PROJECT SUMMARY

Overview:

Scientists in Arkansas and Missouri propose to create an interdisciplinary, state-of-the-art Bioimaging Consortium that will enable researchers to adapt food, fiber, and fuel crops to meet the challenges of a changing climate and a growing world population. Molecular imaging (MI) techniques such as positron emission tomography (PET) are uniquely suited to capture the spatial and temporal dynamics of rapid physiological responses to environmental or biotic stresses, while high-throughput phenotyping (HTP) can compare the longer-term fitness consequences of these responses in numerous genotypes. Together these bioimaging technologies have transformative power to identify genetic sources of stress tolerance. However, adoption of MI and HTP in the plant science community is hampered by limited access to infrastructure and a lack of well-established plant-specific tools and protocols. The proposed consortium will convert previously unlinked, privately-owned physical infrastructure for HTP and MI into core facilities, and make these resources accessible to a plant biology network of more than 130 researchers across Arkansas and Missouri. The program will also unite plant biologists with experts in radiochemistry, phenomics, and computational biology to create the tools, protocols, common standards and cyber-infrastructure needed to establish a unified field of plant bioimaging. This project will: 1) Establish virtual core facilities that will build regional access to and capacity in HTP and MI and position Arkansas and Missouri as national leaders in the emerging field of plant Bioimaging; 2) Develop the imaging tools and approaches needed to understand the spatial and temporal dynamics of plant stress responses; 3) Create public and private repositories for biological imaging data to facilitate research and promote international standards for the design, analysis, and reporting of bioimaging experiments; 4) Train a multi-faceted sustainable workforce that can apply 21st century technologies to address global challenges in food security and agricultural sustainability; and 5) Build pathways to promote scientific literacy and to draw a broad and diverse talent pool into the fields of biology, chemistry, and computational science. To achieve these objectives, the Bioimaging Consortium will develop collaborative, interdisciplinary experimental models that will apply HTP and MI to study four fundamental physiological processes in plant stress adaptation: micronutrient transport, accumulation of reactive oxygen species, antioxidant metabolism, and partitioning of photoassimilates. Using these models as testing grounds, the consortium will develop the protocols, analytical methods, and specialized tracers needed to apply HTP and MI to plant stress biology, and will develop a repository for bioimaging data to promote universal minimum reporting standards. A seed grant program will also expand access to bioimaging infrastructure in Arkansas and Missouri, and stimulate interdisciplinary, multi-institutional collaborations across state lines. These four models and the seed grant program will generate results that could not be achieved by individual investigators, or by either state alone.

Intellectual Merit :

Intellectual Merit: This interdisciplinary consortium will respond to the global climate challenge and address one of the National Academy's 5 Grand Challenge areas in Biology: to predict an organism's phenotype based on its genotype. Bioimaging technologies have transformative potential to overcome the phenotyping bottleneck that currently limits our ability to predict the phenotypic consequences of genetic variation.

Broader Impacts :

Broader Impacts: This project will significantly benefit the agriculture-based economies of Arkansas and Missouri. It will generate new tools and discoveries to reduce crop losses to stresses such as drought, salinity, insects and diseases, which together are the single greatest limitation on agricultural yields. Moreover, it will promote diverse and inclusive workforce development practices while training students and creating linkages with private industry through internships and joint seminar series. Lastly, the consortium will promote STEM education by working with industry to develop a new competency model for primary and undergraduate education in emerging biology fields (i.e. bioimaging). This model would be implemented by disseminating a hands-on teaching module for K12 teachers to develop key competencies, and by creating undergraduate and graduate course modules.