

Fusarium Species and Impact of Root Infection on Growth and Yield of Soybeans: Review Approach

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ABSTRACT:

Fusarium spp. are commonly isolated from soybean roots but the pathogenic activity of most species is poorly documented. Aggressiveness and yield impact of nine species of *Fusarium* were determined on soybean in greenhouse (50 isolates) and field microplot (19 isolates) experiments. Root rot severity and shoot and root dry weights were compared at growth stages V3 or R1. Root systems were scanned and digital image analysis was conducted; yield was measured in microplots. Disease severity and root morphology impacts varied among and within species. *Fusarium graminearum* was highly aggressive (root rot severity >90%), followed by *F. proliferatum* and *F. virguliforme*. Significant variation in damping-off (20 to 75%) and root rot severity (60%) was observed among *F. oxysporum* isolates. In artificially- infested microplots, root rot severity was low.

INTRODUCTION:

including *Fusarium oxysporum* causing Fusarium wilt, *F. solani* causing sudden death syndrome (SDS), and several species causing damping-off and Fusarium root rot. At least 19 species of *Fusarium* have been isolated from soybean roots Among the species and the diseases they cause, economic impact is widely recognized for SDS and damping-off, whereas economic impacts of Fusarium wilt and root rot have not been properly documented. Fusarium root rot is estimated to affect soybean across a geographic area covering >1,900 km north to south and 1,600 km east to west in india Although Fusarium root rot is common and widespread, its yield impact has been difficult to quantify because the disease symptoms are not easily distinguished from other diseases and abiotic disorders. Moreover, Fusarium root rot often occurs in combination with other diseases and disorders Members of *F. oxysporum* and *F. solani* complexes are generally reported to be the major species causing root rot in soybean but additional species may be pathogenic. Previous studies on occurrence, pathogenicity, and cultivar resistance to the two predominant species complexes have been inconclusive. In 1963 French and Kennedy (14) isolated *F. solani* from soybean roots but concluded that the isolates were not pathogenic on soybean. In contrast, another study reported that *F. solani* caused root rot symptoms in soybean seedlings, reducing seedling emergence and seed yield, in greenhouse and field conditions (21). *F. oxysporum* is associated with the Fusarium root rot complex and can cause a range of symptoms, including damping-off, wilt, root rot, cortical decay, and vascular discoloration Pathogenicity, however, has not always been demonstrated due to significant variation among fungal strains in the complex (2,7,10–12). More recently, other species of *Fusarium* such as *F. armeniacum*, *F. graminearum*, *F. proliferatum*, *F. pseudograminearum*, and *F. redolens* have been reported as soybean pathogens, causing root rot on seedlings and older plants (4,8, 9,35,41). Few published reports have estimated the yield impact of Fusarium root rot in soybean. In a study conducted in Delaware by Leath and Carroll (24), two soybean cultivars susceptible to Fusarium root rot incurred 47.6 and 55.6% yield loss following inoculation with *F. oxysporum*. According to Wrather et al. (39, 40), the estimated soybean yield losses to diseases caused by species of *Fusarium* in the United States in 1994 to 2010 were ≈36.2 million bushels/year, mostly due to SDS; estimated losses due to Fusarium root rot were 6.63 million bushels/year. However, this estimate does not include the role of *Fusarium* spp. in seedling diseases, which caused additional losses of 34.3 million bushels/year over the same time period.

Moreover, the portion of seedling disease loss that could be attributed to species of *Fusarium* are not agreed upon, with some reports indicating that species of *Fusarium* are the primary seedling pathogens, while others indicate that *Pythium* and *Rhizoctonia* spp. are the primary pathogens (16). In order to increase understanding of the importance of rootinfecting species of *Fusarium* on soybean **productivity, greenhouse and field experiments were conducted in Iowa.**

The objectives of this study were to:

- (i) determine aggressiveness of predominant Iowa species of *Fusarium* in causing soybean root rot in greenhouse conditions and.
- (ii) estimate effects of root infection by species of *Fusarium* on soybean growth and yield under field conditions.
- (iii) In this article, “aggressiveness” refers to “relative ability to colonize and cause damage to plants” (38).

FUSARIUM ISOLATE IDENTIFICATION.

Fusarium isolates used in the study were obtained from soybean root samples collected during a 2007 survey of Iowa fields (7). The isolates represented the range of species recovered and the number of isolates per species reflected the frequency of isolation of the most common species (7). Isolates were recovered from soybean roots by culturing root pieces on Nash- Snyder artificial medium, which is semiselective for *Fusarium* spp. (1). Putative *Fusarium* colonies were transferred to sterile potato dextrose broth (PDB) (Difco, Benton, Dickinson and Company, Sparks, MD) in 1.5-ml centrifuge tubes and stored at 4°C until identified. Single-spore isolates were grown for 7 to 20 days at room temperature ($25 \pm 2^\circ\text{C}$) under fluorescent light on carnation leaf agar (CLA) modified with KCl to favor production of more and longer microconidial chains (15 g of agar and 6 g of KCl per liter) (26) and antibiotic-amended potato dextrose agar (PDA) (streptomycin sulfate solution at 33 mg ml⁻¹, neomycin sulfate solution at 40 mg ml⁻¹, and 39 g of PDA per liter of water). Each isolate was examined microscopically and identified to species following the system of Leslie and Summerell (26).

Epidemiology:

General conditions that promote seed and seedling disease diseases include wet, poorly drained, and compacted soils. However, the different pathogens have different optimal conditions.

Phytophthora root rot occurs across many environments, but is most common in warm (>60°F/15°C) and wet conditions, while *Pythium* Prefers cold soil temperatures (<60 F). High-residue fields, and heavy or compacted soils are at higher risk because of cooler, wetter conditions (Crop Focus, 2013).

Fusarium root rot is often associated with stressed plant (Crop Protection Network, 2015).

Green house experiment:

At soybean growth stage V3, plants were removed from cones and the roots were washed under a stream of tap water. Root rot severity was assessed using a visual scale as the percentage (0 to 100%) of root area with brown or black discoloration. Percentage of seedling mortality due to damping-off was also documented. Mortality (%) was evaluated as the total number of dead seedlings divided by total number of sampling units (total number of plants). After each root was evaluated for disease severity, roots were scanned using a flatbed scanner (Epson Perfection V700 Photo Scanner) and image analysis was conducted with the software WinRhizo 2008 (Regent Instruments Inc., Quebec, QC, Canada) in order to determine the effect of *Fusarium* isolates on root growth and root system structure. Image analysis provided estimates of root length, surface area, root volume, root diameter). for each individual plant. *Fusarium* isolates were reisolated from symptomatic root tissue of inoculated plants in order to

confirm infection resulting from the inoculated species. Fungi were isolated from roots by excising two 1-cm-long root pieces from each plant. Root pieces were surface disinfected in 0.5% NaOCl for 2 min, rinsed three times in SDW, and blotted dry; then, root pieces were embedded in antibiotic-amended PDA medium and incubated at room temperature ($25 \pm 2^\circ\text{C}$) for 7 days under fluorescent light. Numbers of root pieces with respective *Fusarium* isolate were recorded for each sample. Shoot and root dry weights were measured for each plant after oven drying at 80°C for 24 h.

Implications

In this study, nine *Fusarium* spp. were shown to cause root rot symptoms on soybean during both vegetative and reproductive plant stages in greenhouse and field conditions. Infection by all *Fusarium* spp. resulted in root rot or physical changes in root morphological characteristics, with significant variation among and within species. Furthermore, significant linear relationships between yield and root health indicators indicated the potential for some *Fusarium* isolates to cause yield reductions.

CONCLUSION:

In conclusion: the correct identification and early detection are critical in the proper management of soybean diseases. We have discussed about economic importance, symptomatology, causal organism, disease cycle, epidemiology and integrated management of some economically important fungal diseases of soybean viz. seed and seedling diseases of soybean, Pod blight, *Rhizoctonia* aerial blight or web blight, Charcoal rot disease of soybean. Seed and seedling diseases of soybean are more prevalent when wet season follows planting.

The disease can cause economic loss due to weak and less vigorous plants leading to poor crop stand establishment. *Rhizoctonia* aerial blight disease can cause significant yield loss in soybean when conditions favor disease development. The fungus *Colletotrichum truncatum* (Schwein.) causing pod blight causing severe economic loss as pods get heavily infested, which requires an integrated management approach. *Rhizoctonia bataticola* and *Sclerotium rolfsii* causes root rot and collar rot in Soybean and is considered as economically important diseases of Soybean.

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