Year 4: Investigating Treatments for the Management of Macrophomina on California's Central Coast

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Summary

Since first reported in California in 2006, *Macrophomina* crown rot has now become a serious threat to strawberry production in all three fruit production regions of the state. Multi-site field assessments representing different production regions for screening strawberry germplasm against M*acrophomina* crown rot is crucial for developing long-term sustainable disease management recommendations. The objective of our research was to screen strawberry genotypes for susceptibility to *Macrophomina* crown rot in a controlled field trial. A total of 65 cultivars and elite selections from both public and private breeding programs were planted at Cal Poly in October 2019 and evaluated until August 2020. Plants were inoculated using 5 g *Macrophomina* cornmeal-sand inoculum placed at the crown-soil interface, two weeks after planting. Disease incidence was assessed biweekly in both inoculated and non-inoculated plots. Genotype susceptibility varied widely from 2.5 to 96.1% mortality with an average mortality of 35% and 36.48% for the 26 cultivars common to 2019 and 2020 trials, respectively. Our results show that each strawberry breeding program has genotypes that are representative of the spectrum of susceptibility and common cultivars generally followed last year's trends. This project directly addresses the California Strawberry Commission's high priority research areas of (1) farming without fumigants; (2) control of soilborne diseases; and (5) breeding for disease resistance identified for the California coastal region.

Introduction

Crown rot, caused by the soilborne fungus *Macrophomina phaseolina*, is a damaging pathogen that has become established in all three districts of California strawberry production (Koike et al., 2016). Severe yield losses and plant mortality have resulted after introduction of this pathogen into a field. The unique nature of the biology of the pathogen is that it does not produce any spores like other soilborne pathogens of strawberry. Instead, *M. phaseolina* can be difficult to manage due to its persistence in soil and crop residues as microsclerotia (Islam et al., 2012). The pathogen can survive in soil and plant debris for long periods of time and it has over 500 hosts. Therefore, long-term disease management strategies such as breeding for resistance are warranted. Our prior studies at Cal Poly have shown that host plant resistance will be a critical tool for managing this disease in the post-methyl bromide era. The objectives of this year's research were to evaluate another set of cultivars and elite breeding lines for their ability to grow in the presence of M. phaseolina under field conditions.

Methods and Materials

A replicated field trial was established to evaluate 65 cultivars and elite breeding selections for resistance to *Macrophomina* crown rot as a fall planting. To allow year-to-year comparison, 26 of the cultivars in this experiment were also included in 2019's experiment. Strawberry germplasm was selected from six public and private breeding programs: University of California Davis, University of Florida, Driscoll's, Plant Sciences, Lassen Canyon Nursery, Inc., and California Berry Cultivars, LLC. The trial was conducted during the 2019-2020 growing season and consisted of 20-plant plots replicated four times, with a fifth non-inoculated replicate. On October 23, 2019, bare-root strawberry transplants were planted in field 35b on the Cal Poly San Luis Obispo campus farm. Two weeks later, each plant was challenged by inoculating with 5 g of cornmeal-sand inoculum (Mihail, 1992) colonized with three isolates of locally sourced *M. phaseolina* placed at the crown-root interface of each plant in the inoculated plots. Control plots were fumigated with Ally 33 (67% AITC + 33% chloropicrin at 55 gal/A) on October 7, 2019 and were not inoculated. Drought stressing plants was started on June 13, 2020 by not irrigating during weekends.

Host resistance was assessed by recording disease incidence (plant mortality) in each plot. A plant was considered dead when 100% of the foliage was brown and dry. Plant mortality was assessed every two weeks; the last assessment occurred on August 2, 2020. Presence of the pathogen in symptomatic plants was confirmed by plating pieces of the internal crown tissue on acidified potato dextrose agar (APDA) and pimaricin + ampicillin + rifampicin + pentachloronitrobenzene agar (PARP) (Mihail, 1992) media. PARP media was used to isolate potential infections with Phytophthora spp. and if isolated, the baseline was adjusted for each plot accordingly. Drone imagery was obtained to track the disease development over time by making flights every two weeks throughout the duration of the experiment.

Results

The first wilt symptoms due to infection by *M. phaseolina* were observed on May 23, roughly 200 days after planting. The majority of plant mortality occurred on June 6, genotypes exhibited a wide range of susceptibilities (Figure 1). Two commercial cultivars Florida Radiance and Ruby June, and two proprietary genotypes LC-4 and UC-D_MAC-11, were the most susceptible, with more than 90% mortality by August 1, 2020. Cultivar Mariposa, and proprietary genotype 'UC-D_MAC-7' were the most tolerant genotypes to *Macrophomina* crown rot, with less than 5% mortality by August 1, 2020.

Discussion

In this experiment, all breeding programs have genotypes representing a wide spectrum of tolerance and susceptibility to *Macrophomina* crown rot. Average final plant mortality for all genotypes was 35% which is much lower than last year's average of 50%. This was also true for the 26 cultivars common to both years. The plant response observed in this trial is consistent with other's findings (Zveibil et al., 2012), that is, disease due to *M. phaseolina* occurred late in the season and was exacerbated by high temperatures during the months of June and July. The cornmeal-sand inoculation method continues to provide consistent, but not overwhelming, disease pressure that allows separation of susceptible, moderately susceptible, moderately tolerant, and tolerant genotypes to *Macrophomina* crown rot. This is the fifth year we have conducted this experiment. Changing weather conditions and the genotypes provide the opportunity to observe a large number of genotypes under a variety of conditions. The results from this study will guide growers on managing *Macrophomina* crown rot, and strawberry breeders in the development of cultivars with higher levels of disease resistance.

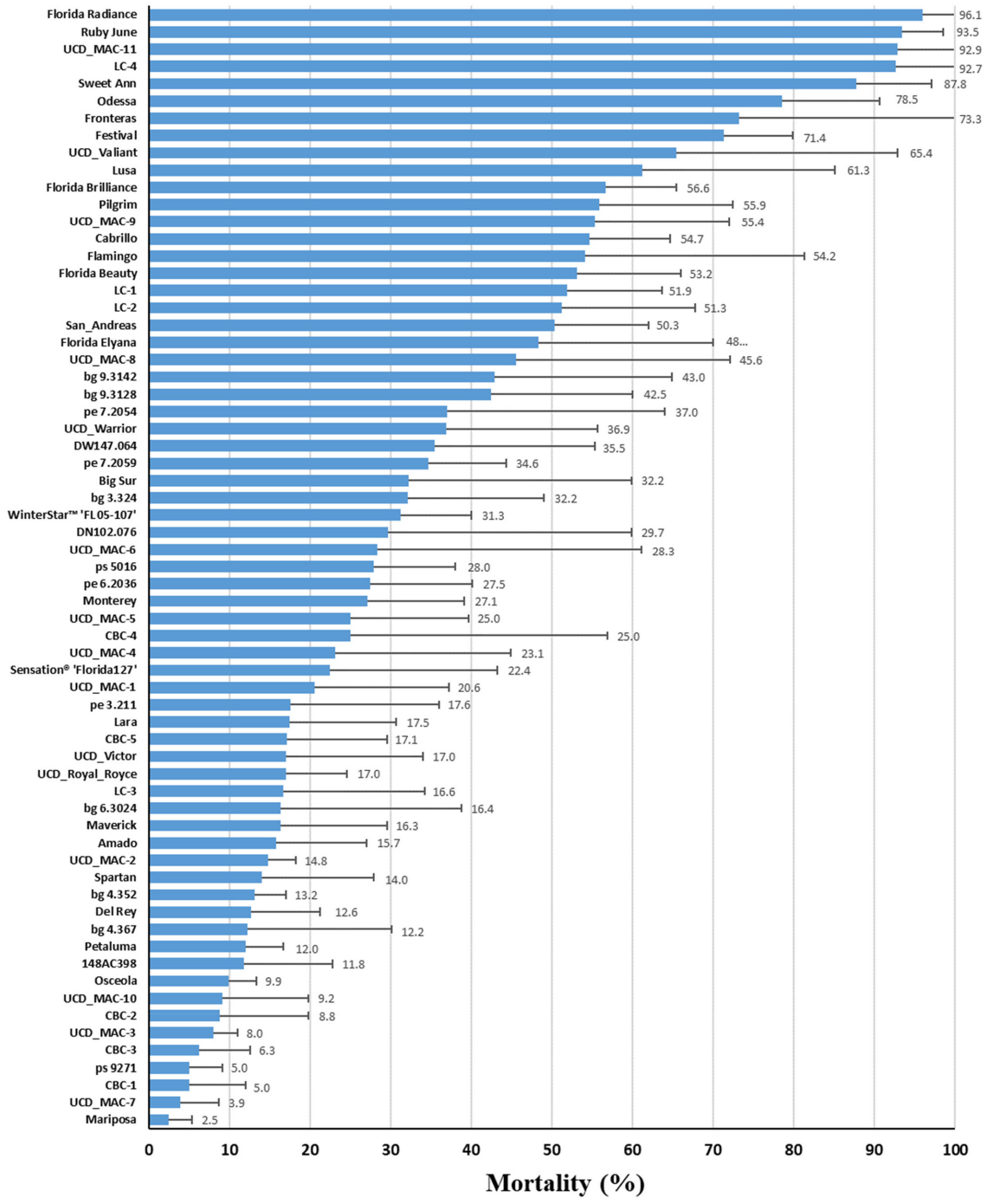

Figure 1. Average percent plant mortality due to Macrophomina crown rot as of August 2, 2019. Cultivars are representative of public and private breeding programs. Error bars represent the standard error of the mean.

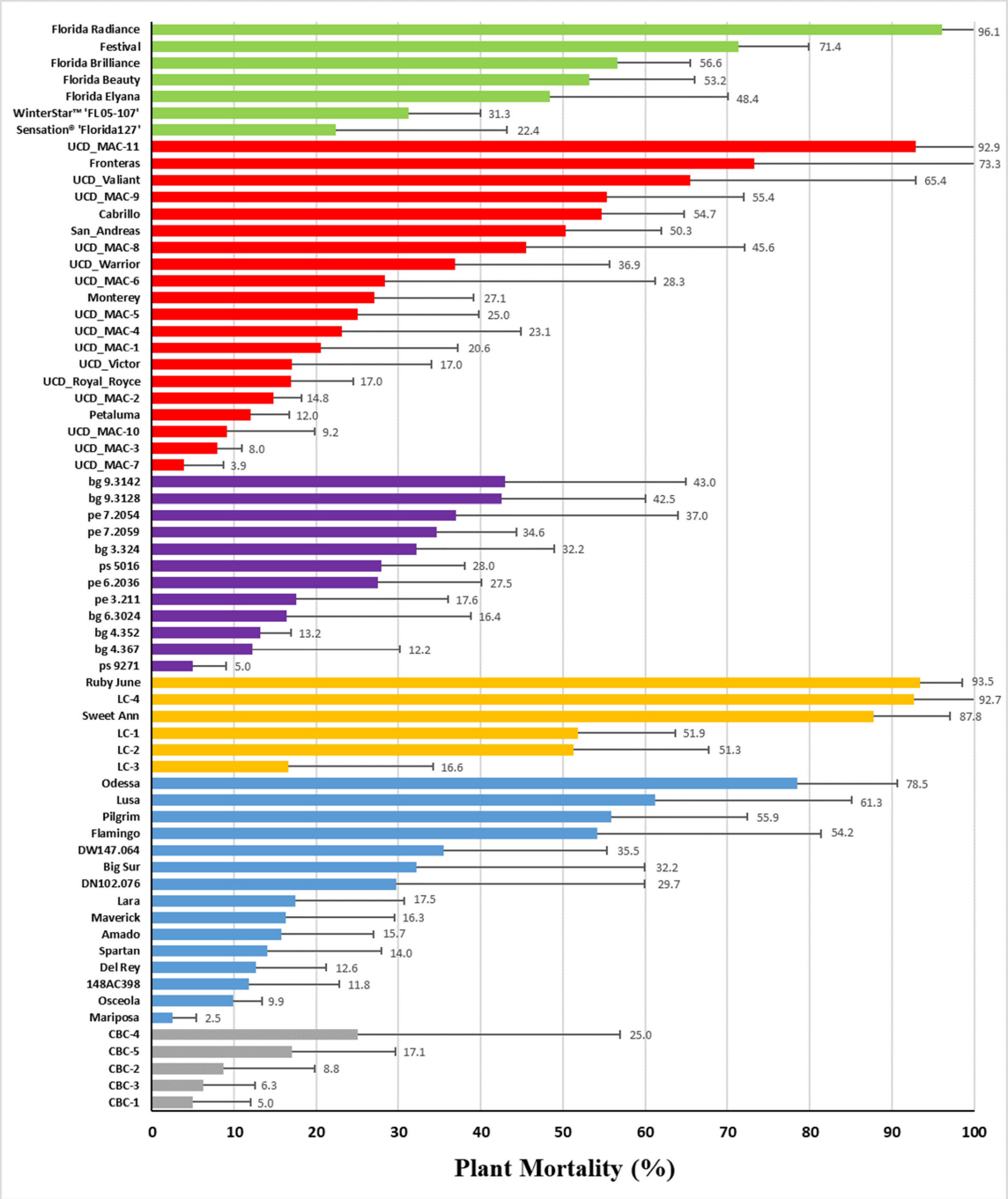

Figure 2. Average percent plant mortality due to *Macrophomina* crown rot as of August 2, 2019, sorted by breeding program. Cultivars are representative of public and private breeding programs. Error bars represent the standard error of the mean.

Acknowledgments

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