

V(A). Planned Program (Summary)

Program # 8

1. Name of the Planned Program

Turfgrass Development and Management

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
111	Conservation and Efficient Use of Water	20%		10%	
201	Plant Genome, Genetics, and Genetic Mechanisms	0%		5%	
202	Plant Genetic Resources	5%		10%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	10%		10%	
204	Plant Product Quality and Utility (Preharvest)	10%		5%	
205	Plant Management Systems	25%		15%	
206	Basic Plant Biology	0%		5%	
211	Insects, Mites, and Other Arthropods Affecting Plants	10%		10%	
212	Diseases and Nematodes Affecting Plants	10%		10%	
216	Integrated Pest Management Systems	10%		20%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	1.5	0.0	2.0	0.0
Actual Paid	5.0	0.0	1.9	0.0
Actual Volunteer	0.2	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
74000	0	92423	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
74000	0	92423	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
638400	0	458073	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

New turf germplasm/varieties having improved abiotic and biotic stress resistance/tolerance will be generated and tested by our program. Research will identify the elite performing species and varieties from both our program and from industry. Elite performing material from our program will be commercialized over time. We will identify new or refined integrated management practices to achieve goals. Research and extension activities will be conducted to improved efficiency of water application and to reduce runoff. Educational materials will be developed featuring improved varieties and how to properly install and maintain them in an environmentally sound manner. Highly effective educational programming and consultations will be conducted for professionals and consumers to help integrate this information into existing management programs.

2. Brief description of the target audience

Audiences include governmental, private industry and multiple end-user areas. Research audiences: basic and applied plant science/turf science researchers, including those from the American Society of Agronomy (ASA), Crop Science Society of America (CSSA), and American Society for Horticultural Science (ASHS). Funding agency audiences: USGA, GCSAA, USDA, OCAST, OTRF and many private corporations. New cultivars developed as well as products such as trade articles, fact sheets, and educational programming will be provided to the target audiences characterized as the turfgrass production sector (sod and seed producers), service sector (landscape/lawn care and pest control operators) and turf managers (which include the golf course, parks & grounds, right of way managers and home consumers).

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	6496	240000	200	14652

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

Patent Applications Submitted

Year: 2014
 Actual: 0

Patents listed

?Latitude 36 Turf Bermudagrass?(*Cynodon dactylon* X *C. transvaalensis*). US Plant Patent 24,271. Issued: 02-25-2014. Inventors: Wu, Y., D.L. Martin, C.M. Taliaferro, J.A. Anderson and J.Q. Moss. On-line at: <https://www.google.com/patents/USPP24271>.

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	6	8	14

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of final stage experimental bermudagrasses sent to national testing phase in the NTEP bermudagrass trial once every 5 years

Year	Actual
2014	0

Output #2

Output Measure

- Number of fine turf program and roadside vegetation management workshops conducted and trade presentations presented each year.

Year	Actual
2014	51

Output #3

Output Measure

- Number of new bermudagrasses developed by our program that are commercially released to the trade for production.

Year	Actual
2014	0

Output #4

Output Measure

- Number of cultivar evaluation trials; weed control trials; management factor trials; and physiological, morphological or other investigations conducted on turfgrass.

Year	Actual
2014	67

Output #5

Output Measure

- Number of scientific abstracts, posters or oral presentations presented to scientific audiences.

Year	Actual
2014	15

Output #6

Output Measure

- Number of turfgrass managers trained in recognition and selection of improved varieties and implementation of integrated turfgrass management systems

Year	Actual
2014	1610

Output #7

Output Measure

- Number of email news releases and fact sheets generated

Year	Actual
2014	55

Output #8

Output Measure

- Number of consultation phone calls and emails completed

Year	Actual
2014	6000

Output #9

Output Measure

- Number of improved experimental bermudagrass types developed by our program that are not yet commercially available but have been advance to USDA-SCRI regional trial testing

Year	Actual
2014	5

Output #10

Output Measure

- Number of new licensees recruited for existing commercialized releases.

Year	Actual
2014	10

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of sod/seed producers growing OSU turf bermudagrasses
2	Number of sod/seed producers growing Oklahoma State University suggested turf bermudagrasses
3	Percentage of professionally managed properties using improved turfgrasses
4	Percentage of professional fine turf managers continuing adoption of improved BMPs and IPM practices
5	Percentage of ODOT roadside vegetation managers continuing adoption of improved BMPs and IPM practices
6	Effect of Low Temperature and/or Drought on Turfgrass

Outcome #1

1. Outcome Measures

Number of sod/seed producers growing OSU turf bermudagrasses

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	52

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Once new varieties of turfgrass have been developed by teams of scientists and the varieties have been released by the University, new producers must be recruited to grow the improved varieties so they can be made conveniently available for both professionals and consumers to purchase at an affordable price with acceptable transportation/shipping costs.

What has been done

OSU Turfgrass Team faculty worked diligently with the existing exclusive licensees of Yukon, Riviera, Patriot, Latitude 36 and NorthBridge bermudagrasses to recruit new producers (sublicensees) of OSU bermudagrass products in 2014. Team members suggested prospective sublicensees to be added and assisted in answering questions of prospective sublicensees to facilitate new growers feeling comfortable in signing up to produce OSU products in pedigree stock certification in their respective states.

Results

Through the joint efforts of OSU selected licensing agent Sod Solutions, Inc, 10 new producers (sublicensees) of OSU bermudagrass products were signed on in 2014 to produce Latitude 36 and NorthBridge. Consultation by OSU faculty with existing producers and prospective new licensees resulted in retention of all existing sublicensees and the addition of 10 new sublicensees and two additional states of production being added. A total of 52 producers in the US and one producer in Europe are growing one or more of the five OSU proprietary, turf-type bermudagrasses with improve quality and cold-hardiness. Growers of the products in the southern US were able to sell to new target areas of installation in the northeastern US where winter-kill had led to common bermudagrass stand loss. Sod producers are able to make at least

a three to five cent per square foot premium on production of high quality winter-hardy bermudagrasses and to somewhat escape the "commodity-like" market place of variety-not-stated common bermudagrass sod production which keeps sale prices and grower profits reduced in the industry as a whole. By mid-2015 to early 2016 professional and homeowners will be able to purchase OSU bermudagrass sod products at a more affordable price from the new 2014 licensees due to less shipping distance from the nearest sod producer. In 2014, the OSU generated bermudagrass Latitude 36 was installed on the infield of the Kansas City Royals, who hosted over half of the games of the World Series. Additionally, NorthBridge was installed on the playing surface of Arrowhead Stadium, home of the Kansas City Chiefs. These installs show the high level of acceptance of the OSU bermudagrasses that demonstrated improved winter hardiness, visual quality and high levels of traffic tolerance. Replacement of winter-susceptible type bermudagrass will be a multi-year, on-going process.

4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
205	Plant Management Systems

Outcome #2

1. Outcome Measures

Number of sod/seed producers growing Oklahoma State University suggested turf bermudagrasses

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	15

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

For 5 decades, 90% of the square footage of warm-season varieties produced and sold as bermudagrass and zoysiagrass sod in Oklahoma consisted of common bermudagrass sold as U-3, Tifway (419) hybrid bermudagrass and Meyer (Z-52) zoysiagrass. These grasses were

considered the standards for operating a successful sod production business and standards understood by the purchasing lawn and landscape industry. However, turfgrass cultivar development programs both within and outside of Oklahoma had generated a number of cultivars with superior quality and stand persistence that were either equal or better in performance than the long term standards. Additionally, newer clonal lines tend to exhibiting higher genetic purity than the old standard lines.

What has been done

Research, demonstration and extension education efforts intensified in the early 1990s and continued in 2014 in an effort to increase product choice available for the consumer and professional alike. A series of 12 trials with newly commercialized and old standard variety bermudagrasses and zoysiagrasses were conducted over the last 25 growing seasons to demonstrate to sod producers, seed producers and end users the field performance of newly commercialized varieties compared to old industry standard types. A yearly turfgrass conference and trade show as well as alternate year field days, extension fact sheets and over 17,000 one on one consultations (average of >700 per year) have been conducted over 24 years to these customer groups to discuss new turfgrass options available for licensing, production and purchase.

Results

While U-3, Tifway and Meyer zoysiagrass still make up the greatest majority of square footage of sales to the construction market, approximately 36% (15 of 41 total producers) of the sod production industry in Oklahoma have diversified production to include Astro hybrid bermudagrass, El Toro zoysiagrass and various new tall fescue/Kentucky bluegrass blends and buffalograsses. Additionally, 7% of the total producers (3 of 41) producers have diversified to include new proprietary bermudagrasses Riviera, Patriot, Latitude 36 and Northbridge which have superior performance traits compared to old standard types. The new proprietary types offer a 3 to 5 cent per square foot profit potential over older standard types. Adoption of proprietary types is limited based on market structure, requirement for pedigree stock production standards and a cap set on number of producers licensed and in some cases limited access to markets due to presence of "no sole source bid" restrictions. It is hoped that the visibility of successes in production of new proprietary types will lead to increased willingness by producers to adopt additional new varieties in the future as they become available for production.

4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
205	Plant Management Systems

Outcome #3

1. Outcome Measures

Percentage of professionally managed properties using improved turfgrasses

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

Percentage of professional fine turf managers continuing adoption of improved BMPs and IPM practices

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	94

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

A majority of both biotic and abiotic problems facing turfgrass managers can be reduced or completely controlled through the use of Best Management Practices (BMPs) and Integrated Pest Management (IPM) strategies. Use of the best adapted cultivars of turfgrass is the cornerstone of both a successful BMP and IPM program. Pests continue to evolve to exploit weaknesses in defense systems posed by turfgrasses. Because of this arms race between pest and host plant, continued development of and implementation of use of improved turfgrasses and improved management practices will be required for the foreseeable future, just as in any cropping system.

What has been done

In 2014, 250 turfgrass industry professionals attended the annual Oklahoma Turfgrass Conference and Trade Show. An estimated 1360 attended 13 turf and pest management sessions offered by various Turfgrass team members around the state. Over 6,000 professionals receive one-on-one consultations primarily through post-conference oral consultation, email, phone, US mail and site visits each year. Simple post conference surveys and oral surveys are

administered at several of the sessions to assess adoption of improved turf management practices.

Results

Recent surveys following yearly education sessions to professional Turfgrass managers have revealed that 94% of attendees are employing techniques that are Best Management Practices. These practices can involve use of newer or best adapted cultivars/species, soil-test based fertility programs, selection of proper mowing and irrigation regimes as well as regular pest scouting and use of economic thresholds concerning treat or no treat decisions. Use of BMPs and IPM helps reduce un-necessary pesticide and reduce over use of fertilizers and irrigation, yield an acceptable Turfgrass stand at an affordable/acceptable cost.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
216	Integrated Pest Management Systems

Outcome #5

1. Outcome Measures

Percentage of ODOT roadside vegetation managers continuing adoption of improved BMPs and IPM practices

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	100

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

An erosion resistant, aesthetically pleasing, low growing, low maintenance vegetation is required for the 240,000 acres of state department of transportation maintained right of way adjacent to concrete and asphalt roads in Oklahoma. Plant community succession is an every present factor affecting species composition in the roadside right of way. ODOT Policy states that plant materials in the safety or clear zone must never exceed 12 inches in height and when mowed should not be mowed lower than four to six inches in height.

What has been done

For 28 years (since 1986) the Oklahoma State University Roadside Vegetation Management Team has been performing annual extension education aimed at development of Best Management Practices (BMP) as well as Integrated Pest Management Practices (IPM) for Oklahoma Department of Transportation vegetation management employees. Annual research projects on roadsides have been underway since 1963 and continued in 2014.

Results

The OSU RVM team annually trains over 630 ODOT employees in BMPs and IPM. Each employee trained (100%) has adopted at least one (and often several more) of the BMP and IPM techniques. These improved management techniques were taught in 2014 through three initial pesticide applicator certification schools (78 attendees), three annual herbicide sprayer calibration workshops (70 attendees) and 14 annual continuing education workshops (637 attendees). There is no single practice or always a ridged set of practices to solve any given problem. ODOT uses an integrated vegetation selection, mowing and herbicide application program to manage the 240,000 acres of right of way. Each ODOT employee engaged in roadside management is using at the minimum at least one integrated practice. Adoption of BMPs and IPM techniques coupled with integration of the latest research results into product bid specifications followed by competitive bid process results annually in a savings of over \$120,000 in ODOT roadside vegetation maintenance costs.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
216	Integrated Pest Management Systems

Outcome #6

1. Outcome Measures

Effect of Low Temperature and/or Drought on Turfgrass

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)

Drought and cold temperature stresses are major limiting factors for sustainable specialty crop production in Oklahoma and the United States. Turfgrass occupies the largest acreage of intensively managed plant material in the U.S. Thus, developing resistant germplasm and elucidating the mechanisms of injury and resistance in response to combined or single stress is critical for economic, environmental, and societal benefit. The objectives of this research are to: 1) evaluate elite turfgrass germplasm with improved cold tolerance and drought resistance from Oklahoma State University Turfgrass Program and industry standards; and 2) elucidate specific physiological and molecular mechanisms associated with stresses.

What has been done

Membrane lipid molecules in "Premier", "Celebration" and "Latitude 36" bermudagrasses were profiled under well-watered and drought stressed conditions. Dehydrin protein expression differences in these grasses was identified, measured, and explained under well-watered condition and drought stress. The response of "OKC1113", "Celebration", and "Tifway" to chilling stress was evaluated and their membrane lipid molecular species was also profiled and specific proteins related to chilling stress are still being identified.

Results

Lower monogalactosyldiacylglycerol (MGDG) and higher phospholipid contents contribute to drought resistance in bermudagrass. The 16- and 23-kDa dehydrin expressions could be associated with drought tolerance and contribute to drought tolerance in bermudagrass. Membrane stability is a core trait for cold and drought stresses in many plant systems. Identification of the responsiveness of membrane lipid composition to single and combined drought and low temperature stress will provide tools for marker-assisted breeding by screening germplasm for drought and low temperature stresses. Furthermore, integration of the lipidome and protein expression data will facilitate understanding the mechanisms of bermudagrass lines that are tolerant to multiple abiotic stresses.

4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
206	Basic Plant Biology

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges

Brief Explanation

During 2014 there were very few factors that hindered adoption of IPM, BMPs and use of new or better adapted species with the exception of those areas that were plagued by persistent drought and where the cost of irrigation water for a new install or limitations on the availability of irrigation water negatively impacted the installation of new varieties. Due to drought in northcentral Oklahoma we postponed an ODOT-funded roadside vegetation management tour of right of way demonstration sites. This planned tour was rescheduled for summer of 2015. With respect to the implementation of BMPs, the persistent drought in southwestern Oklahoma and other western states increased the willingness to adopt future BMPs. This is due to the drought causing focus on the most fundamental problems (drought resistant varieties) and minor distractions such as lighter color or coarser leaf texture become tertiary compared to having a grass with improved stress tolerance and or lower water use rate. There were legal title issues that negatively impacted our ability to facilitate a new grower of buffalograss in western Oklahoma. Currently there are no buffalograss sod producers in Oklahoma west of I-35. The closest locations for buyers in southwest Oklahoma are the Ft. Worth area and Amarillo, TX. At least one new Oklahoma buffalograss producer is expected in western Oklahoma in the next two years.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Adoption of new cultivars and educational practices are informally assessed during one-on-one consultations by phone, email and site visits. Formal post-educational session adoption of new varieties and management techniques is regularly assessed at the OSU Turf TIP Team's premier educational event, the Oklahoma Turfgrass Conference and Trade Show as well as in one-on-one consultations following the annual Turfgrass Short Course, at Turfgrass Field Day and during the time of end-user site visits. Eight one-half day round table discussions are held around Oklahoma in September of each year to respond to concerns and questions posed by Oklahoma Department of Transportation field yard managers. This round table discussion yields insights following the preliminary annual survey of ODOT roadside programs and allows our team insight into the changes undertaken by ODOT during the current season and those planned in the upcoming year. Additionally an annual survey of Oklahoma Sod Producers is conducted and the varieties being offered for sale by producers are updated in the directory each year.

Key Items of Evaluation

Perceived quality and value of education offered, perceived quality and value of education offered by trade show vendors, was education valuable enough that you would participate in educational sessions in the future, increase in knowledge, increase in management effectiveness, use of new or improved varieties, use of scouting techniques, pest id prior to pesticide selection and use, and planned changes to management programs in the next calendar year.