V(A). Planned Program (Summary)

Program # 3

1. Name of the Planned Program

Plant Biological Technology

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
123	Management and Sustainability of Forest Resources	0%		5%	
132	Weather and Climate	0%		5%	
201	Plant Genome, Genetics, and Genetic Mechanisms	0%		25%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	0%		15%	
206	Basic Plant Biology	0%		15%	
211	Insects, Mites, and Other Arthropods Affecting Plants	0%		5%	
212	Diseases and Nematodes Affecting Plants	0%		30%	
	Total	0%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	12.0	0.0
Actual Paid	0.0	0.0	12.2	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
0	0	607491	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	607491	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	3010905	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

- Design and conduct research, including the development of methods and procedures
- Write and submit grant proposals to private, state and federal agencies
- Generate scientific publications - communicating scientific results to a wide range of scientists
- Training of professional scientists - graduate and undergraduate students, technicians and post docs in the scientific discipline
- File patents

2. Brief description of the target audience

- Scientists and scientific societies
- Governmental science organizations
- Educational institutions
- Applied researchers and extension specialists
- Students
- Private, federal, state, and industrial funding agencies
- Other stakeholders (producers, consumers, educators, public)

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2014	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	0	0	0	0

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year: 2014

Actual: 4

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	0	36	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Grant proposals written and submitted

Year	Actual
2014	36

Output #2

Output Measure

- Peer-reviewed publications including journal articles

Year	Actual
2014	38

Output #3

Output Measure

- Graduate students graduated

Year	Actual
2014	11

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Graduate students graduated
2	Improving biomass yield and stress tolerance of biomass crops
3	Adaptation to abiotic stress

Outcome #1

1. Outcome Measures

Graduate students graduated

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	11

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
206	Basic Plant Biology
212	Diseases and Nematodes Affecting Plants

Outcome #2

1. Outcome Measures

Improving biomass yield and stress tolerance of biomass crops

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
: Increase in global temperature, air pollutants such as ozone and the erratic rainfall regimes leading to extended drought pose significant threats to agricultural production not only in Oklahoma, but the entire world. The decrease in arable land compounded by the climate change issues has led to significant reductions in crop yields that will ultimately impact the cost of food, fuels and fodder. Understanding the molecular processes in plants that leads to this decrease in production will provide us with tools for tweaking those pathways and ensure sustainable production in the wake of climate change.

What has been done
Identifying key genes involved in drought stress signaling will provide rational candidates for engineering drought resistant plants. Since drought is a perennial problem in the state of Oklahoma, our research on characterizing key genes involved in drought resistance will have a significant economic impact. Drought is a problem that affects US agriculture and nearly 80% of yield losses world-wide are attributed to water-deficits.

Results
Our research on the Arabidopsis RNA binding protein involved in drought signaling shows the interconnections between the biotic and abiotic stress signaling mechanisms in plants. In the future we will determine the functional role of RBP45b in drought signaling. We will seek to identify the homologs of this key drought responsive protein in wheat. We are also expanding our research on drought in switchgrass, an important biofuel crop. Understanding how the switchgrass plants are able to generate their massive biomass with very limited water will enable us to engineer plants with high water use efficiency.
Plants are exposed to multiple stresses simultaneously in nature. Yet, most studies of plant stress responses are conducted using a single stressor at a time. A combination of drought and ozone stress simultaneously in Medicago truncatula evoked unique sets of genes that were not identified when the stressors were applied singly. This indicates plants perceive combined stress as a new stress state and not just an additive effect of the single stresses. These results indicate that studies on stress tolerance should consider co-occurring stresses that are likely to occur in field conditions.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
206	Basic Plant Biology

Outcome #3

1. Outcome Measures

Adaptation to abiotic stress

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	6

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
MicroRNAs, a class of small noncoding RNAs are, well known for their gene regulatory roles by destroying or repressing translation of the mRNA targets. We are conducting research that might identify miRNAs that might be important for adaptation to abiotic stress conditions. Our recent studies in this direction are described below.

What has been done
1). Identification of oxidative stress induced microRNA in Arabidopsis
Our previous research has shown that miR398 that targets superoxide dismutases is down-regulated under oxidative stress conditions. In contrast, we found an oxidative stress-induced miR395 in Arabidopsis. Because this miRNA is highly conserved among the angiosperms it is highly likely that it will also be regulated in similar fashion in other pants as well.
2). Identification of the upstream biochemical pathway involved in regulating miR395 expression under stress conditions using mutants defective in redox signaling.
In plants, changes in cellular redox properties have been observed under a variety of biotic, abiotic stresses including nutrient deprivation. It has been reported previously that the reduction potential was increased in spinach leaves subjected to S- and P-deprivation and N-deprivation. The readjustment of redox homeostasis fails when excessively available electrons are transferred to oxygen producing reactive oxygen species (ROS), establishing strong electron sinks and thus inducing oxidative stress. The thiol redox homeostasis is maintained by NADPH-dependent

thioredoxin reductases (NTRa, -b and -c) - thioredoxin (TRX) and glutathione reductase - GSH-dependent glutaredoxin (GRX) systems that modify target proteins facilitating stress responses in plants. In order to identify if redox signaling plays a role in miR395 expression under S-deprivation, we used cad2 mutant which partially defective in GRX system, and ntra/ntrb double mutant which is partially defective in TRX system as well as ntra/ntrb/cad2 triple mutant, which is partially defective both in GRX and TRX systems. Compared to wild-type miR395 levels, in single (cad2), double (ntra/ntrb) and triple (ntra/ntrb/cad2) mutants grown under S- deprived conditions approximately 20, 50% and 45% decrease in induction of miR395 levels, respectively. These findings unequivocally demonstrated the involvement of redox signaling in inducing miR395 expression under S-deprivation. Our lab and many other laboratories around the world have shown that the expression of miRNAs is either induced or down-regulated under stress in a variety of plant species. However the upstream signaling pathway that regulates/activates these miRNAs is completely unknown. The study reported the first characterization of upstream biochemical pathway involved in regulation of a miRNA expression in plants.
3) The Role of microRNAs in salt tolerance of Thellungiella salsuginea and T. parvula
Soil salinity is one of the primary causes of crop losses worldwide. Thellungiella salsuginea and T. parvula, both are naturally adapted salt-tolerant species, thus emerged as important model systems for dissecting molecular basis of salt tolerance in plants. Although both of these species are salt-tolerant compared to its close relative Arabidopsis, but differ in their tolerance to salinity. The analysis of these two plant species will allow comparison of the responses between two closely related plant species with contrasting salt tolerance. miRNA profiling has revealed numerous novel miRNAs expressed in these plant species. Most importantly several conserved miRNA families and novel miRNA families are differentially regulated during salt stress.

Results
Six peer-reviewed journal articles were published in 2014. Funding from the NSF-REU helped in recruiting an African-American student (female) from Langston University in the summer of 2014. Significant progress has been made in the OCAST funded project on characterization of miRNAs involved on salt tolerance. Scientists chaired a session on Abiotic Stress at the PAG-Asia-2014, Singapore and co-chaired a session at the Pearl Millet Genome Sequencing Consortium, Shenzhen, China; and were invited to give a seminar in the International Crops Research Institute for Semi-Arid Tropics (ICRISAT), India, Kunming University of Science and Technology, China, University of South Dakota, Vermillion, and University of Alabama, Huntsville.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
206	Basic Plant Biology
212	Diseases and Nematodes Affecting Plants

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges

Brief Explanation

Research in plant biotechnology and crop improvement has been negatively impacted by the very limited federal funding for agricultural research in general. Further, irrational levels of government regulation, mostly at the international level, regarding transgenic plants has a serious chilling effect on research progress in this area.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

None

Key Items of Evaluation

None