Cotton SOW for National Predictive Modeling Tool Initiative (NPMTI)

Background: Pathogens that are spread by insects or wind pose a community-wide threat to cotton production. Unlike soil-borne pathogens, wind- or insect-dispersed pathogens require community efforts to alert growers to potential threats and minimize both control cost and yield/quality loss. Recent advancements in detecting and modeling the movement of human pathogens can be adapted to plant pathogens with appropriate investment. Predictive tools for foliar pathogens that require preventive measures such as planting resistant varieties, residue incorporation, canopy management, irrigation adjustment, or proactive crop protection treatments can provide growers with timely information to avoid crop damage. All of these are viable and encouraged practices except residue incorporation.

U.S. cotton is spread across 18 southern states where high temperatures and summer rainfall events are intense. To address the resulting threats of soil erosion, rainfall runoff, and soil crusting, cotton growers have adopted soil conservation practices including reduced tillage and cover crops. This focus on soil conservation (although necessary for yield stability) has also prevented use of a key disease controlling tool – residue incorporation (aka sanitation). Historically, post-harvest plant residues were mixed with surface soil to promote rapid decomposition of stalks, leaves, and associated pathogens. With conservation tillage, these residues remain on the surface providing necessary soil health benefits but also leaving pathogen inoculum for future infestations.

Methods to forecast inoculum exposure would allow growers to take timely preventative actions such as: delayed planting, resistant varieties, selective fungicides, crop growth regulators, irrigation management, targeted rotations, and only where necessary – limited tillage.

The diseases that could be addressed include target spot, Alternaria leaf spot, areolate mildew, Aspergillus boll rot, and the seedling disease complex. However, the last two years have demonstrated that the U.S. is highly vulnerable to invasive new pathogens spreading from distant states or countries. A forecast system would provide a much-needed level of detection for new foliar pathogens or more virulent pathogen strains before widespread damage is incurred.

The NPMTI is foundational for leveraging existing human and animal infectious decision support tools for agriculture. Adaptation of these tools for key diseases of cotton will facilitate disease preventive and mitigative management actions. These tools offer decision support at varying temporal and spatial scales and individual tools can be used at different points along the spectrum of crop disease surveillance, from early detection to outbreak management to post harvest investigations.

Statement of Work for 2021: Develop and demonstrate community-wide tools for cotton pathogen prediction and management, through the following tasks:

Objective 1. Create DNA detection tools for cotton pathogens that can be multiplexed and deployed in air sampling systems – This will include the following sub tasks:

a. Field collection of fresh areolate mildew samples (Clemson, Florida, Auburn, and UGA only).
b. The National Agricultural Genotyping Center to validate quantitative probes for areolate mildew.

Objective 2. MANAGEMENT PLOTS with active and passive sampling of airborne spores to build and validate pathogen models. – This task will include the following subtasks:

a. 11 MANAGEMENT PLOTS across the cotton belt (Auburn, U of AR, U of F, UGA, LSU, U of MO, MSU, U of Tulsa, Clemson, U of TN, TAMU) with 2 varieties per plot to create a range of maturities or microclimates.
b. 2 varieties (DP 1646 and local susceptible target spot variety).
c. Non-treated and treated (2 x Priaxor 4 fl oz/a – 1st lesion + 2 weeks later) and collect plot yields.
d. Capture daily weather. Visit plot weekly to collect foliar disease data and limited crop phenology (height, 1st flower, 1st open boll) and replace and ship passive and active air cartridges.
e. Weekly air sampling at all 11 management sites for 4 months (mid-June to mid-October) with 1 tall active sampler, 1 tall passive sampler, and 1 short passive sampler. All samples from all sites will be processed for quantification of *Corynespora cassiicola* (target spot). All samples from 6 sites (UFL, UGA, Auburn, LSU, MSU, Clemson) will be processed for *Ramulariopsis gossypii* (areolate mildew). All samples from Texas and Oklahoma will be processed for quantification of *Alternaria alternata* (Alternaria leaf spot). Samples from the last 5 weeks prior to harvest from Texas and Oklahoma will be processed for *Aspergillus flavus.* Hourly weather data and GIS data on field site, soil type, nearby crop usage will be provided by our data aggregator.
f. The University of Tennessee and the University of Florida will each set up three tall active samplers, three short active samplers, three tall passive samplers, three short passive samplers, three tall 360-degree samplers and three short 360-degree samplers in proximity for n=3 comparisons of weekly readings. All samples from both locations will be processed for *Corynespora cassiicola*. Samples from the University of Florida will be processed for *Ramulariopsis gossypii* as well.
g. Phenotype screening to provide spore sampling equipment and to coordinate air sampling cartridge shipping, spore sampling, pathogen analysis, data collection, data QA, data validation, data storage, and data visualization across all management plots.

Objective 3. COMMERCIAL FIELDS with passive sampling of airborne spores to validate models and demonstrate the utility of pathogen sampling in commercial settings. – This task will include the following subtasks:

a. Install tall passive air samplers at 2 opposing locations (1 downwind and 1 upwind) at each of 2 commercial cotton fields located in each of 11 collaborator states. (Alabama, Arkansas, Florida, Georgia, Louisiana, Missouri, Mississippi, Oklahoma, South Carolina, Tennessee, Texas). Sampler cassettes will be changed out weekly. All cassettes from all sites will be processed for quantification of *Corynespora cassiicola* (target spot). All samples from 6 sites (UFL, UGA, Auburn, LSU, MSU, Clemson) will be processed for *Ramulariopsis gossypii* (areolate mildew). All samples from Texas and Oklahoma will be processed for quantification of *Alternaria alternata*. Samples from the last 5 weeks prior to harvest from Texas and Oklahoma will be processed for *Aspergillus flavus*. Hourly weather data and GIS data on field site, soil type, nearby crop usage will be provided by our data aggregator.

b. Event data will be provided for each location:
    - Planting date
    - Variety
    - Row spacing
    - First bloom date
    - Fungicide application(s) by grower (product/rate/date)
    - Defoliation date
    - Harvest date
    - Yield data (from yield monitor or field ticket)

c. Rating 5 fixed points 150 ft from each air sampler in a linear orientation with the row (30 ft apart)
    - Points to be marked by GPS and flagged
    - Target spot incidence and severity (all locations)
    - Leaf spot complex incidence and severity (all locations)
    - Areolate/Ramularia mildew incidence and severity (6 locations: Alabama, Georgia, Florida, Mississippi, Louisiana, South Carolina)
    - Alternaria leaf spot incidence and severity (2 locations: Oklahoma, Texas)

d. Visit plot weekly to collect disease symptoms, limited crop phenology, and to replace passive air sampler throughout the growing season.
e. If funding allows, aerial imagery will be collected by a contracted drone pilot at 3 time points during the growing season (selected commercial plot locations).

Objective 4. SEED TREATMENT TRIALS to relate soil-borne pathogens, environmental conditions, and seed treatment pesticides to cotton stand establishment.

a. Install standardized seed treatment trials at 9 locations (U of Tulsa, MSU, U of Tenn, UGA, Auburn, TAMU, LSU, U of F, U of AR) with a set of commercially available seed treatments.
b. Collect soil and plant tissue samples for disease prevalence.
c. Capture daily weather including soil temperature.

Objective 5. Create cotton epidemiology models for target spot, Ramularia, and seedling disease to predict disease progression, crop impact, and pathogen load.

Objective 6. Archive all data, models, and samples from Objectives 2 and 3 to allow future investigators to improve models and tools and to retrospectively identify invasive pathogens or virulent strains.