PATHOLOGY

SECONDARY NUTRIENT APPLICATIONS TO MANAGE CHARCOAL ROT IN SOYBEAN

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Charcoal rot of soybean is an important disease that occurs annually and can limit profitable soybean production. The estimated yield losses as a result of charcoal rot are comparable to other soybean root-associated diseases including sudden death syndrome and seedling disease. Nationally, approximately 400 million bushels of soybean were lost to charcoal rot over the past 20 years. *Macrophomina phaseolina* (Tassi) Goid, the fungus responsible for causing charcoal rot, is a ubiquitous soilborne pathogen that affects over 500 hosts including rotational hosts such as corn, cotton and grain sorghum. Charcoal rot is typically more devastating in hot dry years in non-irrigated situations, but can also be problematic in irrigated fields when stressed. Symptoms of charcoal rot can be visible at vegetative stages, but are predominately observed during reproductive stages especially once plants set pods (> R3).

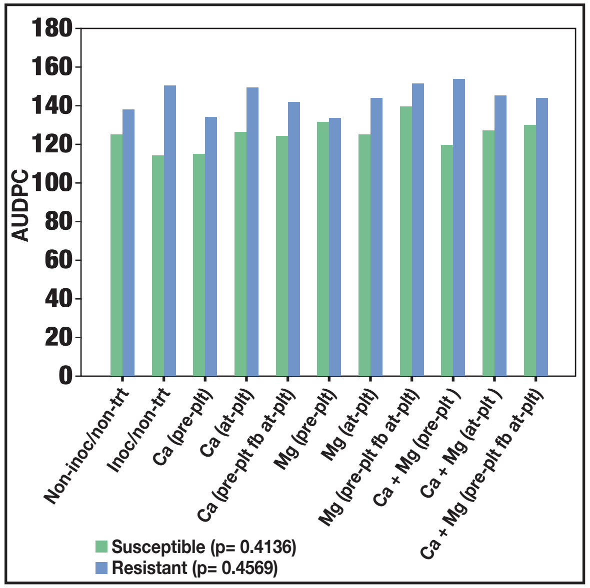

Figure 1. *AUDPC calculated from disease severity assessments from root tissue throughout the season.*

The symptoms associated with charcoal rot include interveinal chlorosis, stunting, wilting, and premature plant death. Currently, management practices suggest reducing stress and planting resistant germplasm; however, a general lack of complete resistance is available within the commercially available germplasm so the management options for charcoal rot remain extremely limited.

In prior research, a relationship between the concentrations of calcium and magnesium in plant tissue and the incidence of charcoal rot was observed. Between 2014 and 2016, non-irrigated field trials were conducted at the Delta Research and Extension Center with a susceptible cultivar, Pioneer P46T21R, and a moderately resistant cultivar, Pioneer P49T80. Treatment applications consisted of 1,000 pounds per acre of calcium and magnesium alone and in combination at pre-plant, at-plant, and

"ANNUALLY, CHARCOAL ROT ACCOUNTS FOR SIGNIFICANT YIELD LOSSES THROUGHOUT MISSISSIPPI, ESPECIALLY DURING YEARS WHERE THE ENVIRONMENT IS DOMINATED BY HOT AND DRY CONDITIONS. HOWEVER, MANAGING CHARCOAL ROT IS MADE DIFFICULT SINCE RESISTANT VARIETIES ARE RARELY AVAILABLE AND FUNGICIDE TREATMENT IS INEFFECTIVE."

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pre-plant followed by at-plant compared with a non-treated. Field plots were inoculated with *M. phaseolina* grown on sterilized millet and applied in-furrow at planting in addition to a non-inoculated set of plots (no *M. phaseolina* and no secondary nutrients). In-season evaluations, including stand count, vigor, and plant height were taken at vegetative and reproductive stages. Root samples were taken beginning at pod initiation (R3) through maturity (R8). Disease was visually assessed in root tissue using a 1-5 scale (1= no visible microsclerotia and 5= completely colonized). These values were used to calculate the area under the disease progress curve (AUDPC) which captures the multiple ratings conducted during the season. Yield was collected from all plots and post-harvest evaluations were conducted to determine 100 kernel weight and % germination. Colony forming units (cfu) were used to quantify *Macrophomina phaseolina* colonization from ground root tissue. Collectively, environmental conditions were not conducive for charcoal rot development in any of the three years. Although no significant benefit was observed between treatments when compared to control treatments, minimal numerical differences occurred in disease severity (Figure 1.) and yield (Table 1.).

Average Yield Across 2014-2016 for Charcoal Rot Susceptible and Moderately Resistant Varieties

Treatment (timing)	Susceptible	Moderately Resistant
Non-Inoculated untreated	56.3 c	59.1
Inoculated untreated	64.4 ab	58.8
Calcium 1,000 lb/ac (pre-plant)	63.8 ab	55.9
Calcium 1,000 lb/ac (at-plant)	64.2 ab	58.1
Calcium 1,000 lb/ac (pre-plant fb at-plant)	63.5 ab	58.2
Magnesium 1,000 lb/ac (pre-plant)	65.4 a	59.0
Magnesium 1,000 lb/ac (at-plant)	64.3 a	59.5
Magnesium 1,000 lb/ac (pre-plant fb at-plant)	62.7 ab	59.1
Calcium 1,000 lb/ac + Magnesium 1,000 lb/ac (pre-plant)	60.2bc	57.6
Calcium 1,000 lb/ac + Magnesium 1,000 lb/ac (at-plant)	61.5 ab	56.7
Calcium 1,000 lb/ac + Magnesium 1,000 lb/ac (pre-plant fb at-plant)	64.6 a	56.8
P-value for F-statistic	0.0010	0.7732

Image 1. *(A) Inoculated field prior to the onset of disease symptoms. (B) Wilting and premature death of soybean. (C) Colonization of Macrophomina phaseolina in soybean root tissue.*