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Report Form

Project Title: Disease Management for Sustainable Chestnut Production
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Producer and Location of Farm: Route 9 Cooperative, Carrolton, Ohio

Summary
Culinary chestnut production in the United States is a rapidly growing sector of sustainable agriculture, supporting both fresh market and value-added industries. Chestnuts are a perennial food crop that promote soil stability, carbon sequestration, and wildlife biodiversity. Demand for chestnuts is driven by consumers looking for wholesome foods that are low-fat, gluten free, and/or align with ethnic traditions. As production increases there is an urgent need to provide current and new growers with science-based information for sustainable production, including disease management.

Blossom end rot (BER) of chestnut, first reported in 1958 in orchards in Georgia and Maryland, reduces nut yield and quality and is ranked as the most significant issue facing chestnut producers in Ohio. The disease is caused by the fungal pathogen *Colletotrichum gloeosporiodes* species complex (CGSC). The disease cycle of the CGSC has not been deciphered in chestnut and thus recommendations for controlling BER are non-existent. This projected aimed to begin to decipher the disease cycle by determining the initial stages of infection and to explore host resistance to BER through the identification of resistant or moderately resistant varieties.

What was done?
To understand the spatial and temporal patterns of *Colletotrichum* spp. in the chestnut orchard, and to discover potential overwintering tissues and sources of inoculum, a *Colletotrichum* spp. survey was conducted within commercial chestnut orchards associated with Route 9 Cooperative. Plant reproductive tissue (flowers, burs, developing nuts) was collected every two weeks, starting with flowers at bloom time and ending with mature nuts. Source tissue types varied seasonally and included senesced leaves, live leaves, dead twigs, live twigs, fresh and mummified chestnut galls, senesced burs, chestnut flowers (male and female), young and developing chestnut burs, and mature chestnuts and burs. Tissue was mainly collected from Chinese chestnut (*Castanea mollissma*), but nearby trees such as American chestnut (*C. dentata*), Chinkapin (*C. pumila*), and Apple (*Malus* x *domestica*) were also sampled to explore whether these species could be pathogen reservoirs and/or sources of inoculum. Bloom windows were assessed for eight Chinese and hybrid chestnuts cultivars (cvs. Qing, Sandaechan, Perry, ACE, Peach, Szego, Lui, and Homestead) and regional weather data (average daily rainfall, maximum and minimum daily temperature) were collected during the bloom periods. Cultivar evaluations to assess disease incidence and severity were also conducted. The nuts from each cultivar were sorted based on the presence or absence of BER symptoms and counted. BER severity was

determined by cutting nuts in half from tip to hilem and measuring the length of the necrotic BER lesion as a proportion of the total kernel cross-section length. Simple linear regression analysis was used to compare disease incidence with weather variables.

What were the results?

Overall disease pressure was low compared to disease pressure reported by commercial growers in previous years, however significant differences in disease incidence among cultivars were observed (Table 1). Disease incidence was highest in nuts collected from cv. Peach Empire compared to all of the other cultivars ($p<0.00001$). Disease incidence for 'Liu', 'Perry', and 'ACE' ranged from 2% (Liu) to 11% (Szego) and 'Qing' and 'Sandaechan' had no diseased nuts. Mean severity per cultivar, expressed as percent of kernel infected, ranged from 52%-64%, with no significant differences in severity among cultivars (data not shown). Average bloom time was 6.6 days with 'ACE' having the longest bloom period (15 days). No significant correlations were detected between disease incidence and average daily rainfall ($p=0.82$, $R^2=0.01$), maximum daily temperatures ($p=0.61$, $R^2=0.05$) or minimum daily temperatures ($p=0.17$, $R^2=0.34$). Over 200 putative *Colletotrichum* isolates were identified morphologically, given a unique isolate number, and stored for nucleic-acid-based species identification.

How have the results contributed or will they contribute to sustainable agriculture?

Host resistance is the most effective, sustainable and economical practice for controlling plant diseases. Seasonal, antidotal observations in commercial chestnut orchards suggest that there is cultivar variation in susceptibility to BER. Replicated cultivar evaluations support producer observations and indicate that even when disease pressure is low, the impact on cultivars could differ. Interestingly, among the nuts with BER, no difference in disease severity were observed. Based on these results we can begin to provide producers with recommendations on cultivar selection, although additional trials will need to be done to confirm our results under moderate and high disease pressure conditions.

Deciphering the disease cycle is the first step in developing sustainable disease management recommendations. The recovery of over 200 *Colletotrichum* spp. isolates from a wide range of tissues provides evidence that *Colletotrichum* spp. is ubiquitous in the chestnut orchard and that specific (yet to be determined) variables and or triggers are associated with the initiation of infections. Daily temperatures (high and low) and rainfall during bloom and the length of the bloom period did not correlate with disease incidence suggesting that bloom time may not be the phenological stage associated with primary infections. However, additional replicated studies and more comprehensive data analyses need to be done before bloom time can be excluded as the primary infection stage.

Table 1. Bloom window, bloom window weather conditions, and disease incidence associated with Chinese and hybrid chestnuts cultivars.

Cultivar	**Bloom Window**	**Bloom Days**	**Total Rainfall per Bloom Window (in)**	**Average Rainfall *(Std Dev)* per Bloom Window (in)**	**Average High Temperature *(Std Dev)* per Bloom Window (°F)**	**Average Low Temperature *(Std Dev)* per Bloom Window (°F)**	**Percent BER at Harvest**
Qing	25-30 June	6	1.06	0.18 *(0.3)*	87.4 *(2.4)*	64.8 *(1.5)*	No crop
Sandaechan	16-20 June	5	3.01	0.60 *(0.1)*	78.6 *(1.9)*	65.1 *(1.9)*	0.0
Perry	16-20 June	5	3.01	0.60 *(0.1)*	78.6 *(1.9)*	65.1 *(1.9)*	3.7
ACE	16-30 June	15	4.92	0.33 *(0.3)*	82.2 *(5.0)*	62.7 *(4.5)*	6.3
Peach	20-23 June	4	1.27	0.32 *(0.4)*	77.6 *(1.7)*	57.6 *(5.6)*	21.2
Szego	25-30 June	6	1.06	0.18 *(0.3)*	87.4 *(2.4)*	64.8 *(1.5)*	11.1
Liu	25-30 June	6	1.06	0.18 *(0.3)*	87.4 *(2.4)*	64.8 *(1.5)*	2.0
Homestead	27 June to 2 July	6	0.58	0.10 *(0.1)*	88.2 *(1.8)*	63.4 *(3.1)*	0.0
							$p<0.00001$