommendations. Plots received at least 50 mm of water each week from rain or irrigation from planting to harvest.

At the time of harvest, plants from the central 3 m of the two inner rows of each treatment were pulled out of the ground, counted and weighed. Pods were manually stripped from plants and separated and counted as flat (immature), usable (green), and dry (overly mature). The green pods were threshed mechanically and the seed fresh weight (economic yield) determined. All data were recorded on a per plant and per unit area (m^2) basis. In 2004, the numbers of nodes and branches on 10 plants from each treatment–replication combination were counted.

Results and Discussion

Since in-row gaps had no effect on any variable in either year, only the results of percentage stand reduction are reported. Kahn et al. (1995) similarly noted that seed yield and harvest index of cowpea [*Vigna unguiculata* (L.) Walp] was unaffected by uniformity of within-row spacing. The 17.8 and 20.0 plants/m^2 achieved in 2003 and 2004, respectively, with no stand reduction (Table 1) represented 83% and 93% of the potential stand of 215, 000 plants/ha. The nominal 16.7%, 33.3%, and 50.0% nominal stand reductions were, respectively, 23.6%, 35.9%, and 49.4% in 2003, and 19.5%, 31.5%, and 49.5% in 2004.

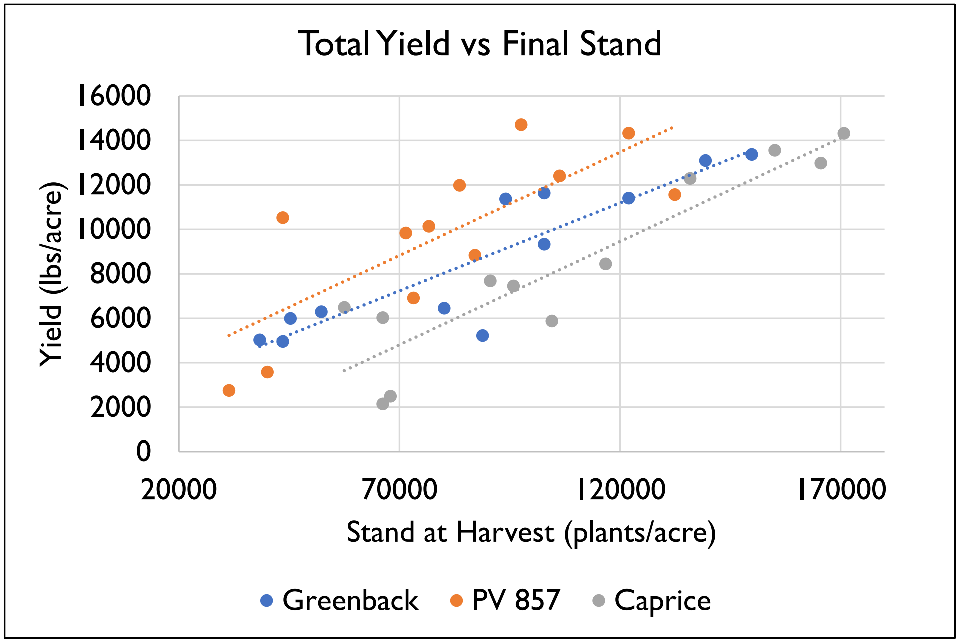
As stand decreased from 100% to 50%, shoot fresh weight per square meter decreased only 21% in 2003 and was unaffected in 2004 ; while bean fresh weight per square meter was unaffected in 2003 and decreased only 13.8% in 2004 (Table 1). This absence or less than proportional decrease in shoot or bean fresh weight in response to stand reduction has been reported in soybean (Johnson and Harris, 1967; Stivers and Swearingin, 1980; Torii et al., 1987; Vasilas et al., 1990) and large-seeded lima bean (Smith, 1980), and reflects the ability of plants to respond vegetatively and reproductively in a compensating manner to the decreasing population density.

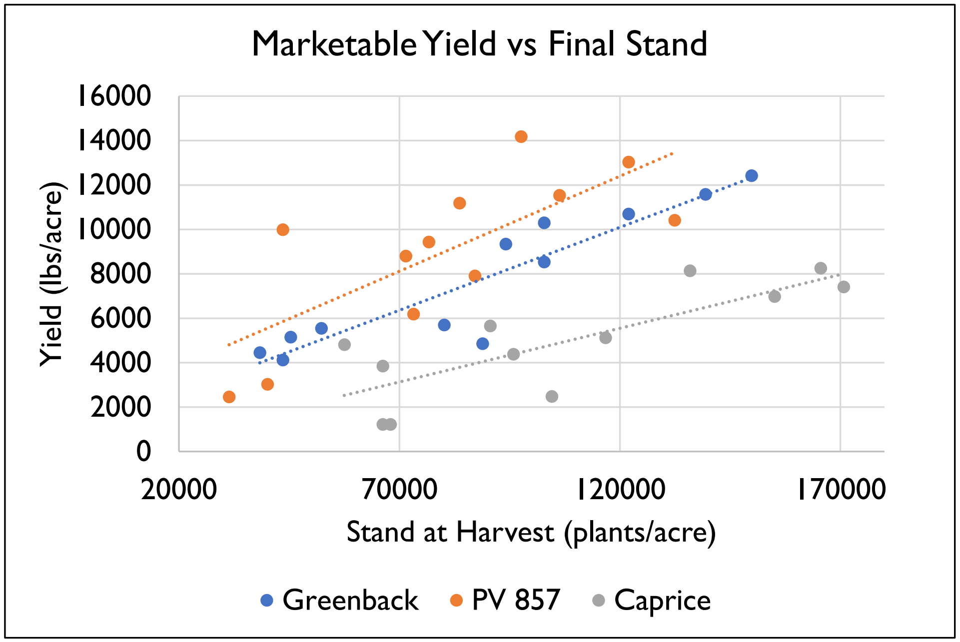
The numbers of flat, dry or usable pods/m^2 were unaffected by stand reduction in either year. In both years, the usable pods were 87% of the total pod number per plant, indicating that plant population density had no effect on crop maturation rate.

Linear increases in shoot fresh weight, number of usable pods and bean fresh weight of individual plants in response to decreasing stand during both years (Table 2) confirmed the ability of plants to respond positively to reduced population density. Early research revealed the positive correlation between seed yield and vegetative growth of lima bean plants (Fisher and Weaver, 1974; Lambeth, 1950; Rappaport and Corolus, 1956; Smittle, 1986). Decreas-

Stand Reduction Impact on Yield

Snap beans do not compensate well for reduced stands.
Plant population at harvest is significantly correlated with yield.





Research done by Emmalea Ernest in 2023.

Management

- Cultural Practices
- Seed-treatment Fungicides
- Biological control agents

Pythium in Sweet Corn

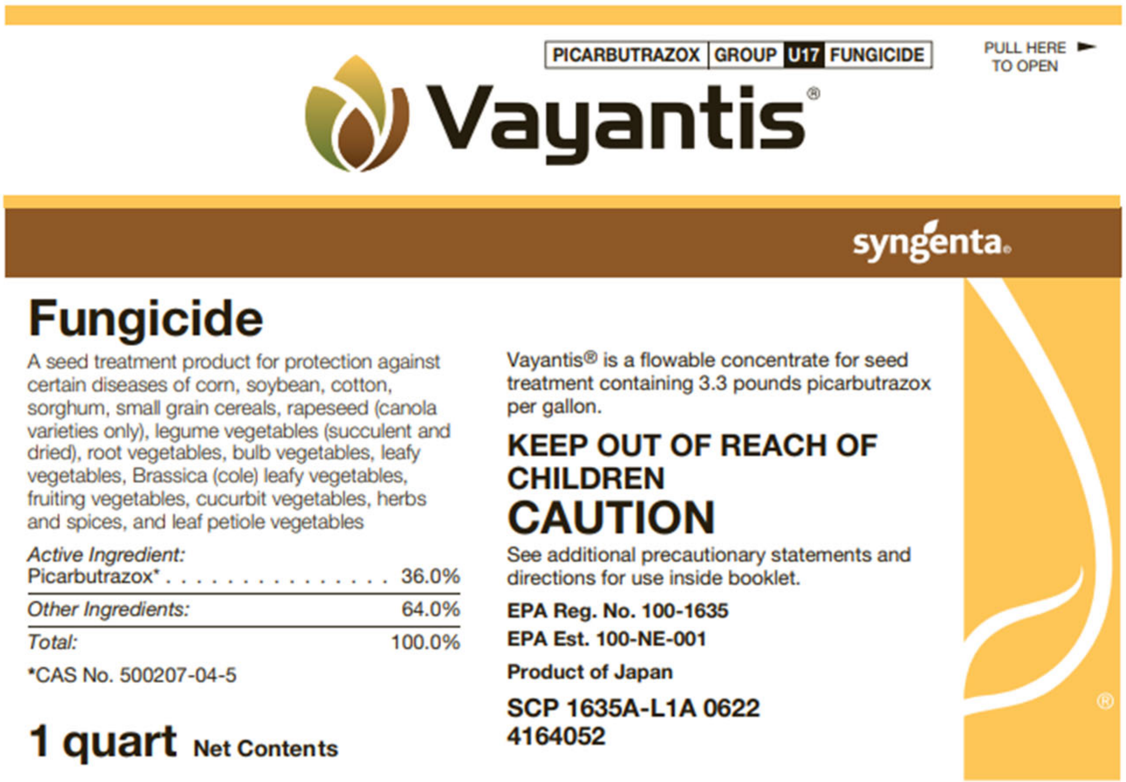
- Favored by wet conditions
- Usually worse in early planting
  - Soil temps <55 F
  - Slower germination
- Multiple species, can be favored by cool or warm weather

Pythium Management in Sweet Corn

- Minimize wet soil conditions – reduce compaction, timing of planting, avoid irrigating right after planting
- Delay planting until soils have warmed above 50-55 F
- Optimal planting depth
- Seed treatments

Seed Treatments for Sweet Corn

Product (active ingredient)	***Rhizoctonia solani***	***Pythium* spp.**
Allegiance (Metalaxyl and methyl ester)		x
Apron XL (mefenoxam)		x
Dynasy (azoxystrobin)	x	
Intego Solo Fungicide, Lumiante (ethaboxam)		x
Maxim XL (fludioxonil and mefenoxam)	x	x
Thiram (Thiram Tetramethylthiuram disulfide)	x	x
Vitavex	x	
Vayantis (picarbutrazox)		x

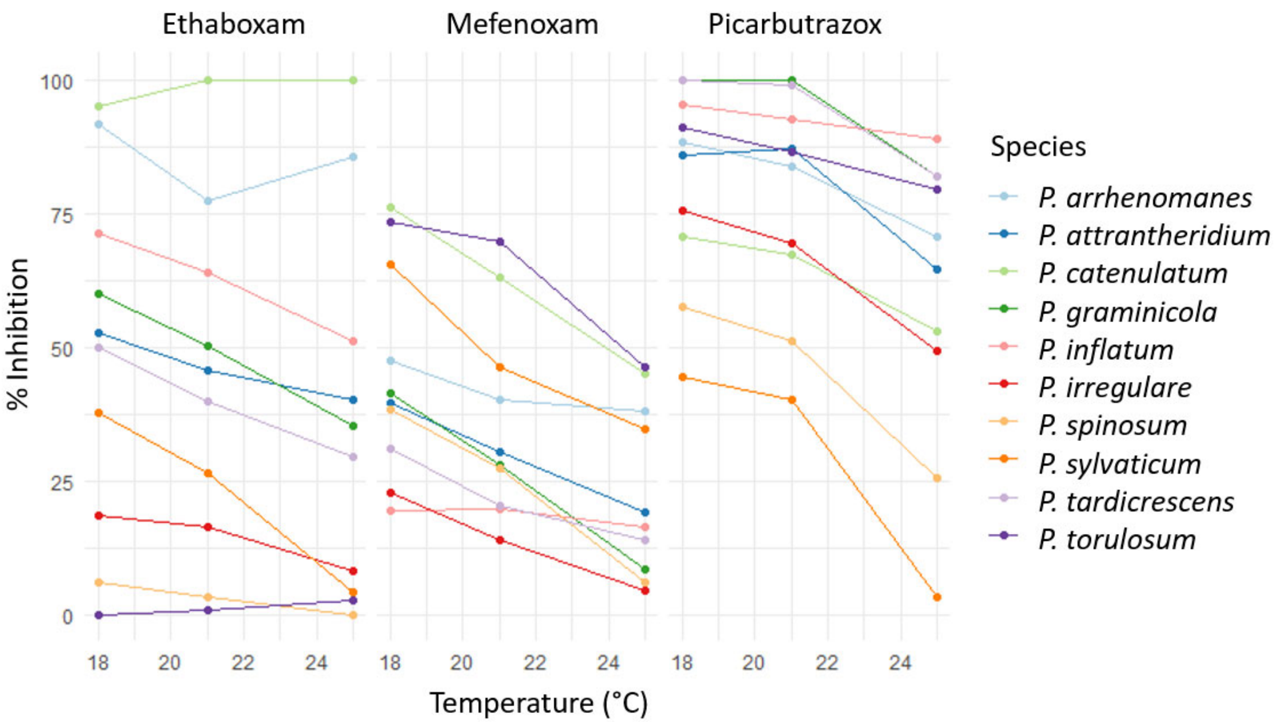


- 2021 registration
- Began to see some use in 2022

In Vitro Screening

EC50[z] Values by Fungicide (µg/ml)			
Pythium spp.	Mefenoxam	Ethaboxam	Picarbutrazox
P. attrantheridium	0.02	0.10	0.0009
P. graminicola	0.05	0.10	0.0003
P. inflatum	0.14	0.08	0.0005
P. sylvaticum	0.04	0.21	0.0022
P. torulosum	0.04	>10.00[y]	0.0010

[z] EC50 values calculated using linear regression of percent inhibition data points against logarithmic transformation of the concentrations (µg/mL) in the amended petri plates.
[y] Calculated EC50 value exceeded the measured range.



In vitro fungicide efficacy trials:

mefenoxam (ApronXL®, 0.01 ug ml^{-1})

ethaboxam (Elumin®, 0.01 ug ml^{-1})

picarbutrazox (Vayantis®, 0.0001 ug ml^{-1})

Vayantis Trials

- Small sweet corn in seed treatment trial in 2022- reduced stunting in Vayantis treatments
- Seed treatment trials in field corn happening Jan-March 2024
  – keep an eye on the WCU for project results

Pythium in Snap Bean

- Root Rot
- Pods covered in white hyphae – reduces quality of beans for processing
- Aerial Phases – decline of upper leaves

Pythium Management in Snap Bean

- Rotation (avoid other legumes)
- Minimize wet soil conditions – reduce compaction, timing of planting, avoid irrigating right after planting
- Delay planting until soils have warmed above 50-55 F – role of planting date?
- Optimal planting depth
- No commercially available cultivars claim resistance – some white seeded snap bean lines reported to be less susceptible – continued screening

Seed Treatments for Snap Beans

Product (active ingredient)	*Pythium* spp.
Apron XL (mefenoxam)	x
Intego Solo Fungicide (ethaboxam)	x
Apron Maxx RFC (fludioxonil and mefenoxam)	x
Vayantis (picarbutrazox)	x

Biologicals

Snap bean (*Phaseolus vulgaris* 'Pony Express')
Rhizoctonia root rot; *Rhizoctonia solani*,
Pythium diseases; *Pythium* spp.

X. Fan, S. Zhang, X. Mo and Y. Fu
University of Florida, IFAS
Trop. Res. & Ed. Center, Homestead, FL 33031

Field evaluation of Serenade SOIL for suppressing *Rhizoctonia* & *Pythium* on snap bean in South Florida, 2011- 2012

A field trial was carried out at the University of Florida's Tropical Research and Education Center in Homestead, FL to evaluate the effect of Serenade SOIL (AgraQuest) against *Rhizoctonia* and *Pythium* on snap bean. The field was known to be infected with *Rhizoctonia solani* and *Pythium* spp. in previous growing seasons. Snap bean (cv. 'Pony Express') was directly seeded into the beds about 2-3 in apart within rows on 8 Nov 2011. The beds prepared for snap bean cultivation in South Florida were each 1.5 ft wide. The trial was designed as a randomized complete block (RCB) with 4 replications of each treatment. Each plot consisted of a 20 ft section with a 5 ft buffer zone between adjacent plots. Treatments were applied at planting by spraying into the seed furrow using a handheld sprayer (2- gallon) fitted with a single hollow cone tip nozzle (Cone Jet TXVS-6) calibrated to deliver 60 gal/A at 40 psi. After emergence, plants were checked for infection with *Rhizoctonia* and *Pythium*, and infected plants were either removed or left to die. Plant vigor was recorded on 21 Dec 2011, and total number of plants that survived in each plot was counted on 3 Jan 2012. Because infected plants had been removed or had died, the effect of treatments on these two soil pathogens was evaluated based on the number of plants that had survived. Pods of snap bean were manually harvested on 3 Jan 2012.

In general, there were no significant difference in total plant number of plant that survived, plant vigor and the yield of snap bean between the treatments and untreated control ($P = 0.05$). However, treatment with Serenade SOIL at 2.2 oz per1000 ft in this field trial showed significantly greater plant vigor than at 4.4 oz per1000 ft and had a significantly higher yield than at 4.4 and 8.8 oz per 1000 ft.

Treatment (rate)	Total plant count (number/plot)	Plant vigor *	Yield (lb/plot)
Serenade SOIL, 2.2 oz/1000ft	65.8 a **	7.5 a	7.2 a
Serenade SOIL, 4.4 oz/1000ft	56.0 a	6.0 b	5.2 b
Serenade SOIL, 8.8 oz/1000ft	57.3 a	6.8 ab	5.3 b
Quadris, 0.6 oz/1000ft	66.0 a	7.3 ab	6.4 ab
Untreated control	59.3 a	7.3 ab	6.1 ab

* A scale of 1 - 9 scale was used for rating plant vigor, where 1 = dead or dying plants, 6 = acceptable appearance, and 9 = optimal appearance.
** Values followed by the same letter in a column are not statistically significant ($\alpha = 0.05$) according to Fisher's LSD test.

Summary

- Multiple species of *Pythium* are present in DE soils
- *Pythium* is able to survive for long periods and species are present that prefer cool or warm conditions
- Stand loss is more impactful to snap beans than sweet corn or lima bean
- New seed treatment, Vayantis, is available

Acknowledgements

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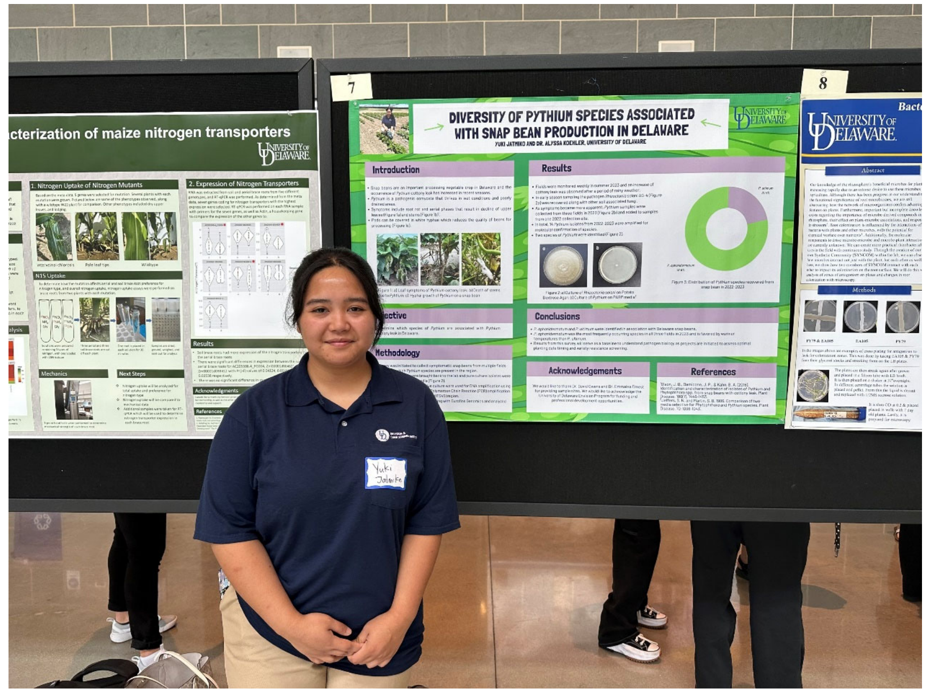
- Maddle Henrickson
- Erin Wright

- Carvel Research and Education Farm Crew



UD Summer Envision Program

Questions?

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