Plant Stress Biology - Programmatic Description & Priorities
June 2011

Plant abiotic and biotic stresses result in major limitations to agricultural production in Missouri, the nation, and the world. Plant stresses of foremost economic importance include drought, flooding, temperature stress (cold and heat), nutrient stress (soil mineral deficiencies and toxicities), plant disease, insect damage, and the global impacts of a changing climate. Development of economical and environmentally sustainable approaches to limit the effects of plant stress on agricultural production is one of the major challenges facing plant science researchers today. To address these challenges, the Plant Stress Biology programmatic area supports fundamental research from the molecular to the systems level to provide a solid knowledge base from which to develop new or improved strategies for decreasing the impact of abiotic and biotic stresses on agricultural productivity and sustainability. The programmatic area in plant stress biology builds and expands upon existing world renowned research strengths at MU, ranging from drought stress physiology to plant disease resistance. **Our current priorities include the areas of plant-microbe and plant-insect interactions, plant nutrition, drought physiology, and root biology with particular focus on soybean, grape, maize, grasses, and the model plant Arabidopsis.** Our goal is to bring experts in the field together to promote and foster interaction among researchers and train the next generation of scientists interested in solving problems in plant stress biology to create an environment that will bring MU to the forefront of the field.

List of four faculty position priorities (not prioritized):

- Fungal molecular biologist
- Plant stress metabolism
- Biotic plant stress biologist
- Rhizosphere biologist

<u>Fungal Molecular Biologist</u>

Justification
The Division of Plant Sciences has a critical mass of research groups focused on plant stress biology, a recognized strength within the Division and among the plant biology community at MU as a whole. However, despite this strength there has been a long-standing gap in research addressing fungi and fungal-like organisms. Fungi represent the most diverse and least understood kingdom of eukaryotes. Among plant pathogens, fungi belong to the economically most devastating class. Over eighty percent of land plants also have beneficial interactions with fungi in the form of mycorrhizal associations, which improve plant nutrition and water status. Fungi therefore directly and indirectly fundamentally shape plant interactions with their environment. While a gap in fungal molecular biology within the Division has been recognized for years, only recently have genomic tools become available that allow a comprehensive study of fungi and fungal-like organisms. These approaches will complement existing strengths in plant genomics, developmental biology and mycology to address long-standing open questions about the molecular foundations of fungal development and genetic diversity shaped by sexual or asexual reproduction and evolution. All of these have a direct bearing on beneficial and detrimental interactions of fungi and fungal-like organisms with plant hosts.

Responsibilities
Assistant Professor, Fungal Molecular Biology, tenure track, research and teaching (80/20%). The successful candidate will conduct innovative basic research on the biology of filamentous fungi or fungal-like organisms. The candidate will complement and strengthen existing research programs without duplicating them. In addition, the candidate will fill important gaps in undergraduate and graduate instruction. Areas of emphasis could include but are not limited to:

- fungal or fungal-like pathogens
- mycorrhizal fungi
- fungal endophytes
- diversity and evolution of fungal effector suites
- fungal developmental biology, in particular as it relates to structures such as appressoria, haustoria or arbuscules
- fungal reproduction
- intersections between fungal-plant interactions and abiotic stress (e.g. nutrients, water)

Potential linkages and partnerships
Includes but not limited to: Interdisciplinary Plant Group; USDA-ARS, Extension, Plant Diagnostic Clinic, Forestry, Molecular Microbiology and Immunology, Mizzou Advantage (Food for the Future and Bioenergy areas), corporate (Monsanto, Pioneer, etc).

Plant Stress Metabolism

Justification
The Division of Plant Sciences and Interdisciplinary Plant Group have research strengths in plant responses to abiotic and biotic stresses, including adaptation to drought, heat and flooding, and tolerance to pathogens. However, research programs that focus on the interface between the genetic and physiological aspects of stress responses are lacking. This interface requires a biochemical and metabolic research focus that translates phenotypic and physiological responses to stress to gene and protein function. Such a research focus, coupled with our existing genetic and physiological strength, offers the most promise for deepening our understanding of the ways in which plants adapt to stresses and for enhancing our ability to use genetic strategies for crop improvement. A biochemical and metabolic focus would not only fill the large gap that exists within current research programs but also fill a critical need in our teaching curricula. New technologies have fueled a renewed interest and capability to explore plant metabolism and this is a key integrative area that will drive plant stress biology for the foreseeable future. Strategically, this is a critical need to enhance the success and impact of the Division's plant stress program.

To achieve this goal, we seek to fill a new position with a candidate who studies aspects of plant metabolism under abiotic and/or biotic stress that will complement existing strengths on campus and will lead to new research synergisms.

The current priority areas of the Plant Stress Biology programmatic area include plant-microbe interactions, plant-insect interactions, plant nutrition (a former strength, now identified as a high priority gap), drought physiology, and root biology. An understanding of plant metabolism is central to all of these areas and the possible linkages between integrated plant responses to multiple stresses. Expertise in plant metabolism is also critical to modernizing the training of undergraduate and graduate students in the areas of basic and applied plant biochemistry. The position will complement a new position in plant metabolism in the Division of Biochemistry for which a search is in progress, and will help to restore the loss in plant biochemistry expertise at MU that resulted from the recent retirements of Art Karr and Dale Blevins in DPS and Doug Randall and Joe Polacco in Biochemistry.

Responsibilities
Assistant/Associate/Full Professor, Plant Stress Metabolism, tenure track, research and teaching. The successful candidate will conduct innovative research on the metabolism of plant stress responses. In addition, the candidate will fill important gaps in undergraduate and graduate instruction. Areas of emphasis could include but are not limited to:

- Metabolomics

- Metabolic flux modeling
- Source sink relationships and carbon/nitrogen cycling
- Systems biology
- Plant nutrition
- Stress response cross-talk and signaling

Potential linkages and partnerships
Includes: IPG; Biochemistry; Mizzou Advantage (Food for the Future and Bioenergy areas); Nutrition (animal and human); USDA-ARS; Danforth Center; corporate (Monsanto, Pioneer, etc).

Note
In relation to this position, we urge consideration of competing for Mizzou Advantage matching funds to pursue the appointment of Dr. John Cushman, Univ. Nevada-Reno (Full Professor level). Dr. Cushman is strongly interested in the possibility of a position at MU both because of our strength in plant stress biology and because of the economic downturn at the University of Nevada-Reno. Dr. Cushman is an internationally recognized expert in the biochemistry and metabolism of plant responses to abiotic stresses, including drought and salinity. His interests and expertise also encompass several other areas of great interest to the Division and IPG, including the metabolism of CAM plants and algal systems as related to bioenergy, grape genomics, and extension/outreach education. Recruitment of Dr. Cushman represents a unique opportunity to synergize and strengthen several key areas of the Division's research and educational programs. This recommendation was the unanimous opinion of the search committee for the recently filled plant stress biology position, and is supported by the IPG Executive Committee.

Biotic Plant Stress Biologist

Justification
The University of Missouri as a whole and the Division of Plant Sciences in particular have a recognized research strength in plant responses to abiotic and biotic stresses. With the acceleration of global climate change, the Midwest will face challenges from the introduction of new biotic stress agents (e.g. insects and plant pathogens) to shifting population dynamics and altered multitrophic interactions. We therefore seek to fill a new position with a candidate who would address biological questions at multiple levels (systems biologist) employing a range of techniques from molecular to ecological. The candidate would focus on the systems biology of the impact of stress on plant pests and diseases in order to discover general principles that quantitatively describe these complex interactions.

Responsibilities
Assistant Professor, 12 month, tenure track; 80% research, 20% teaching. The Division of Plant Sciences, University of Missouri, invites applications for a tenure-track position focused on plant interactions with biotic stress agents to complement and strengthen existing research programs without duplicating them. A Ph.D. with training in plant pathology, entomology, plant biology or related field and postdoctoral experience is required. The successful candidate will be expected to establish an active, extramurally funded research program; areas of emphasis could include but are not limited to:

- Insect vectors of plant pathogens
- Multitrophic interactions
- Influence of environment on diseases or pests
- Emergence of new diseases and pests in the Midwest
- Plant response to pathogens or insect pests
- Molecular biology of plant pest and disease interactions

The successful candidate is expected to participate in the teaching (undergraduate and graduate) and service missions of the Division of Plant Sciences. The candidate will be expected to contribute to the

curriculum in the plant stress biology program area. The University of Missouri has a long history of excellence in plant science and provides a rich environment for research collaboration.

Potential linkages and partnerships
Includes but not limited to: Interdisciplinary Plant Group; USDA-ARS, Extension, Plant Diagnostic Clinic, Forestry, Molecular Microbiology and Immunology, Mizzou Advantage (Food for the Future and Bioenergy areas), corporate (Monsanto, Pioneer, etc).

Rhizosphere Biologist

Justification
The Division of Plant Sciences has research strength in several areas of plant root biology, with particular focus on root responses to abiotic and biotic stress conditions. Current programs include: physiology and genetics of root growth and development under drought in maize and soybean; biology of soybean root hair responses to abiotic stresses including drought and heat; maize/western corn rootworm/drought interactions; soybean/soybean cyst nematode interactions; soybean root/*Phytophthora* interactions.
To date, most research on the biology of root responses to stress conditions has focused on responses to single stresses, and has generally utilized controlled environment studies of model systems. These limitations are applied because of the relative difficulty in studying root systems, sometimes referred to as "the hidden half" of the plant, and because of the complexity of variables that exist in the rhizosphere under field conditions, such as soil quality, nutrient status, and microbial populations. While it is often inferred that results obtained under controlled environments extrapolate to field conditions, testing the validity of this assumption usually remains left for 'future studies'. However, without long-term strategic planning and commitment, these extremely important field studies are never initiated. Thus, a critical need in the Division's studies of root adaptation to abiotic and biotic stresses is to "scale up" to the study of root stress biology under natural field conditions. To help achieve this goal and to capitalize on the Division's research strength in root biology, we seek to fill a new faculty position in rhizosphere biology as it relates to stress (abiotic and/or biotic) and/or plant nutrition. The proposed position will greatly enhance MU's established international presence in the area of root biology.

The current priorities of the Plant Stress Biology programmatic area include plant-microbe interactions, plant-insect interactions, plant nutrition (a former strength, now identified as a high priority gap), drought physiology, and root biology. An understanding of the rhizosphere is central to all of these areas, and is also of importance for other research interests in the Division including pest and disease management, precision agriculture, water quality, and bioremediation.

Responsibilities
Assistant Professor, Rhizosphere Biology, tenure track, research and teaching (possible split 70/30%). The successful candidate will conduct innovative research on the biology of root interactions with the soil abiotic and biotic environment in order to gain a deeper understanding of these complex interactions. The candidate will complement and strengthen existing research programs without duplicating them. In addition, the candidate will fill important gaps in undergraduate and graduate instruction. Areas of emphasis could include but are not limited to:

- Mycorrhizal and nitrogen-fixing symbioses
- Pathogen and pest interactions
- Root-shoot signaling and root and shoot growth promotion
- Molecular communication
- Multitrophic interactions
- Water and nutrient use efficiency
- C and N cycling

Potential linkages and partnerships

Includes: Interdisciplinary Plant Group; Natural Resources (including Agroforestry, Soil Science); Mizzou Advantage (Food for the Future and Bioenergy areas); Nutrition (animal and human); corporate (Monsanto, Pioneer, etc).