**Summer Meeting NCERA**

**Agenda 2017**

**International Turfgrass Society Meeting**

**July 16, 2017**

**Meeting Agenda**

1. Welcome and meeting organization (J. Hoyle/ J. Fry)
2. Updates:
   1. Regional Weed Control Publication (Aaron Patton/ J.Hoyle)
   2. Organic Weed Control (Bruce Branham/ T. Voigt)
   3. Evaluating Cool-Season Grasses in U-Mowed Roughs (Tom Voigt)
   4. NTEP Update (E. Watkins)
   5. Regional Roadside Turfgrass Testing Program (Sam Bauer/Eric Watkins)
   6. Growth Potential Model Validation Project (Bill Kreuser)
   7. Student Recruitment Discussion
      1. Survey Results (E. Watkins)
3. State reports *(1-2 min each)*
   1. Chicago District Golf Association
   2. University of Illinois
   3. Purdue University
   4. Iowa State University
   5. Kansas State University
   6. University of Maryland
   7. Michigan State University
   8. University of Missouri
   9. University of Nebraska-Lincoln
   10. North Dakota State
   11. The Ohio State University
   12. University of Wisconsin
4. Turfgrass Information File (P. Cookingham)
5. NCERA 221 Website (A. Patton/ J. Hoyle)
6. Group Scholarly Activity Tracker (A.Patton/ J. Hoyle) <https://scholar.google.com/citations?user=4vVgP3AAAAAJ&hl=en&authuser=1>
7. Historian Report (N. Christians/ J. Hoyle)
8. New Business
9. Adjourn

Minutes for NCERA meeting July 16, 2017

New Brunswick, NJ

(Secretary Xi Xiong was not present – J. Fry volunteered to take minutes)

Dr. Hoyle gave up date on weed control publication. Aaron provided handout.

Organic weed control – Tom V. Bruce is seeking funding for the project and will keep us updated.

NTEP – Eric Watkins. NTEP is a good state financially. Looking to make data more accessible and useable by public and universities. Grant from SCRI is sought and will help with stakeholder surveys and new ways to present data.

Regional Roadside Turfgrass Testing Program – Eric. Several states in the region have DOTs cooperating among the states: MN, NE WI, NJ, MI. Generally has been well received by the DOTs.

Regional creeping bentgrass dollar spot project. Manuscript was declined by Crop, Forage, and Turfgrass Management. Qi Zhang and Cole Thompson are going to take the lead to revise, possibly as a brief.

Growth Potential – Bill has a new student who is going to be analyzing the data.

Survey results – see handout.

Student recruitment – some discussion about Tennessee and their efforts in recruiting. No good solutions – effort is needed. Some efforts through online classes and general education classes trying to recruit students. Superintendents are not necessarily positive when it comes to recruiting.

Brief state reports.

Present: Ed Nangle (OH), David Gardner (OH), Sam Bauer (MN), Eric Watkins (MN), Tom Voigt (IL), Chris Erickson (WI), Pete Cookingham (MSU), Bill Kreuser (NE), Quincy Law (Purdue), Kevin Frank (MSU), Aaron Hathaway (MSU), Jack Fry (KS), Jared Hoyle (KS), Deying Li (NDSU).

**NCERA221 Regional Research Committee**

**HISTORIAN'S REPORT**

Nick Christians

July 16, 2017 in New Brunswick, NJ

Following is the Historian's Report for the NCERA221 (formerly NCR-10, NCR-192, and NCERA192) Regional Research Committee. Its purpose is to maintain a record of meeting sites and officers of the NCERA211 committee.

**Year Meeting Site Chairperson Secretary**

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# PROPOSED SITES

2022 North Dakota Deying Li To be announced

2021 Nebraska Bill Kreuser Deying Li

2020 Minnesota Eric Watkins Bill Kreuser

2019 Missouri Xi Xiong Eric Watkins

2018 Kansas Hoyle/Fry Xi Xiong

HISTORICAL SITES

2017 At ITS meetings Rutgers Hoyle/Fry Xi Xiong

2016 Illinois Voigt/Nangle Hoyle/Fry

2015 Iowa State Shui-Zhang Fei Tom Voigt/Nangle

2014 Purdue Aaron Patton Shui-Zhang Fei

2013 ASA-CSSA-SSSA Patton/Bigelow

2012 Joint meeting with WRC-11 Zac Reicher Aaron Patton

in Corvallis, Oregon .

2011 Joint meeting with WRC-11 Zac Reicher Cale Bigelow

at Ft.Collins, CO (Nebraska co-host)

2010 Southern Illinois Ken Diesburg Cale Bigelow

2009 Michigan State University Kevin Frank Ken Diesburg

2008 Ohio State David Gardner Kevin Frank

2007 Wisconsin John Stier David Gardner

2006 North Dakota Ron Smith John Stier

2005 South Dakota Leo Schleicher Ron Smith

2004 Nebraska (Joint with WRC 11) Gerald Horst Leo Schleicher

2003 Minnesota State University Brian Horgan Gerald Horst

2002 Missouri John Dunn Brian Horgan

2001 Kansas State University Jack Fry Barb Corwin

2000 Glenview, Ill. Bruce Branham Jack Fry

1999 Michigan Jim Baird Bruce Branham

1998 Iowa State University Dave Minner Jim Baird

1997 Purdue University Clark Throssell Dave Minner

1996 Colorado State (joint WRC-11) Clark Throssell Tom Voigt

1995 University of Wisconsin Frank Rossi Clark Throssell

1994 Southern Illinois Univ. Ken Diesburg Frank Rossi

1993 Palm Beach Florida Karl Danneberger Ken Diesburg

1992 Ohio State University Karl Danneberger Ken Diesburg

1991 University of Minnesota Don White Karl Danneberger

1990 University of Nebraska/

Joint meeting with WRC 11 Roch Gaussoin Don White

1989 Kansas State University Jeff Nus Roch Gaussoin

1988 University of Illinois David Wehner Jeff Nus

1987 University of Missouri David Minner David Wehner/Tom Fermanian

1986 Michigan State University Bruce Branham David Minner

1985 Iowa State University Nick Christians Bruce Branham/Paul Rieke

1984 Purdue University Bill Daniel Nick Christians

1983 Beltsville Maryland Bob Carrow Bill Daniel and

(Joint NCR‑10, WRCC‑11, NE‑139 meeting) Ray Freeborg

1982 Ohio State University Keith Karnok Bob Carrow

1981 University of Minnesota Don White Keith Karnok

1980 University of Nebraska Bob Shearman Don White

1979 University of Illinois A. J. Turgeon Bob Shearman

1978 Kansas State University David Martin A. J. Turgeon

1977 St. Louis, MO Ed Kinbacher David Martin

1976 St. Louis, MO K. T. Payne E. J. Kinbacher

1975 Indianapolis, IN C. Hodges K. T. Payne

1974 Indianapolis, IN J. H. Dunn C. Hodges

1973 St. Louis, MO P. E. Rieke J. H. Dunn

1972 Fort Mitchell, KY R. W. Miller P. E. Rieke

1971\*

1970 Monticello IL R. C. Newman R. W. Miller

1969 Chicago, IL R. C. Newman A. E. Dudeck

1968 Chicago, IL J. B. Beard R. C. Newman

1967 East Lansing, MI J. D. Butler J. B. Beard

\* No meeting in 1971; a joint meeting between NCR-10 and the NE group was planned for summer but never took place because of scheduling conflicts.

**Regional Weed Control Publication Update – 07/16/17 (A. Patton)**

* A regional publication with 12 states (IA, IL, IN, KS, KY, MI, MN, MO, NE, NY, OH, WI) collaborating was produced and distributed in February 2017. 2,350 hard copies in total were printed.
* An overwhelmingly positive response to the publication was received.

**Changes for an updated 2018 version**

* Updates for the 2018 version are going to start sooner this year with a goal to get all collaborators copies of the 2018 publication by mid-December in time for January conferences in most states. The revision timeline will be as follows:
  + Sept 1 - Edits/additions to Aaron
    - Please send me your edits!
  + Sept 25 – Compiled edits/additions due to editor
  + Oct 16 – Revisions to designer
  + Nov 13 – Send files to printer – Prior to this date I will need to know how many copies you want to order.
  + December 4 – ship publications to collaborators
* Edits planned for the publication include
  + Minor updates to text/ratings and a new cover photo
  + Addition of new herbicides and deletion of old products
  + Addition of 6-9 weeds in the ID section
    1. Wild onion
    2. Sulfur cinquefoil
    3. Birdseye pearlwort
    4. Field horsetail
    5. Redstem filaree
    6. Speedwell purslane
    7. Timothy
    8. Witchgrass
    9. Yellow violet
  + Reduce the total length of the publication by 4 pages (reduced white space)
  + Added section on herbicide movement in plants
  + Add Rutgers (Matt Elmore) to the list of collaborators.

**Future project efforts**

* I would like to use the color pictures in the publication to make a weed ID poster that can be used in garden centers, and turf shops and breakrooms. The poster would likely have about 36 weeds on it and be a mixture of grasses, sedges, and broadleaves. Does the group want to participate in this poster creation effort? We will need to identify weeds common to all locations. This should be a fairly straight forward project.
* Paul Koch is leading an effort to incorporate the weed control ratings into a responsive website (works on phones and tablets) that can help turfgrass professionals choose the right product for the right pest.

**NC Project Station Report Content - Chicago District Golf Association**

Jesse J Benelli, PhD – Director of Turfgrass Programs. Chicago District Golf Association.

**1. Impact Nugget:  A concise statement of advancements, accomplishments and impacts.**

The CDGA Turfgrass Program has updated the format of the weekly Scouting Reports. We are using the digital platform Medium to create a living document that is linked to our social media accounts.

**2. New Facilities and Equipment. Include production areas, sensors, instruments, and control systems purchased/installed.**

The CDGA received funds from the Illinois Turfgrass Foundation that paid for a new SterilElite 16 tabletop autoclave and other laboratory supplies.

**3. Unique Project Related Findings.  List anything noteworthy and unique learned this year.**

Our group is currently developing more precise management tools that focus on turfgrass disease solutions.

**4. Accomplishment Summaries.  Draft one to three short paragraphs (2 to 5 sentences each) that summarize research or outreach accomplishments that relate to the project objectives.  Please use language that the general public can readily comprehend.**

Our weekly scouting reports have grown to include more than 1,300 email subscribers. These scouting reports continue to be the primary means of communication to our CDGA member superintendents and assistant superintendents. These reports are open access and individuals do not need to be associated with the CDGA to view them.

Our trial work is focusing on dollar spot, anthracnose, fairy ring, and take-all patch research. This research will be on display at two field day events in the Chicago area. The first field day will be on August 29th at Kemper Lakes Golf Club in collaboration with the Midwest Association of Golf Course Superintendents. Our second field day will be hosted at Cog Hill Golf Club at a date to be determined in conjunction with the Chicagoland Association of Golf Course Superintendents.

**5. Impact Statements.  Please draft 2 or 3 impact statement summaries related to the project objectives.  Statements should be quantitative when possible and be oriented towards the general public.  This is perhaps the most difficult yet most important part of the report.**

We are developing multiple survey response forms to gain feedback of our research, education, and extension efforts. Our extension and education program is critical in developing research based solutions that meets the needs of the golf industry in the greater Chicago area.

Our extension and education program is built on both in-person and digital avenues. In-person extension efforts include on-site diagnostic visits to our member clubs. As of July 2017, the CDGA Turfgrass Program has conducted more than 60 on-site visits. Additionally, we try and maintain high visibility through public speaking engagements to our golf turf associations in the state of Illinois. Our digital extension and education efforts include the use of social media and through an email list-service.

Our trial work on dollar spot has indicated that reduced spray rate volumes of fungicide mixtures may not affect dollar spot control when using various SDHI fungicides on fairway height creeping bentgrass.

**6. Published Written Works.  Include scientific publications, trade magazine articles, books, posters, websites developed, and any other relevant printed works produced.  Please use the formatting in the examples below.**

Benelli, J.J. 2017. Midwest welcomes new turf pathologist to the CDGA. On Course. 70 (10): 5.

Benelli, J.J., and R. Townsend. 2017. Understanding the SDHI fungicides. On Course. 4-5.

**7. Scientific and Outreach Oral Presentations.  Include workshops, colloquia, conferences, symposia, and industry meetings in which you presented and/or organized.  See below for formatting.**

Benelli, J.J. 2017. What’s new at the Midwest Golf House? Illinois Turfgrass Foundation conference. Hoffman Estates, IL. January 10th 2017.

Benelli, J.J. 2017. Managing Turfgrass Diseases with and without the Boom. 8th Annual Midwest Monthly Meeting and Wee One Fundraiser. Woodridge, IL. January 24th 2017.

Benelli, J.J. 2017. Direction of the CDGA Turfgrass Program. CDGA Club Leadership conference. Medinah, IL. March 4th 2017.

Benelli, J.J. 2017. What to expect in 2017. Central Illinois Association of Golf Course Superintendents. Spring kick off. East Peoria, IL. March 6th 2017.

Benelli, J.J. 2017. Summer Disease Control Strategies for Putting Greens. NWIGCSA Educational Meeting. Rockford, IL. March 7th 2017.

Benelli, J.J. 2017. Plant Health and Disease Control using Strobilurin Fungicides. ITF/MAGCS Spring Golf Day. Naperville, IL. May 22nd 2017.

Benelli, J.J. 2017. Plant Health and Disease Control using Strobilurin Fungicides. NWIGCSA Golf Day. Janesville, WI. June 20th 2017.

**8. Fund leveraging, specifically, collaborative grants between stations and members.**

Part of 10 site project evaluating zoysiagrass germplasm.

9. Other relevant accomplishments and activities.

**NC Project Station Report Content:**

1. Impact Nugget:  A concise statement of advancements, accomplishments and impacts.  (Limit to 1-2 sentences)

In 2015, University of Illinois provided turf and grassy weed identification training for Chicago-area golf, lawn-care, and sod-producing professionals that will potentially reduce misapplication of weed control products and better serve clientele.

2. New Facilities and Equipment. Include production areas, sensors, instruments, and control systems purchased/installed.

**Nothing to report.**

3. Unique Project Related Findings.  List anything noteworthy and unique learned this year.

**Nothing to report.**

4. Accomplishment Summaries.  Draft one to three short paragraphs (2 to 5 sentences each) that summarize research or outreach accomplishments that relate to the project objectives.  Please use language that the general public can readily comprehend.

Maintained and evaluated Kentucky bluegrass cultivar, fine-leaf fescue cultivar, bentgrass fairway and putting green cultivar, tall fescue cultivar, and un-mowed golf course rough turf species trial to identify grasses that perform well with limited inputs.

Presented the findings of these trials to more than 200 professional turf managers.

5. Impact Statements.  Please draft 2 or 3 impact statement summaries related to the project objectives.  Statements should be quantitative when possible and be oriented towards the general public.  This is perhaps the most difficult yet most important part of the report.

* Presented the findings of these trials to more than 200 professional turf managers.
* Provided turf and grassy weed identification training for Chicago-area golf, lawn-care, and sod-producing professionals that will potentially reduce misapplication of weed control products and better serve clientele.

6. Published Written Works.  Include scientific publications, trade magazine articles, books, posters, websites developed, and any other relevant printed works produced.  Please use the formatting in the examples below.

1. Anderson, E.K., D.K. Lee, D.J. Allen, and T.B. Voigt. 2015. Agronomic factors in the establishment of tetraploid seeded *Miscanthus* x *giganteus.* GCB-Bioenergy. 7: 1075-1083.
2. Quinn, L.D., E.C. Scott, A.B. Endres, J.N. Barney, T.B. Voigt, and J. McCubbins. 2015. Resolving regulatory uncertainty: legislative language for potentially invasive bioenergy feedstocks. GCB-Bioenergy. 7: 909-915.
3. Quinn, L.D., K.C. Straker, J. Guo, S. Kim, S. Thapa, G. Kling, D.K. Lee, and T.B. Voigt. 2015. Stress tolerant feedstocks for sustainable bioenergy production on marginal land. Bioenergy Research. 8: 1081–1100.
4. Anderson, E.K., T.B. Voigt, S. Kim, and D.K. Lee. 2015. Determining effects of sodicity and salinity on switchgrass and prairie cordgrass germination and plant growth. Industrial Crops and Products. 64: 79–87.
5. Anderson, E.K., A.G. Hager, D.K. Lee, D.J. Allen, and T.B. Voigt. 2015. Response of seeded *Miscanthus* × *giganteus* to PRE and POST herbicides. Weed Technology. 29: 274-283.
6. Straker, K.C., L.D. Quinn, T.B. Voigt, D.K. Lee, G.J. Kling. 2015. Black locust as a bioenergy feedstock: a review. Bioenergy Research. 8: 1117-1135.
7. Dougherty, R.F., L.D. Quinn, T.B. Voigt, and J.N. Barney. 2015. Response of naturalized and ornamental biotypes of *Miscanthus sinensis* to soil moisture and shade stress. Northeastern Naturalist. 22: 372-386.
8. Kaiser, C.M., L.V. Clark, J.A. Juvik, T.B. Voigt, and E.J. Sacks. 2015. Characterizing a *Miscanthus* germplasm collection for yield, yield components, and genotype × environment interactions. Crop Sciences. 55: 1978-1994.
9. Arundale, R.A., S. Bauer, F.B. Haffner, V.D. Mitchell, T.B. Voigt, and S.P. Long. (2015.) Environment has little effect on biomass biochemical composition of *Miscanthus* x *giganteus*, across soil types, nitrogen fertilization and times of harvest. BioEnergy Research. DOI 10.1007/s12155-015-9613-2.
10. Li, D., T. Voigt, and A.D. Kent. (2015.) Plant and soil effects on bacterial communities associated with *Miscanthus* ×*giganteus* rhizosphere and rhizomes. GCB-Bioenergy. DOI 10.1111/gcbb.12252
11. Guo, J., S. Thapa, T. Voigt, A.L. Rayburn, A. Boe, and D.K. Lee. (2015.) Phenotypic and biomass yield variations in natural populations of prairie cordgrass (*Spartina pectinata* Link) in the USA. Bioenergy Research. DOI 10.1007/s12155-015-9604-3
12. Hager, H., L.D. Quinn, J.D. Barney, T.B. Voigt, and J.A. Newman. (2015) Germination and establishment of bioenergy grasses outside cultivation: a multi-region seed addition experiment. Plant Ecology. DOI 10.1007/s11258-015-0516-2.

7. Scientific and Outreach Oral Presentations.  Include workshops, colloquia, conferences, symposia, and industry meetings in which you presented and/or organized.  See below for formatting.

1. T. Voigt. 2015. Turf and Grassy Weed Identification. Turfgrass Foundation Turf Conference. Bolingbrook, IL. Illinois.
2. T. Voigt. 2015. Cool-Season Turf and Grassy Weed Identification. Workshop Illinois Turfgrass Foundation Turf. Lemont, IL.
3. T. Voigt. 2015. Warm-Season Turf and Grassy Weed Identification Workshop. Illinois Turfgrass Foundation Turf. Lemont, IL.
4. T. Voigt. 2015. Energy Crops at the U. of I. Energy Farm. RAP Minority Students. Urbana, IL
5. T. Voigt. 2015. Energy Crops at the U. of I. Energy Farm. BASF Employees. Urbana, IL.
6. T. Voigt. 2015. Energy Crops at the U. of I. Energy Farm. CPSC 415 Students. Urbana, IL.
7. T. Voigt. 2015. NTEP Cultivar Trials. Central Illinois Golf Course Superintendents Association Field Day. Urbana, IL.
8. T. Voigt. 2015. NTEP Cultivar Trials. Illinois Professional Lawn Care Association Field Day. Urbana, IL.
9. T. Voigt. 2015. Creeping Bentgrass Cultivar Trials. Workers at Champion’s Tour Golf Event. Glenview, IL.
10. T. Voigt. 2015. Turf Cultivar Studies. Illinois Professional Lawn Care Association. Urbana, IL.
11. T. Voigt. 2015. Turf Cultivar Studies. Central Illinois Golf Course Superintendents Association. Urbana, IL.
12. T. Voigt. 2015. Grasses for Un-Mowed Golf Course Roughs. Chicago District Golf Association Field Day. Lemont, IL.
13. T. Voigt. 2015. Tall Fescues for Illinois Lawns. Illinois Professional Lawn Care Association. Glenview, IL.

8. Fund leveraging, specifically, collaborative grants between stations and members.

**Nothing to report.**

9. Other relevant accomplishments and activities.

**Nothing to report.**

**NC Project Station Report Content: Purdue University**

**1. Impact Nugget**.

Our focus on the chemical ecology and biogeochemical interactions of important turfgrass insect pests provides a foundation for the development of more sustainable, next-generation pest management tools.

Purdue University researchers discovered how to enhance weed control with 2,4-D through new strategies such as improving spray tank water quality. Forty-five percent of workshop participants changed their tank-mixing practices based on this new research.

A Purdue University Extension publication (AY-336) popular among clientele, was distributed to over 7,136 clientele since 2012. A survey of found this reference helped 76% of them improve their weed control helped each save $500 to $833 annually.

Purdue University researchers finished a multi-year project entitled “Feasibility of Grass-Legume Systems for Low Maintenance Lawns. This research provides data to support recommendations for the installation and management of these systems which reduce nitrogen inputs to lawns.

Research on reducing the water needs for lawns and golf turf in the cool-humid region is ongoing with a focus on grasses that better tolerate acute drought stress.

Current projects include efforts to describe the spatial and temporal distribution of fungicide residues in golf course turf. Results provide a scientific foundation for turf managers to adjust fungicide scheduling based on an understanding of where fungicides persist and how long effective residues remain.

Research on genotypic variation in salinity, flooding, heat and low N tolerance in cool-season turfgrass species, providing insights into turf adaptation to stress conditions.

**2. New Facilities and Equipment**.

NONE

**3. Unique Project Related Findings**.

Our chemical ecology work with billbugs indicates that males primarily respond to host plant volatiles whereas females most likely respond to male-produced volatile cues. Qualitative and quantitative differences in the composition of cuticular hydrocarbons indicate that tactile chemical cues may be important for mate recognition among sympatric billbug species.

Our biogeochemical work with Japanese beetle larvae suggest that JB infestations may reduce soil organic matter, increase soil CO2 emissions and cause significant and lasting changes to soil microbial diversity. Analysis of 16S microbial rDNA revealed the presence of ammonia oxidizing, nitrogen fixing and organic residue-degrading larval gut bacteria, many of which are commonly associated with soil.

**4. Accomplishment Summaries**.

Our combined research and extension efforts have resulted in the development of extension materials and other outputs that provide turfgrass managers and the general public with science-based recommendations for sound insect pest management and are laying the groundwork for the development of environmentally sustainable, next-generation pest management tools.

We have identified physiological traits and genes that are associated with growth and abiotic stress tolerance. The results revealed mechanisms of plant growth and adaptation to stress conditions. The research provides a better understanding of how plants respond to environmental stress. The gene-traits associations identified through the project may be used for assessment of germplasm to uncover genetic diversity for improving stress tolerance of turfgrass varieties.

**5. Impact Statements**.

**Turf Weed Control Publication (2012-2016)**

**Issue:** There is a need among practitioners for current information about best practices for weed control. **Objective:** Create a publication that addresses the diverse weed control needs of turfgrass professionals in lawn care, golf course, athletic, grounds, roadside, sod, and cemetery turf. **Product:** A 96 page publication was developed in 2012 to broadly recommend weed control strategies for turf managers. **Delivery:** The for sale publication is available in print and electronic versions. It is updated annually. **Impact:** A survey of 723 people (18% response), who purchased the publication, found this reference helped 76% of them improve their weed control (8% no improvement, 16% undecided). The publication had little impact on total herbicide use (63% no change, 16% increase, 21% decrease), but the survey revealed the publication helped each save $500 to $833 (weighted avg.=$833, median =$500) annually. **Distribution**: Over 7,136 hard or electronic copies were purchased and distributed since 2012.

**Billbug Injury to Turfgrass**

Billbugs are increasingly being recognized as a serious threat to turfgrass across the United States. Recent expansion in the range of several billbug species has resulted in a national collage of billbug species assemblages. Resulting variation in seasonal life histories, behavior, and ecology that accompany such novel species interactions have challenged management schemes in many regions. Our work to date indicates that volatile and tactile chemical cues are important in the host- and mate-finding behaviors of billbugs. These chemical cues could potentially be exploited for the development of more environmentally sustainable management tools.

**Microbial Interactions with Invasive Turf Insects**

Invasive species are a serious economic and ecological threat throughout the world. Although the ecological consequences of invasion by above-ground insects have been well documented, the impacts of invasive insects that spend the majority of their life underground have received much less attention. Our work to date indicates that that Invasive soil insects such as Japanese beetle could potentially alter soil microbial communities in ways that influence C-cycling and soil health, and that interactions between these insects and the soil is, in part, microbially-mediated. These microbial interactions could provide a foundation for the development of next generation pest management tools.

**6. Published Written Works**.

*Refereed Journal Articles - 2016*

1. Bigelow, C. A., & Kaminski, J. E. (2016). Social Media and Electronic Networking Use and Preferences among Undergraduate Turf Science Students. Natural Sciences Education, 45(1).
2. Fardisi, M., Mason, L. J., Ileleji, K. E., & Richmond, D. S. (2016). Investigating Dried Distiller's Grains with Solubles vulnerability to Tribolium castaneum (Herbst) infestation by using choice and no-choice experiments. Journal of Stored Products Research, 66, 25-34.
3. Jiang, Y, Y Li, G Nie, H Liu (2016) Leaf and Root Growth, Carbon and Nitrogen Contents, and Gene Expression of Perennial Ryegrass to Different Nitrogen Supplies. Journal of the American Society for Horticultural Science 141 (6), 555-562.
4. Jiang, Y., Cui, Y., Pei, Z., Liu, H., & Sun, S. (2016). Growth response and gene expression to deficit irrigation and recovery of two perennial ryegrass accessions contrasting in drought tolerance. HortScience, 51(7), 921-926.
5. Law, Q. D., Bigelow, C. A., & Patton, A. J. (2016). Selecting turfgrasses and mowing practices that reduce mowing requirements. Crop Science, 56(6), 3318-3327.
6. Law, Q. D., Trappe, J. M., Jiang, Y., Turco, R. F., & Patton, A. J. (2017). Turfgrass Selection and Grass Clippings Management Influence Soil Carbon and Nitrogen Dynamics. Agronomy Journal. 109:1719–1725.
7. Liu, Q., & Jiang, Y. (2016). Exogenous application of nitrogen and cytokinin on growth, carbohydrate, and antioxidant metabolism of creeping bentgrass after de-submergence. HortScience, 51(12), 1602-1606.
8. Luo, N., Yu, X., Nie, G., Liu, J., & Jiang, Y. (2016). Specific peroxidases differentiate Brachypodium distachyon accessions and are associated with drought tolerance traits. Annals of botany, 118(2), 259-270.
9. Parker, N.S., N.A. Anderson, D.S. Richmond, E.Y. Long, K.A. Wise and C. H. Kripke. 2016. Larval western bean cutworm feeding damage encourages the development of Gibberalla ear rot on field corn. Pest Management Science 73(3): doi:10.1002/ps.4313.
10. Patton, A. J., Trappe, J. M., Karcher, D. E., & Richardson, M. D. (2016). Impact of golfer divots on golf course maintenance. Crop, Forage & Turfgrass Management, 2(1).
11. Patton, A. J., Weisenberger, D. V., & Johnson, W. G. (2016). Divalent Cations in Spray Water Influence 2, 4-D Efficacy on Dandelion (Taraxacum officinale) and Broadleaf Plantain (Plantago major). Weed Technology, 30(2), 431.
12. Powell, G. S., Shukle, J. T., Richmond, D. S., & Holland, J. D. (2016). Saproxylic Beetle Biodiversity in Golf Course Habitats. Crop, Forage & Turfgrass Management, 2(1).

*Extension Publications*

1. Kirkpatrick, T, T. Spurlock, A.J. Patton, R. Bateman, and D. Moseley. 2016. Controlling nematodes on golf courses. University of Arkansas Cooperative Extension Publication. MP-481.
2. Latin, R. Turfgrass Disease Profiles: BP-115-W Summer Patch (revised 2016).
3. Latin, R. Turfgrass Disease Profiles: BP-123-W Spring Dead Spot (2016).
4. Martin, A., F. Whitford, A. Patton, R. Latin, D. Richmond. 2015. Turf Pest Management. Purdue University Extension Publication. PPP-3b.
5. Patton, A.J. 2016. Lawns. p. 293-319. In R. Lerner (ed.) Purdue Master Gardener Manual. Purdue University Extension Publication. MG-3. Major revision.
6. Patton, A.J. 2016. Weeds. p. 459-480. In R. Lerner (ed.) Purdue Master Gardener Manual. Purdue University Extension Publication. MG-3. Major revision.
7. Patton, A.J., D.V. Weisenberger, J. Kao-Kniffin, B. Branham, T. Voigt, N. Christians, A. Thoms, J. Hoyle, G. Munshaw, A. Hathaway, T. Nikolai, S. Bauer, B. Fresenburg, X. Xiong, W. Kreuser, C. Thompson, D. Gardner, D. Soldat, and P. Koch. 2017 Turfgrass Weed Control for Professionals. Purdue University Extension Publication. TURF-100. 6th revision. pp. 132.
8. Richmond, D.S. and C. Sadof. 2016. Protecting pollinators in home lawns and landscapes. Purdue Extension Publication POL-1.
9. Richmond , D. 2016. Turfgrass Insects: Turfgrass Insect Management. Purdue University Extension Publication. E-61-W.
10. Richmond , D. 2016. Turfgrass Insects: Turfgrass Insects: Managing White Grubs in Turfgrass. Purdue University Extension Publication. E-271-W.
11. Richmond , D. and J. Realey. 2016. Turfgrass Insects: Managing Black Cutworms in Turfgrass. Purdue University Extension Publication. E-270-W.
12. Richmond, D., A.J. Patton, R. Latin, Y. Liu, D. McClure, and M.Hill. 2017. The Purdue Turf Doctor app for Apple iOS. Available on iTunes. Purdue University Extension Publication. ID-474-APP.
13. Richmond, D., A.J. Patton, R. Latin, Y. Liu, D. McClure, and M.Hill. 2017. The Purdue Turf Doctor app for Apple iOS. Available on Google Play. Purdue University Extension Publication. ID-474-APP-A.

**7. Scientific and Outreach Oral Presentations**.

1. Li, Y., X. Song, N. Gang, M. Taylor, J. J. Camberato, and Y. Jiang.2016. Genetic mechanism of nitrogen use efficiency in perennial ryegrass. The Annual Meeting of the Crop Science Society of America, Phoenix, AZ, USA. Poster No. 242-2.
2. Gang, N., X. Yu, M. Taylor, X. Song, X. Wang, X. Zhang, and Y. Jiang. Genome-wide association study of heat tolerance in diverse population of perennial ryegrass. The Annual Meeting of the Crop Science Society of America, Phoenix, AZ, USA. Poster No. 168-1634.
3. Song, X., N. Gang, Y. Li, S-M. Wang, and Y. Jiang. Association of candidate genes with salinity tolerance in perennial ryegrass. The Annual Meeting of the Crop Science Society of America, Phoenix, AZ, USA. Poster No. 168-1635.
4. Chandra, A., D. Geonovesi, J.D. Fry, A.J. Patton, M.M. Kennelly, and M. Xiang. 2016. Development of fine textured seeded types and clonally propagated zoysiagrasses. Paper presented at: Resilience Emerging from Scarcity and Abundance. ASA, CSSA, and SSSA Annual Meetings, Phoenix, AZ. 6-9 Nov. Paper 261-2.
5. Duffy, A.G., G. Hughes, M.D. Ginzel and **D.S. Richmond**. 2016. Volatile and tactile chemical cues associated with billbug (Coleoptera: Curculionidae) behavior in managed tufgrass. Annual Meeting of the North Central Branch of the Entomological Society of America, Cleveland, OH, June 5-8, 2016.
6. Duffy, A.G., G.P. Hughes, M.D. Ginzel, **D.S. Richmond**. 2016. Chemically-mediated dispersal and mating behavior of billbugs (Coleoptera: Curculionidae) associated with turfgrass. International Congress of Entomology, Orlando, FL, September 25-30, 2016.
7. Patton A.J. February 10, 2016. The Impact of Your Spray Tank Water on Pesticide Performance. Golf Course Superintendents Association of America Education Conference, San Diego, CA. 102 attendees. Invited speaker. 2 hours.
8. Patton A.J., and J.T. Brosnan. February 8, 2016. Enhanced Weed Management for Cool-Season Turfgrass. Golf Course Superintendents Association of America Education Conference, San Diego, CA. 45 attendees. Invited speaker. 4 hours.
9. Patton, A.J. and Q. Law. July 12, 2016. Diagnosis Common and Not So Common turf Problems. Purdue Turfgrass and Landscape Field Day. 400 attendees. West Lafayette, IN. 2 hours.
10. Patton, A.J. and Z.J. Reicher. February 9, 2016. Creating your agronomic program. Golf Course Superintendents Association of America Education Conference, San Diego, CA. 45 attendees. Invited speaker. 6 hours.
11. Patton, A.J. August 25, 2016. The Turf Year to Date. 2016 Indiana Professional Lawn and Landscape Association Field Day. 120 attendees. Danville, IN.
12. Patton, A.J. December 1, 2016. Turf Herbicide Workshop: Identification, biology, and control of common turf weeds. 94 attendees. Fort Wayne, IN. 7 hours.
13. Patton, A.J. December 6, 2016. Factors impacting pesticide performance. 240 attendees. Columbus, OH. 1.0 hour.
14. Patton, A.J. December 6, 2016. The science of choosing broadleaf herbicides. 120 attendees. Columbus, OH. 1.0 hour.
15. Patton, A.J. December 7 2016. New herbicides for turfgrass weed control. 120 attendees. Columbus, OH. 1.0 hour.
16. Patton, A.J. December 7, 2016. Fine tuning your agronomic program for your putting greens. 240 attendees. Columbus, OH. 1.0 hour.
17. Patton, A.J. December 8, 2016. Turf Herbicide Workshop: Identification, biology, and control of common turf weeds. 42 attendees. St. Charles, IL. 7 hours.
18. Patton, A.J. February 15, 2016. The Impact of Your Spray Tank Water on Pesticide Performance. Macon, GA. 70 attendees. 3 hours.
19. Patton, A.J. February 17, 2016. Weed management in turfgrass. Great Lakes School of Turfgrass Science. 2 hours. Online webcast. 55 attendees.
20. Patton, A.J. February 24, 2015. Identification and management of turf weeds. Initial certification training for commercial pesticide applicators – category 3b – turfgrass pest control. West Lafayette, IN. 56 attendees.
21. Patton, A.J. February 24, 2016. Cultural practices of turf. Initial certification training for commercial pesticide applicators – category 3b – turfgrass pest control. West Lafayette, IN. 56 attendees.
22. Patton, A.J. January 14, 2016. Advanced weed control and identification. Arkansas Turf Association Conference. Hot Springs, AR. 35 attendees. 2 hours.
23. Patton, A.J. January 14, 2016. Calibrating your application equipment. Arkansas Turf Association Conference. Hot Springs, AR. 230 attendees. 1 hour.
24. Patton, A.J. January 14, 2016. Turfgrass weed control and herbicide update. Arkansas Turf Association Conference. Hot Springs, AR. 230 attendees. 30 minutes.
25. Patton, A.J. January 15, 2016. Common mistakes in athletic field management. Arkansas Turf Association Conference. Hot Springs, AR. 20 attendees.
26. Patton, A.J. January 15, 2016. Managing troublesome areas with site-specific programs. Arkansas Turf Association Conference. Hot Springs, AR. 50 attendees.
27. Patton, A.J. January 28, 2016. Enhancing crabgrass control and new pesticides. Kentucky Nursery and Landscape Conference, Louisville, KY. 125 attendees.
28. Patton, A.J. January 28, 2016. Water and pesticides. Kentucky Nursery and Landscape Conference, Louisville, KY. 125 attendees.
29. Patton, A.J. January 6, 2016. Building quality lawn care programs. Indiana Green Expo. 15 attendees. Indianapolis, IN. 3 hours.
30. Patton, A.J. January 7, 2016. Purchasing new products and technologies: Questions to ask. Indiana Green Expo. 75 attendees. Indianapolis, IN.
31. Patton, A.J. January 7, 2016. Welcome to the Indiana Green Expo. Indiana Green Expo. 150 attendees. Indianapolis, IN.
32. Patton, A.J. July 12, 2016. Weed identification and weed research update. Purdue Turfgrass and Landscape Field Day. 120 attendees. West Lafayette, IN. 2 hours.
33. Patton, A.J. July 28, 2016. Field Tour of Perennial Grassy Weed Control. Midwest Regional turf Foundation – Diagnostic Series – Lawn Care Diagnostic Training. 58 attendees. West Lafayette, IN. 2 hours.
34. Patton, A.J. July 28, 2016. Making cents of all the nitrogen fertilizers. Midwest Regional turf Foundation – Diagnostic Series – Lawn Care Diagnostic Training. 58 attendees. West Lafayette, IN. 1 hours.
35. Patton, A.J. July 28, 2016. You’re one tough son of a weed: controlling tough weeds. Midwest Regional turf Foundation – Diagnostic Series – Lawn Care Diagnostic Training. 58 attendees. West Lafayette, IN. 1 hour.
36. Patton, A.J. March 1, 2016. Cultural practices of turf. Initial certification training for commercial pesticide applicators – category 3b – turfgrass pest control. West Lafayette, IN. 70 attendees.
37. Patton, A.J. March 1, 2016. Identification and management of turf weeds. Initial certification training for commercial pesticide applicators – category 3b – turfgrass pest control. West Lafayette, IN. 70 attendees.
38. Patton, A.J. March 17, 2016. Herbicide update. BASF. Fishers, IN. 25 attendees.
39. Patton, A.J. March 29, 2016. How turfgrass grows: the basics of turf maintenance. 3B Training. 70 attendees. West Lafayette, IN. 2 hours.
40. Patton, A.J. March 30, 2016. Common turf pests and treatment programs: The biology and control of weeds, insect pests, and diseases. 3B Training. 70 attendees. West Lafayette, IN. 3 hours.
41. Patton, A.J. March 9, 2016. How to kill and dandelion and keep it dead. Northwest Indiana Nursery and Landscape Association. Crown Point, IN. 60 attendees.
42. Patton, A.J. March 9, 2016. Yellow nutsedge biology and control. Northwest Indiana Nursery and Landscape Association. Crown Point, IN. 60 attendees.
43. Patton, A.J. November 17, 2016. Jeopardy. MRTF Turf and Ornamental Seminar. 67 attendees. West Lafayette, IN.
44. Patton, A.J. November 17, 2016. Light requirements and shade management of plants. MRTF Turf and Ornamental Seminar. 67 attendees. West Lafayette, IN.
45. Patton, A.J. November 17, 2016. Worst weeds of 2016. MRTF Turf and Ornamental Seminar. 67 attendees. West Lafayette, IN.
46. Patton, A.J. November 30, 2016. Turf Herbicide Workshop: Identification, biology, and control of common turf weeds. 82 attendees. Indianapolis, IN. 7 hours.
47. Patton, A.J. October 6, 2016. Creating your pest management program. 3B Training. 60 attendees. West Lafayette, IN. 3 hours.
48. Patton, A.J. October 6, 2016. How turfgrass grows: the basics of turf maintenance. 3B Training. 60 attendees. West Lafayette, IN. 2 hours.
49. Patton, A.J. September 21, 2016. Enhancing your weed control. Golf Course Superintendents Association of America. 34 attendees. Online webcast. 90 minutes.
50. Patton, A.J. September 7, 2016. Turf program and research update. Tri-State GCSA meeting. 20 attendees. West Lafayette, IN. 0.5 hours.
51. Patton, A.J. September 9, 2016. Calibrating turf equipment the easy way. Illinois Professional Lawn Care Association -TED. 75 attendees. Chicago, IL.
52. Patton, A.J. September 9, 2016. Update on Spray Tank Water Quality Research. Illinois Professional Lawn Care Association -TED. 75 attendees. Chicago, IL.
53. Patton, A.J., D.V. Weisenberger, and G. Schortgen. 2016. Iron source in 2,4-D tank-mixtures influences weed control. Paper presented at: Resilience Emerging from Scarcity and Abundance. ASA, CSSA, and SSSA Annual Meetings, Phoenix, AZ. 6-9 Nov. Paper 337-1303.
54. Price, G.Y., B.F. Peterson, M.E. Scharf, M.D. Ginzel and **D.S. Richmond**. 2016. Biogeochmical interactions between an invasive scarab (Japanese Beetle *Popillia japonica* Newman) and its subterranean environment. International Congress of Entomology, Orlando, FL, September 25-30, 2016.
55. Price, G.Y., B.F. Peterson, M.E. Scharf, M.D. Ginzel and **D.S. Richmond**. 2016. Biogeochmical interactions between an invasive scarab (Japanese Beetle *Popillia japonica* Newman) and its subterranean environment. Annual Meeting of the North Central Branch of the Entomological Society of America, Cleveland, OH, June 5-8, 2016.
56. Pruitt, H.M., J.C. Dunne, X. Yu, B.M. Schwartz, A.J. Patton, C. Arellano, and S.R. Milla-Lewis. 2016. Quantitative trait loci (QTL) analysis of freezing tolerance in zoysiagrass. Paper presented at: Resilience Emerging from Scarcity and Abundance. ASA, CSSA, and SSSA Annual Meetings, Phoenix, AZ. 6-9 Nov. Paper 196-6.
57. Richmond, D. and Patton, A.J. November 16, 2016. Turf Doctor App: Using a New Tool to Diagnose Problems, Doug Richmond & Aaron Patton. 67 attendees. West Lafayette, IN.
58. Richmond, D.S. and C. Sadof. 2016. Workshop - Protecting pollinators in urban landscapes. Purdue Turf & Landscape Field Day, West Lafayette, IN, July 12, 2016.
59. Richmond, D.S. 2016. Management of white grubs in the Midwest. Purdue Turf & Landscape Field Day, West Lafayette, IN, July 12, 2016.
60. Richmond, D.S. 2016. White grub update. Hoosier Golf Course Superintendents Association, Ft. Wayne, IN, March 1, 2016.
61. Richmond, D.S. 2016. White grub control update. Indiana Green Expo, Indianapolis, IN, January 7, 2016.
62. Richmond, D.S. 2016. Controlling insect pests infesting turf. Pesticide applicator training (category 3b), Purdue Pesticide Programs, Purdue University, West Lafayette, IN, March 2, 2016.
63. Richmond, D.S. 2016. Controlling insect pests infesting turf. Pesticide applicator training (category 3b), Purdue Pesticide Programs, Purdue University, West Lafayette, IN, February 24, 2016.
64. Richmond, D.S. 2016. Billbugs and other pest of warm-season turf. Indiana Green Expo, Indianapolis, IN, January 8, 2016.
65. Duffy, A.G., G. Hughes, M.D. Ginzel and **D.S. Richmond**. 2016. Volatile and tactile chemical cues associated with billbug (Coleoptera: Curculionidae) behavior in managed tufgrass. Annual Meeting of the North Central Branch of the Entomological Society of America, Cleveland, OH, June 5-8, 2016.
66. **Richmond, D.S.** 2016. Japanese beetle: Spatial and biogeochemical dimensions of an invasive soil insect. Seminar presented to the Department of Horticulture & Landscape Architechture, Purdue University, Wes Lafayette, IN, November 10, 2016.
67. Richmond, D.S. 2016. Japanese beetle: Spatial and microbial dimensions of an invasive soil insect. Seminar presented to the Department of Entomology, University of Wisconsin, Madison, WI, April 15, 2016.
68. Schortgen, G., and A.J. Patton. 2016. Nitrogen sources vary in their ability to overcome 2,4-D antagonism from hard water. Paper presented at: Resilience Emerging from Scarcity and Abundance. ASA, CSSA, and SSSA Annual Meetings, Phoenix, AZ. 6-9 Nov. Paper 335-1202.
69. Schortgen, G., and A.J. Patton. 2016. The influence of 2,4-D formulation on hard water antagonism. Paper presented at: Resilience Emerging from Scarcity and Abundance. ASA, CSSA, and SSSA Annual Meetings, Phoenix, AZ. 6-9 Nov. Paper 36-12.

**8. Fund leveraging, specifically, collaborative grants between stations and members**.

1. Agency/Title of Grant: Purdue AgSeed: Exploring the gut microbiota of

Japanese beetle: leveraging information for

development of next generation pest management

tools

2. Duration of Funding: One (1) year (2016-2017)

3. Total amount of award: $43,682

4. Your role: PD (Richmond)

5. Total Funding if Co-PI:

1. Agency/Title of Grant: United States Golf Association: Understanding billbug

chemical communication to improve management.

2. Duration of Funding: Two (2) years (2015-2016)

3. Total amount of award: $59,208

4. Your role: PD (Richmond)

5. Total Funding if Co-PI: NA

1. Agency/Title of Grant: United States Golf Association: Baculovirus research

to control black cutworms.

2. Duration of Funding: Three (3) years (2015-2016)

3. Total amount of award: $60,000

4. Your role: Co-PI (Richmond, R. Behle USDA-ARS lead)

5. Total Funding if Co-PI: $14,000

1. Agency/Title of Grant: United States Golf Association/Evaluation of experimental approaches for annual bluegrass control in golf course putting greens.

2. Duration of Funding: 2014-2017 (initially funded for two years and then extended)

3. Total amount of award: $84,437

4. Your role: PI (Patton)

5. Responsibility: 40% ($33,849); Collaborators at University of Illinois and Univ. of Nebraska

1. Agency/Title of Grant: United States Golf Association/Evaluation of experimental zoysiagrasses for the transition zone.

2. Duration of Funding: 2013-2017

3. Total amount of award: $120,059

4. Your role: Co-PI (Patton)

5. Responsibility: 38% ($45,234); Collaborators at Kansas State Univ. and Texas A&M Univ.

**9. Other relevant accomplishments and activities**.

**Great Lakes School of Turfgrass Sciences - ONLINE - new**

**Issue:** There is a large need for information and education among the turf professionals. Historically, many states conducted their own week-long turfgrass short courses as a way to educate clientele. However, these short courses are expensive due to additional travel costs (hotel, mileage, meals) and in recent years, events in the Midwest were cancelled due to low registration. **Objective:** Provide high-quality, science-based, topic-focused, online turf education in a short course like fashion to reduce obstacles to attendance. **Product:** The Great Lakes School of Turfgrass Science Online launched in 2014 and has since been held annually. Twelve turf Extension specialists cover various topics over ten, 2-hour online sessions (offered live with access to recordings) scheduled each Wednesday night (7-9 pm EST) from January through March. The audience is turfgrass professionals including lawn, golf, sports, and sod. This program is co-lead out of the University of Minnesota and the University of Wisconsin with instructor participation from seven other institutions. **Delivery:** Online using Google Hangouts, PPT, chat rooms, and Moodle. **Attendance**: (2014-2017): 65 (avg.) annually including some international participants (13%).

**The Purdue Turf Doctor App**

**Authors:** D. Richmond, A. Patton, R. Latin, M. Hill, Y. Liu, D. McClure, E. Luke, and B. Prickel. **Issue**: There is an increased demand for information on turfgrass management and diagnostics via mobile/smart phones and tablets. This demand stems from the fact that people continue to use devices more and more as a preferred learning platform. **Product:** The Purdue Turf Doctor app is the latest modern turfgrass management tool produced by the Purdue Turfgrass Science team. The app is designed to help homeowners and land managers diagnose and address turfgrass problems caused by a variety of factors including weeds, insects, diseases, nuisance animals, and abiotic stress. Turfgrass management professionals and garden center personnel can also use the app to improve communication with their customers and build customer confidence. The flexible yet powerful user interface has several features: (1) Quick access to the latest science-based recommendations from Purdue University experts on how to manage over 135 turfgrass disorders. (2) Identify turfgrass disorders by matching patterns, symptoms and signs to hundreds of high-resolution photos. (3) Check diagnoses with detailed descriptions of damage and stages of problem development linked to each photo. (4) Search for information on specific disorders by common or scientific name. (5) Use integrated filters to refine diagnoses by problem type, time of year, turfgrass species, field pattern, symptoms, signs, weed type, flower color, and more. (6) Easily create and add problems to your favorites list for quick reference later. (7) Automatically view a list of your most recent searches. **Delivery:** The app is available for iOs (Apple) and Android devices and is accessible through: <https://www.entm.purdue.edu/turfdoctor/>. The Turf Doctor app is also supported by a growing social media community through the twitter handle @TurfDoctorApp.

**North Central Region Turf Weed Control Publication**

**Issue:** Not all North Central region states have a turf weed scientist or up-to-date weed control recommendations. As such, there is a need among practitioners for current information. Dr. Patton already produces a publication that addresses this need and is highly recommended amongst his peers. **Objective:** Solicit collaborators from surrounding states and transform Purdue’s popular “Turfgrass Weed Control for Professionals” publication by Dr. Patton into a multi-state effort. The goal is to expand the reach of the publication and address regional differences in weed populations and control strategies. **Product:** A new, 12 state (IA, IL, IN, KS, KY, MI, MN, MO, NE, NY, OH, WI), regional publication was developed in 2016 to broadly recommend weed control strategies for turf managers in the north central region. **Delivery:** This first edition of the multi-state effort was released in 2017. **Impact:** The existing Purdue publication helped improve practitioner weed control and decrease their application cost. Impact data will also be collected on this latest multi-state effort. **Distribution**: 2,600.

**National Turfgrass Entomology Workshop and Pollinator Summit**

**Issue:** Practitioners and industry representatives need access to science-based information surrounding pollinator health and conservation in order to minimize the impact of turfgrass pest management programs. **Objective:** To generate Best Management Practices for promoting pollinator-friendly turfgrass. **Product:** A new refereed publication entitled “Optimizing Pest Management Practices to Conserve Pollinators in Turf Landscapes: Current Practices and Future Research Needs” was developed. **Delivery:** This publication has been accepted and will be published in 2017 in the Journal of Integrated Pest Management. **Impact:** Expertise at Purdue was leveraged to produce the “research needs” section of the manuscript. **Distribution:** TBD.

**State Report for NCER221**

University: Iowa State University

Official NCERA rep: Nick Christians

Email: nchris@iastate.edu

Phone: 515-450-1263

**Staffing:**

Current team members: Nick Christians, Shuizhang Fei, Adam Thoms

Additions:

Adam began on July 1, 2016

**General turf program comments:** We have seen considerable reductions in funding the last 5 years, but we still have positions in teaching, research, and extension, with a good balance between the three. Adam has begun a number of new projects at the turf research area and has added some new graduate students.

**Teaching Program**

Current undergraduate enrollment: 35

Trend in undergraduate enrollment over last 3 years: Decreased from about 60 4 years ago.

Placement: 100%

Brief comments on teaching: We have seen a downturn in the golf area, but an increase in sports turf. Increases in tuition are beginning to affect recruitment. There are also 5 two-year programs in the state and many undergrads go to community colleges first to save money.

**Research**

Faculty member (complete for each faculty member):

**Nick Christians**

Current or recently graduated graduate student: Josh Lenz finished an MS in 2016. He is currently a sports turf manager at the Univ. of Colorado. Isaac Mertz finished his MS in summer 2015 and began a Ph.D. in fall. The following is a statement on his current research.

Isaac Mertz – PhD Research Project Update

Creeping bentgrass is a cool-season grass species that is commonly used for intensely managed, high value sports surfaces. As temperatures increase during the summer months, creeping bentgrass experiences abiotic stress due to a combination of heat and drought. At this point, plant respiration rates often exceed plant photosynthesis rates, resulting in what is commonly referred to as summer bentgrass decline (Dernoeden, 2000). Symptoms of summer bentgrass decline include root dieback, excessive leaf senescence, and thinning of the turf canopy. One way to possibly alleviate this stress, and prevent summer bentgrass decline, is the use of amino acid containing products. The purpose of my current research is to evaluate the effect of the three branched-chain amino acids (BCAA) leucine, isoleucine and valine on creeping bentgrass performance.

During preliminary greenhouse studies, it was shown that when applied as a standalone treatment, leucine, isoleucine and valine could be used as a nitrogen source, but their effect on plant growth was not different than an application of mineral nutrition only. However, when applied in a three-way combination, these compounds did exhibit plant-growth regulating responses, with some experimental ratios resulting in an increase in creeping bentgrass shoot density. Through that work, a handful of optimal ratios were identified and selected for a outdoor research trial.

This summer marked the start of my first year field trial, with the same trial being repeated in the summer of 2018 for a second year’s worth of data. The primary focus of this trial is the comparison of different ratios of BCAA compared to mineral nutrition only, and a commercialized amino acid containing product that has previously shown abilities to increase creeping bentgrass shoot density. The first year field trial is scheduled to conclude at the end of August, 2017.

MS or PhD: Nick currently have 1 MS student, Matt Hollan. He is enrolled in the Masters of Agronomy program and is working full time at the University of Georgia as a sports turf manager.

Mertz\*, I., N. Christians, E.H. Ervin, and X. Zhang. 2017. Physiological responses of creeping bentgrass (*Agrostis stolonifera* L.) to a tryptophan-containing organic byproduct. Intl. Turfgrass Soc. Res. J. 13 (In press).

ASA Poster:

Mertz, I. and N.E. Christians. 2016. Evaluation of creeping bentgrass (*Agrostis stolonifera* L.) responses to foliarly applied branched-chain amino acids. ASA, CSSA and SSSA International Annual Meetings. p. 101973.

**Shuizhang Fei**

Current or recently graduated graduate student: Stephanie Argetsinger (distance), Paul Merrick.

MS or PhD: Shuizhang currently has two PhD students (Yang Liu, Allen Chen), two distance MS students (Reginald Poellnitz, Dustin North) and one exchange MS student (Han Jin).

Project(s): Targeted gene editing in perennial grasses (Funded by the United States Department of Agriculture); doubled haploid induction in turfgrass; screening perennial grasses as cover crops for corn and soybean production (USDA-funded), develop plant breeding curricula for African universities (funded by the Bill and Malinda Gates Foundation).

**List Publications (*published or in press*):**

Zhang C, **Fei S**, Liu P, Ji T, Peng J, Frei U, Hannapel D., 2016. Transcriptome changes in response to cold acclimation in perennial ryegrass as revealed by a cross-species microarray analysis. Crop Science. DOI: 10.2135/cropsci2016.04.0252.

Jiang J, Guan Y, McCormick S, Juvik J, Lubberstedt T, **Fei S**. 2016. Gametophytic self-incompatibility is operative in *Miscanthus sinensis* (Poaceae) and is affected by pistil age. Crop Sci doi:10.2135/cropsci2016.11.0932.

Liu Y, Merrick P, Yang B, **Fei S**. 2017.Targeted mutagenesis in tetraploid switchgrass (*Panicum virgatum* L.) by CRISPR/Cas9. Plant Biotechnology J. doi:10.1111/pbi.12778

Hao J, Yang J, Dong J, **Fei S.** 2017. Characterization *BdCBF* genes and genome-wide transcriptome profiling of BdCBF3-dependent and -independent cold stress responses in Brachypodium Distachyon. Plant Science doi:10.1016/j.plantsci.2017.06.001

Feng Y, Yin Y, **Fei S.**2017. *BdVRN1* expressionconfers flowering competencyand is negatively correlated with freezing tolerance in *Brachypodium distachyon. Frontiers in Plant Science* *doi:10.3389/fpls.2017.01107*

Infante, P. A., Moore, K., Scott, P., Archontoulis, S., Lenssen, A., **S. Fei.** 2017. Phenology and biomass production of adapted and non-adapted tropical corn populations in Central Iowa. Agronomy Journal, accepted.

**Adam Thoms**

Current or recently graduated graduate student: N/A.

MS or PhD: Adam currently has one PhD student (Ben Pease), and two MS students (Ryan May, Tim Dalsgaard) all starting in the Fall of 2017.

Project(s): Hollow tine core recycling on Creeping bentgrass putting greens; performance and safety of athletic fields subjected to various cultural practices; wetting agent performance under subjected athletic traffic; home lawn seeding timing and fertility product testing; tall fescue performance as an Iowa athletic field surface; athletic field performance and safety under herbicide restrictions; fairway thatch removal and recovery with a Fraze mower; bermudagrass cultivar testing for Iowa

**List Publications (*published or in press*):**

Dickson, K.H., J.C. Sorochan, J.T. Brosnan, J.C. Stier, J. Zobel, and A.W. Thoms. 2017. Crumb rubber depth is more important than particle size for improving bermudagrass traffic tolerance Crop Sci. doi: 10.2135/cropsci2017.03.0168

M.D. Richardson, G. Mattina, M. Sarno, J.H. McCalla, D.E. Karcher, A.W. Thoms and J.C. Sorochan. 2017. Shade effects on overseeded bermudagrass athletic fields: II. Rooting, botanical composition, and traction. Crop Sci. *(In press)*.

K. Dickson, G. Munshaw, J.C. Sorochan, and A.W. Thoms. 2017. Comparison of Cultivation Methods Impact on Playability of Agrostis stolonifera Greens J. of Testing and Evaluation. *(In press)*

Thoms, A.W., J.T. Brosnan, J.C. Sorochan, and A.M. Saxton. 2016. Exploring relationships in surface hardness data collected with different instruments. J. of Testing and Evaluation 44(2):945-951.

Thoms, A.W., J.T. Brosnan, and J.C. Sorochan. 2016. Root zone construction affects hybrid bermudagrass responses to simulated traffic. Procedia Eng. 147:824-829*.*

M.D. Richardson, M. Girolamo, M. Sarno. D.E. Karcher, D.E. J. McCalla, J.C. Sorochan, and A.W. Thoms. 2016. Shade effects on overseeded bermudagrass athletic fields. Intl. Agron. Ann. Meet. Abstracts. P 101390.

A. Thoms and D. Minner. 2016. Chapter 15: Turfgrass Management. Ed. D. Schrock and S. DeBlieck. Resource Guide for Iowa Master Gardeners. MG 15. P. 207-223.

A. Thoms, I. Mertz, and N. Christians. 2017. Athletic field safety and performance study. 2016 Ann. Progress Rpts. Hort. Res. Station. ISRF16-36. RFR-A1619. P. 47-48.

Thoms, I. Mertz, and N. Christians. 2017. Golf course putting green organic matter recycling study. 2016 Ann. Progress Rpts. Hort. Res. Station. ISRF16-36. RFR-A1617. P. 49-50.

Thoms, I. Mertz, and N. Christians. 2017. Golf course fairway organic matter management with Fraze mowing. 2016 Ann. Progress Rpts. Hort. Res. Station. ISRF16-36. RFR-A1616. P. 51-52.

A. Thoms, I. Mertz, and N. Christians. 2017. Home lawn seeding mixtures and timing trial. 2016 Ann. Progress Rpts. Hort. Res. Station. ISRF16-36. RFR-A1618. P. 53- 54

N. Christians, A. Thoms, and I. Mertz. 2017. Fairway height bentgrass cultivar trial. 2016 Ann. Progress Rpts. Hort. Res. Station. ISRF16-36. RFR-A1635. P. 55

N. Christians, A. Thoms, and I. Mertz. 2017. Green height bentgrass cultivar trial. 2016 Ann. Progress Rpts. Hort. Res. Station. ISRF16-36. RFR-A1636. P. 56-57.

N. Christians, A. Thoms, and I. Mertz. 2017. NTEP turf-type tall fescue study. 2016 Ann. Progress Rpts. Hort. Res. Station. ISRF16-36. RFR-A1634. P. 58-61.

N. Christians, A. Thoms, and I. Mertz. 2017. NTEP Kentucky bluegrass study. 2016 Ann. Progress Rpts. Hort. Res. Station. ISRF16-36. RFR-A1632. P. 62-64.

N. Christians, A. Thoms, and I. Mertz. 2017. NTEP perennial ryegrass study. 2016 Ann. Progress Rpts. Hort. Res. Station. ISRF16-36. RFR-A1633. P. 65-67.

**Extension Program.**

State conference dates: January 17-19th 2017

Collaborating with other organizations on conference (yes/no): Yes

If so who: Iowa Turfgrass Institute, Iowa GCSA, ISTMA and IPLCA

Iowa Turf Conference Attendance figure: 748

Research field day held (yes/no): Yes

If so, when: July 28th, 2016

Attendance figure in 2016: 125

Ryan Adams left the extension Job in June 2016 and Adam Thoms took over extension responsibilities on July 1, 2016.

Other Extension activities: I have given several presentations to groups such as Iowa Master Gardeners, Shade Tree Short Course, Iowa State Pesticide Applicator Video Training, Regional Extension Training, and chapters of the Iowa GCSA/ISTMA. I also spoke at the Kansas and Arkansas Turf Conferences and several talks at the Iowa Turf Conference. Upcoming presentations include regional Iowa GCSA events, national STMA/GCSAA Educational Conferences, and online videos and tutorials on pest management. Several extension visits have been made through-out Iowa. One of current activities is revising out of date publication and creating new articles. There are also monthly article contributions to the IA Reporter.

Web (yes/no): Yes

FaceBook/Twitter/social networking (yes/no): Yes – Twitter, Blog at http://iaturf.blogspot.com/ ,as well Nick Christians Facebook, Twitter to circulate information.

Joint Extension publications with other regional collaborators in the last two years:

Patton and D. Weisenberger. 2017. Turfgrass weed control for professionals. Collaborators: A. Thoms and N. Christians. Purdue Ext. Pub. ISU Hort. 3066. Several more are in the works.

Extension Publications:

A. Thoms and D. Minner. 2016. Chapter 15: Turfgrass Management. Ed. D. Schrock and S. DeBlieck. Resource Guide for Iowa Master Gardeners. MG 15. P. 207-223.

R. Adams. 2016. PM. 3050. Topdressing Athletic Fields. Iowa State Extension Store. Prepared by Ryan Adams, turfgrass specialist, Iowa State University.

R. Adams. 2016. PM. 3048. Putting a Field to Bed. Iowa State Extension Store. Prepared by Ryan Adams, turfgrass specialist, Iowa State University.

R. Adams. 2016. PM. 3046. Managing the Field within the Field. Iowa State Extension Store. Prepared by Ryan Adams, Turfgrass specialist, Iowa State University.

R. Adams. 2016. PM. 3047. Mowing Your Lawn. Revised by Marcus Jones, horticulture graduate student; Nick Christians, university professor, horticulture; and David Minner, extension turfgrass specialist. Originally prepared by Michael Agnew, former extension turfgrass specialist, and Nick Christians, professor of horticulture.

R. Adams. 2015. PM.3031. Organic Turfgrass Fertilization. Prepared by Ryan Adams, turfgrass specialist, Iowa State University.

**Station Report**

*University:* Kansas State University  
*Official NCERA or WERA rep:* Jared A. Hoyle

*Email:* jahoyle@ksu.edu

*Phone:* 785-532-1419

1. Impact Nugget:

Kansas State University turfgrass researchers released a new zoysiagrass cultivar, and evaluated cultural practices for establishing and maintaining turf with lower requirements for fertilizer, pesticides, and water.

2. New Facilities and Equipment

The Rocky Ford Turfgrass Research Center in Manhattan, KS received irrigation pump upgrades in the spring of 2016. Two submersible VFD pumps, operating at 110 PSI, were installed into two new intake tubes, buried beneath the riverbed to maximize water availability during drought, in the Big Blue River to supply water to the turfgrass and pathology research plots. In 2017, a new building was purchased and in the process of construction to enclose the new irrigation pump controller.

New turfgrass research plots (approx. 3 acres) are currently being installed at the Rocky Ford Turfgrass Research Center. Research plots were exchanged between the Department of Horticulture and Natural Resources and the Department of Pathology. With the exchange the turfgrass research group gained another operating facility.

New equipment/services/supplies donated from various sources; John Deere skid steer, Club Cart Utility Cart, stand on trencher, concrete floor donated and installed by HAGCSA in Turfgrass Building at the Olathe Horticulture Research and Extension.

3. Unique Project Related Findings

* A newly developed zoysiagrass which has been released jointly by K-State and Texas A&M, has hardiness equivalent to ‘Meyer’, but superior quality.
* Successful conversion from Tall Fescue to buffalograss can be achieved with glyphosate applications up to 3 days after seeding to reduce time of green cover loss.
* The addition of proxy to fall large patch applications on ‘Meyer’ zoyisagrass will reduce spring seedhead development.
* Kansas Department of Transportation and KSU turfgrass researchers explored combination of rygrass and buffalograss mixtures for roadside establishment. Trials resulted in successful establishment of buffalograss for roadside vegetation cover.
* Research trials conducted in conjunction with Cole Thompson (UNL) explored mowing frequency prior to herbicide applications show effective broadleaf weed control is not affected by mowing. Although, scalping tall fescue prior and immediately after glyphosate applications reduce efficacy.
* Also see accomplishment summaries for more unique project related findings.

4. Accomplishment Summaries:

Pyrimisulfan and penoxsulam are two new acetolate synthase (ALS) inhibiting herbicides utilized for weed control in turfgrass systems. Research trials in 2014 through 2016 in Kansas were conducted to further explore pyrimisulfan and penoxsulam use in turfgrass systems and safety to non-target landscape vegetation. Pyrimisulfan + penoxsulam applications in ‘Meyer’ zoysiagrass and buffalograss resulted in excellent large crabgrass control and no turfgrass injury. Applications also do not have any negative influence on tested ornamental species. These research trials ensure pesticide applicators that products can be safely applied in the landscape without any adverse effects to non-target ornamental species.

Native turfgrass systems contain a variety of species vegetation and can reduce fertility, fuel and water inputs. Due to diverse flora, weed control can be problematic. The objective the collaborative studies are to determine the use of indaziflam in native turfgrass systems. Multiple research trials were conducted from 2014 to 2016 to determine the use of indaziflam in native turfgrass systems. Results indicated that evaluated species are tolerant to indaziflam applications throughout the year.

Athletic field conditions have shown to influence playability. Results of ball-roll speed studies can be used to predict success of infield hits. Field trials were conducted to determine the influence of tall fescue baseball infield mowing height on ground ball speed and batter on-base success. Utilizing ground ball speed results, researchers were able to predict that a simulated batter, if a ground ball was hit to the shortstop position (30.5 m distance), would result in an unsuccessful at bat if a tall fescue infield was mown at 2.5 cm and successful if mown at 5 and 7.6 cm, utilizing consistent player athletic ability data.

Minimal research exists on potential clothing blemishing when athletes contact turfgrass applied with colorants. Field trials were conducted to test the effect of turfgrass colorant applications on clothing blemishing if a athlete is to come in contact with the playing surface. Turfgrass colorants will adhere to turfgrass leaf blades and do not blemish clothing. Although, tested turfgrass pigments did result in significant blemishing of clothing.

Turfgrass damage has been observed from misapplication of human insect repellents. Greenhouse research trials were conducted to survey various human insect repellents on turfgrass growth and recovery. Insect repellents resulted in a wide range of damage. No common trend was observed although research trial shows possible repellents to be utilized around turfgrass that will minimize turfgrass injury.

A new zoysiagrass cultivar, KSUZ 0802 (formal name coming soon), was released jointly by the Kansas Agricultural Experiment Station and Texas A&M AgriLife Research. The cultivar is a hybrid between *Z. japonica* and *Z. matrella*, and has better quality than Meyer, but equivalent cold tolerance.

Research continues to evaluate way to make zoysiagrass more amenable to homeowners and golf courses when it is dormant. Graduate students have evaluated colorants and application volumes and times and observed these can be effectively used to enhance winter-long color. Current research is focusing on the benefits of using seed mixtures of zoysiagrass and tall fescue.

A joint project between K-State, Purdue, and Texas A&M focuses on screening zoysiagrass genotypes for quality and resistance to large patch. Other cooperators evaluating grasses within the NCERA region include the Chicago District Golf Association and the University of Missouri.

5. Impact Statements:

With increasing drought conditions and decreasing water supplies, drought tolerant turfgrass species are being explored for use in golf courses, home lawns, recreational and utility turfgrass systems. Research at Kansas State University has demonstrated that cool-season grasses can be converted to buffalograss and that its quality can be maintained when good cultural practices are used – even under traffic stress.

Through estimated consultation fees for extension consultations and direct communication KSU turfgrass research and extension specialist save Kansas Turfgrass stakeholders: $140,943 in 2016.

A new cold-hardy zoysiagrass cultivar was released, and has better quality but equivalent cold tolerance to Meyer, which has been the cultivar of choice for over 60 years. Homeowners may be more accepting of zoysiagrass lawns when colorants are used to improve winter color, and we identified several that were effective. Seeded zoysia can also be mixed with tall fescue to enhance winter color and reduce the incidence of brown patch.

We surveyed users of the K-State Turf E-newletter/blog In that survey, 73% of respondents indicated they use the resource to diagnose disease problems, 67% to identify weeds, and 63 % to identify insects. On an overall scale of 1-6, with 6= best, the participants gave a ranking of 4.95 in overall usefulness and 5.02 in overall quality. Finally, 87% of users responded “yes” to the question, “"Has the K-State turf and landscape newsletter/blog helped you better communicate about turf or landscape topics with others (e.g., your supervisor, your employees, your clients, your neighbors, or others)?"

Small unmanned aircraft systems: Kansas State University is evaluating the ability of small unmanned aircraft systems (UAS) to detect drought stress in turfgrass across a gradient of well-watered to severe deficit irrigation. They compared the remote measurements with traditional (handheld) techniques. Preliminary results indicates high-resolution remote sensing with small UAS can detect drought stress before it is visible to the human eye.

Nitrous oxide (N2O) is important greenhouse gases that has been implicated in global climate change and is the most important ozone-depleting substance in the atmosphere. Turfgrass systems are typically fertilized with nitrogen (N) and irrigated, which may result in significant N2O emissions. The development of management practices such as slow-release N fertilizer and/or deficit irrigation may mitigate N2O emissions, but also affect carbon sequestration in turf soils. Our objective was to quantify the magnitude and patterns of N2O emissions in turfgrass and determine how irrigation and N fertilization may be managed to reduce N2O emissions. In the first year of measurements, urea fertilizer had higher peak N2O-N fluxes (ug N m-2/h-1) after fertilization and overall annual emissions than polymer-coated N-fertilizer and differences were negligible due to irrigation treatment.

Future water availability is a serious issue in the United States, and state and local drought restrictions may be imposed on turf managers with no regard for damage to turfgrass. Past research has been conducted separately into the issues of drought resistance and traffic tolerance in turfgrass. Our objective was to evaluate the combined effects of golf cart traffic on both warm- and cool-season turfgrass species at golf course related heights during a simulated drought period and evaluate the subsequent recovery period. Preliminary results in the first year indicated remarkable recovery in turf quality after a 40-day dry down with cart traffic.

6. Published Works:

*Refereed Journal Articles*

Braun, R.C., J.D. Fry, J.D.,M.M. Kennelly, M.M.,D.J. Bremer, D.and J.,.J. Griffin, J.J. 2017. "Single and Sequential Colorant Application Effects sequential colorant application effects on Buffalograss and Zoysiagrass Color During Dormancy".buffalograss and zoysiagrass color during dormancy. HortTechnology. 393-398. (in press).

Braun, R., J. Fry, M. Kennelly, D. Bremer, and J. Griffin. 2016. Colorant application volume and color persistence on a ‘Chisholm’ zoysiagrass lawn. HortTechnology: 26:314-319

Obasa K, White F.F., Fellers J, Kennelly M, Liu S., Katz B., Tomich J., Moore D., Shi-nogle H., and Kelley K. 2017. A dimorphic and virulence-enhancing endosymbiont bacte-rium discovered in *Rhizoctonia solani*. Phytobiomes. Posted online on 26 Jan 2017.

http://dx.doi.org/10.1094/PBIOMES-08-16-0005-R.

Chabon, J., D.J. Bremer, J.D. Fry, and C. Lavis. 2017. Effects of soil moisture-based irrigation controllers, mowing height, and trinexapac-ethyl on tall fescue irrigation amounts and mowing requirements. Int. Turf. Soc. Res. J. (in press).

Miller, G., D. Earlywine, R. Braun, J. Fry, and M. Kennelly. 2016. Influence of nitrogen source and application timing on large patch of zoysiagrass. Crop, Forage, and Turfgrass Management: doi:10.2134/cftm2015.0189

Raudenbush, Z. and S. Keeley. 2016. Effect of irrigation water pH and acidifying-source on silvery-thread moss (*Bryum argenteum* Hedw.) establishment. The Bryologist 119(1):1-7.

McCurdy, J.D., J.S McElroy, M.L. Flessner, J.A. Hoyle and E.T. Parker. 2016. Tolerance of Three Trifolium Species to Common Herbicides. Weed Technology 30(2):478-485.

Barton, E.T., E.A. Barton, S. Barton, C.R. Boyer, P. Hill, J.A. Hoyle, J. Reid, J. Seger and Eric Stafne. 2017. Using Technology to Enhance Extension Education Outreach. HortTechnology. 27(2):177-186.

Alderman, E.J, J.A. Hoyle, S. Keeley and J. Fry. 2017. Buffalograss Divot Recovery as Affected by Nitrogen Source and Rate. Crop, Forage and Turfgrass Management. 3. doi:10.2134/cftm2016.06.0044

Hoyle, J.A. and J.A. Reeves. 2017. Effect of Colorant and Glyphosate Application Timing on Annual Bluegrass and Tall Fescue Control in Dormant ‘Meyer’ Zoysiagrass. International Turfgrass Research Journal. *Accepted – In Press*. (CROP-2016-90-0828-ITTS.R3)

Peterson, K.W., D.J. Bremer, K. B. Shonkwiler, and J.M. Ham. 2017. Measurement of evapotranspiration in turfgrass: A comparison of techniques. Agron. J. (in press).

Peterson, K.W., D.J. Bremer, and J.M. Blonquist Jr. 2017. Estimating transpiration from turfgrass using stomatal conductance values derived from infrared thermometry. Int. Turf. Soc. Res. J. (in press).

*Abstracts and Proceedings*

Hoyle, J.A. and J.A. Reeves. 2016. Response of Seven Woody Ornamentals to Turfgrass Herbicide Applications of Arylex, Penoxsulam and Pyrimisulfan. Proc. Amer. Soc. of Horticulture Sci. 313.

Hoyle, J.A. and J.A. Reeves. 2016. Use of Pyrimisulfan and Penoxsulam in Turfgrass Systems. Proc. Agron. Soc. Amer. 261-7.

Hoyle, J.A. and J.A. Reeves. 2016. Native Turfgrass Tolerance to Indaziflam Applications. Proc. Agron. Soc. Amer. 261-8.

Reeves, J.A., J.A. Hoyle, S.J. Keeley and D.J. Bremer. 2016. Glyphosate Application Timing Affects Tall Fescue Conversion to ‘Sharp’s Improved II’ Buffalograss. Proc. Agron. Soc. Amer. 35-4.

Braun, R. D.J. Bremer, J.A. Hoyle and N. Bloedow. 2016. Performance and Recovery of four Turfgrass Species Subjected to Golf Cart Traffic during Prolonged Drought. Proc. Agron. Soc. Amer. 198-6.

*Popular Articles*

Bremer, D. 2016. Small unmanned aircraft systems detect turfgrass drought. USGA Research Update: <http://www.usga.org/course-care/turfgrass-and-environmental-research/research-updates/small-unmanned-aircraft-systems-detect-turfgrass-drought.html>

Braun, R. D. Bremer and J.A. Hoyle. 2016. Performance and recovery of four turfgrass species subjected to golf cart traffic during prolonged drought. Golf Course Management Magazine. November 2016. P.79-80

Hoyle, J.A., J.A. Reeves and E. Alderman. 2016. Best Way to Get your Turf Noticed – Brown Patch!. TURFnews, The Kansas Turfgrass Foundation Newsletter. July 2016.

Alderman, E.J., J.A. Hoyle, S.J. Keeley and J.D. Fry. 2016. Divot recovery in fairway buffalograss. Golf Course Management Magazine. May 2016. P.93

Hoyle, J.A. and W. Upham 2016. Controlling Wild Violets in Lawns. TURFnews, The Kansas Turfgrass Foundation Newsletter. April 2016.

Alderman, E.J. and J.A. Hoyle. 2016. Buffalograss Divot Recovery as Affected by Nitrogen Source and Rate. TURFnews, The Kansas Turfgrass Foundation Newsletter. April 2016.

Hoyle, J.A. 2016. Spring into Greener Lawns. TURFnews, The Kansas Turfgrass Foundation Newsletter. April 2016.

Hoyle, J.A. 2016. CDD Tracker for Poa annua Seedhead Supression. TURFnews, The Kansas Turfgrass Foundation Newsletter. April 2016.

*Other Creative*

E.J. Alderman, J.A. Reeves and J.A. Hoyle. 2016. Preventative Control of Brown Patch with Select Fungicides. Kansas Agriculture Experiment Station Research Reports: Vol.2: Iss.4.

E.J. Alderman, J.A. Hoyle, J. Fry, and S, Keeley. 2016. Evaluating the Effects of Simulated Golf Cart Traffic on Dormant Buffalograss and Turfgrass Colorants. Kansas Agriculture Experiment Station Research Reports: Vol.2: Iss.4.

Reeves, J.A. and J.A. Hoyle. 2016. Late Pre-Emergent Control of Annual Bluegrass with Flazasulfuron and Indaziflam. Kansas Agriculture Experiment Station Research Reports: Vol.2: Iss.4.

Reeves, J.A., J.A. Hoyle, D. Bremer and S. Keeley. 2016 Influence of Glyphosate Timings on Conversion of Golf Course Rough from Tall Fescue to ‘Sharps Improved II’ Buffalograss. Kansas Agriculture Experiment Station Research Reports: Vol.2: Iss.4.

Parsons, L., J. Griffin and J.A. Hoyle. 2016. 2013 National Turfgrass Evaluation Program Bermudagrass Test: 2015 Data. Kansas Agriculture Experiment Station Research Reports: Vol.2: Iss.4.

Parsons, L., M. Kennelly, J. Griffin and J.A. Hoyle. 2016. 2012 National Turfgrass Evaluation Program Fall Fescue Test: 2015 Data. Kansas Agriculture Experiment Station Research Reports: Vol.2: Iss.4.

7. Scientific and Outreach Presentations:

**Presentations By Jared A. Hoyle – KSU Turfgrass Extension Specialist**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Event** | **Presentation** | **Location** | **Date (mo/yr)** | **Est. # Attend** |
| Olathe Research and Extension Open House | Turfgrass Research Update (W/ Dr. Fry) | Olathe, KS | 7/16 | 12 |
| Home Lawn Demonstration – Riley Co KSRE | Fall Lawn Care | Manhattan, KS | 8/16 | 20 |
| BMG Training | Turfgrass Management | Manhattan, KS | 9/16 | 11 |
| BMG Training | Turfgrass Management **(Live Digital Online Delivery from Manhattan, KS)** | Finney Co, KS | 9/16 | 5 |
| Horticulture Night | Low-water Use Turfgrass | Hays, KS | 9/16 | 51 |
| Advanced Master Gardener (AMG) | Common Turfgrass Weeds: Identification and Control | Manhattan, KS | 9/16 | 15 |
| AMG Training | Common Turfgrass Weeds: Identification and Control | Manhattan, KS | 9/16 | 5 |
| BMG Training | Turfgrass Management | Johnson Co & Wyandotte Co | 10/16 | 75 |
| Heartland Green Industry Expo/Common Ground Educational Conference | What’s New, What’s Hot and What’s Not: Commercial Products Coming Through the Pipeline | Olathe, KS | 12/16 | 110 |
| Heartland Green Industry Expo/Common Ground Educational Conference | Turfgrass Pests and Their Control | Olathe, KS | 12/16 | 226 |
| KSRE IPM Commercial Pesticide Applicator Training Program | Introduction to Turf and Ornamental Weed Control | Salina, KS | 11/16 | 115 |
| KSRE IPM Commercial Pesticide Applicator Training Program | Advanced Turfgrass Weed Control | Salina, KS | 11/16 | 115 |
| KSRE IPM Commercial Pesticide Applicator Training Program | Weed Management Strategies and The Influence on Turfgrass Health | Salina, KS | 11/16 | 110 |
| Pesticide Applicators Recertification Training | Weed Management in Turf | Wichita, KS | 11/16 | 210 |
| Metropolitan Golf Course Superintendents Association Annual Meeting | Weed Management in Native and Natural Golf Course Roughs | Fairfield, CT | 11/16 | 125 |
| 83rd Iowa Turfgrass Conference & Trade Show | The Meat and Potatoes of Tough To Control Weeds | Altoona, IA | 1/17 | 140 |
| 83rd Iowa Turfgrass Conference & Trade Show | Using Social Media In the Green Industry | Altoona, IA | 1/17 | 120 |
| 83rd Iowa Turfgrass Conference & Trade Show | To Maintain or Not to Maintain Natural Areas? | Altoona, IA | 1/17 | 125 |
| 83rd Iowa Turfgrass Conference & Trade Show | Sod Growers Herbicide Update | Altoona, IA | 1/17 | 35 |
| Golf Course Superintendents Association of American National Conference | Turfgrass Colorant’s: It’s more than Just Green Color | Orlando, FL | 2/17 | 250 |
| Golf Course Superintendents Association of American National Conference | Low Maintenance Roughs and Natural Areas for Golf Courses | Orlando, FL | 2/17 | 175 |
| American Society of Horticulture Science | 0 to 1,000 Followers; Building a Social Media Presence in the Green Industry | Atlanta, GA | 8/16 | 55 |
| 66th Annual Kansas Turfgrass Conference | Weed Management in naturalized and Native Golf Course Roughs | Topeka, KS | 12/16 | 76 |
| 66th Annual Kansas Turfgrass Conference | Round Table Discussions – Weed Control | Topeka, KS | 12/16 | 10 |
| 66th Annual Kansas Turfgrass Conference | KSU Research Overview | Topeka, KS | 12/16 | 255 |
| 66th Annual Kansas Turfgrass Conference | From River to Roots | Topeka, KS | 12/16 | 45 |
| Kansas Turfgrass Field Day | Difficult to Control Weeds – How new products are going to help you! | Manhattan, KS | 8/16 | 265 |
| Spring Turfgrass Management Workshop | Preparing Your Lawn for 2016 | Colby, KS | 2/16 | 25 |

**Turf Presentations (Jan 2016-present) by KSU Hort Plant Pathologist Megan Kennelly**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Conference/Venue | Title | Location | Date | # participants |
| GCSAA national conference | Managing Moss Madness | San Diego | 2-10-16 | 80 |
| Plant Pathology 590, Landscape Diseases | Turf diseases | Manhattan | 5-6-16 | 12 |
| Turf field day | Disease update | Manhattan | 8-4-16 | 150 |
| Certified pesticide applicator training | Turf and ornamentals hands-on disease id | Salina | 11-3-16 | 80 |
| Kansas Turfgrass Conference | Research update | Topeka | 12-7-16 | 300 |
| Kansas Turfgrass Conference | Meet the pests disease id hands-on booth | Topeka | 12-6 and 12-7 -16 | 60 |
| Kansas Turfgrass Conference | Women in turfgrass and landscape industry roundtable (facilitator/leader) | Topeka | 12-7-16 | 10 |
| TurfNet | Plant health beyond the rough: An overview of diseases of trees and ornamentals | Online national webinar | 4-5-2017 | 20 |

**Presentations By KSU Turfgrass Graduate Students**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Event** | **Presentation** | **Location** | **Date (mo/yr)** | **Est. # Attend** |
| 66th Annual Kansas Turfgrass Conference | Turfgrass Weeds – Evan Alderman (MS Student) | Topeka, KS | 12/16 | 50 |
| 66th Annual Kansas Turfgrass Conference | Fertilization - Mingying Xiang (PhD Student) | Topeka, KS | 12/16 | 40 |
| 66th Annual Kansas Turfgrass Conference | Cultivation – Evan Alderman (MS Student) | Topeka, KS | 12/16 | 50 |
| 66th Annual Kansas Turfgrass Conference | “Not Carts Today” – The Effect of Traffic on Drought Stressed Turfgrass - Ross Braun (PhD Student) | Topeka, KS | 12/16 | 65 |
| Kansas Turfgrass Field Day | Herbicide Options for Converting Tall Fescue to Buffalograss – Jake Reeves (MS Student) | Manhattan, KS | 8/16 | 265 |
| Kansas Turfgrass Field Day | Zoyisagrass Update - Mingying Xiang (PhD Student) | Manhattan, KS | 8/16 | 265 |
| Kansas Turfgrass Field Day | Carts During Drought - Ross Braun (PhD Student) | Manhattan, KS | 8/16 | 265 |
| Home Lawn Demonstration – Riley Co KSRE | Fall Lawn Fertility – Jake Reeves (MS Student) | Manhattan, KS | 8/16 | 15 |
| HNR Departmental Seminar | The Effect of Management Practices on Buffalograss Divot Recovery and Tolerance to Golf Cart Traffic | Manhattan, KS | 7/16 | 20 |

8. Funding leveraging

Current collaboration with UNL (Dr. Kreuser) is exploring growth potential models for cool-season turfgrass in the transition zone. Preliminary research across multiple universities is currently being conducted. More information can be found in the University of Nebraska Station Report.

Kansas State University is working with PI, Dr. Watkins in obtaining funding for the Regional Roadside Turfgrass Testing Program.

Multiple-state cooperation on project to evaluate zoysiagrass genotypes for quality, cold hardiness, and resistance to large patch (USGA sponsored).

Various industry supported research trials are being conducted across multiple states to explore herbicide efficacy and safety.

9. Other Relevant Accomplishments and Activities:

**Extension Programing**

*State conference dates:* Dec 6-8, 2016 in Topeka, KS

In 2016, the Kansas Turfgrass Foundation continued collaboration with the Kansas Nursery and Landscape Association (KNLA) and NurseryWorks Conference to join the Annual Conference and Trade Show.

Attendance figure*:* about 600-800

*Research field day held (yes/no):* Yes

If so, when: Always first Thursday in August. Aug. 4, 2016, in Manhattan, KS and Aug. 3, 2017 in Wichita, KS.

Attendance figure*:* varies by location, average 200-300

*Digital Outreach*

Kansas State University has expanded the digital outreach through a targeted social media campaign. The digital outreach consists of;

1. Facebook – [www.facebook.com/ksuturf](http://www.facebook.com/ksuturf) - As of July17, the KSU Turfgrass Facebook Page has **1,013 followers.** This has increased the audience engagement reaching up to **7,100 users** by an individual post.
2. YouTube - <https://www.youtube.com/channel/UCCR_yPZef0uVkcDLi4dvdXA> Launched in May of 2016, the KSU Turfgrass YouTube Channel has uploaded 4 videos with over **1,516 views**. YouTube serves as a repository for research, extension and teaching videos available to the public.
3. Twitter – [www.twitter.com/ksuturf](http://www.twitter.com/ksuturf) - @KSUTurf - Contributed **1,357** **tweets** specifically about KSU turfgrass research, extension and teaching to **1,680** **followers.**
4. KSU Turfgrass Blog - <blogs.ksu.edu/turf> - The KSU Turfgrass Blog had **29,749** page views from June 2016 to June 2017.
5. Digital Newsletter - Information from social media, KSU Turf Blog, publications and other media is distributed via a weekly email to **1,171 subscribers** on the K-State Turf List-Serve Newsletter. Information contained in the newsletter is identified through communication with extension agents, reports from commercial turfgrass managers, and the Plant Diagnosis Clinic. Information distributed is on current needs of homeowners, extension agents, and professional turfgrass managers.
6. Video Broadcasts – Periodic video interviews and educational programming are distributed through local broadcast channels of NBC, ABC and FOX.
7. Radio Broadcasts – Monthly radio interviews are conducted to address homeowner needs in the lawn and landscape through Kansa State University’s Radio Program, Agriculture Today.
8. KSU Turfgrass Website – [ww.ksu.edu/turf](http://www.ksu.edu/turf) – The KSU Turfgrass Website serves a hub for all digital information supported in the social media campaign. The KSU Turfgrass website had **44,365** page views from June 2016 to June 2017 with **82%** being new users.

**Teaching Program**

Current undergraduate enrollment: 45 in turf-related areas

Trend in undergraduate enrollment over last 3 years: Flat for last 3 years, after a downward trend for several years prior to 2011. The department is initiating new efforts to recruit freshmen and transfer students using web site development and social media. View a new recruitment video on YouTube here: <https://www.youtube.com/watch?v=9jeKiQnCBFQ>

Placement: excellent

Brief comments on teaching: A distance course, Water Issues in the Lawn and Landscape (3 cr.) has been quite popular over the last several years, and is available to students outside of KSU through the AgIdea program. Bremer, Fry, Keeley, Lavis are contributing instructors.

In the Fall of 2016, HORT 495, Undergraduate Research – Turfgrass Science was developed as an independent study.

**NCERA 221**

**Project Station Report: Maryland**

**Report Date July 2017**

**Period Summarized 2016**

**Impact Nugget.** Research activities continue to focus identifying strategies that will reduce fertilizer usage and runoff from turfgrass. Additionally with the most highly populated county within the state imposing a ban the use of pesticides on turfgrass reduced pesticide input studies on athletic field and home lawns have become highly visible and valued component of the UMD turfgrass program in the past year.

**New Facilities and Equipment.** Several new pieces of equipment (ie., large commercial sprayer and topdresser) were purchased in 2016 along with upgrading of portions of farm irrigation system. These purchases were done in support of a wide spectrum of research activities underway at the UMD turf farm.

**Accomplishment Summaries.** Compost use and the inclusion of legumes in turfgrass seed mixtures provide two possible ways to reduce runoff and fertilizer use on turfgrass. In a study aimed at evaluating the effect of high volume amounts of compost on the establishment of a tall fescue + microclover lawn, the incorporation of 2 inches of either yard trimmings or biosolids compost prior to seeding suppressed microclover establishment. Use of the biosolids compost was more deleterious to microclover establishment that was the use of the yard trimmings compost. In this same study it was also determined that high rates of straw coverage within the seedbed were more suppressive to the establishment of miroclover than to tall fescue.

Due to turfgrass nutrient management regulations in Maryland as well as potential bans on pesticide use by lawn care companies and individual homeowners, numerous research efforts are being made to address reduced maintenance inputs while maintaining quality turf. National Turfgrass Evaluation Program (NTEP) trials for Kentucky bluegrass, tall fescue, fine fescue, bermudagrass, zoysiagrass and mixed species are being conducted with reduced fertilizer and water inputs compared to historic recommended levels, and with no fungicidal disease control measures. University of Maryland and Virginia Tech are also conducting joint statewide trials for Kentucky bluegrass and tall fescue, in addition to joint trials in a cooperative breeders program with Kentucky bluegrass, tall fescue, and perennial ryegrass. A recommended turfgrass cultivar publication based on the results of these trials is released annually.

Additional trials underway to address the aforementioned issues include:

1. Compare synthetic to organic lawn care programs, including N-sources, N-rates, and synthetic versus bio-rational herbicides on tall fescue quality and weed encroachment

2. Compare four mowing heights and two N-rates on tall fescue turf quality and weed encroachment

**Impact Statements.**   Amending soil with 2 inches compost prior to turfgrass establishment is a recommended practice to improve the chemical and physical properties of compact infertile soils frequently found on the lots of newly constructed homes. Research at the University of Maryland has demonstrated that the incorporation biosolids compost should be avoided when there is an expressed desired to establish a lawn that contains a high portion of clover within it.

The annual turfgrass cultivar publication produced by the University of Maryland, is used by the MD Department of Agriculture Turf and Seed Section to administer the states certified sod program, and is used by the MD State Highway Department to define acceptable seed mixes for use on MD highways. Landscape architects within the state also frequently cite this publication when providing specifications for the creation of newly established turfgrass areas.

**Published Written Works.**

*Refereed Articles*

Landschoot, P., and M. Carroll. 2016. Tolerance of microclover to postemergence and preemergence herbicides. Crop, Forage & Turfgrass Management.

*Bulletins*

Turner, T.R, and M. Carroll. 2016. 2016 Nutrient management guidelines for turfgrass seeding and sod installation. TT116.

Turner, T.R. 2016. Turfgrass cultivar recommendations for certified sod and professional seed mixtures In Maryland. Univ. of Maryland Turfgrass TT #77.

*Magazine articles*

Turner, T.R. 2016. Nutrient Management Guidelines for Turfgrass Seeding and Sod Installation. Maryland Turfgrass Council Magazine (Fall Issue).

Turner, T.R. 2016. Cultivar Recommendations for 2016. Maryland Turfgrass Council Magazine (Spring Issue).

**Scientific and Outreach Oral Presentations**.

*Scientific Conferences*

Chen, S., M.J, Carroll and T.R. Turner. 2016. Fertilizer use restrictions and organic lawn care: Evaluation of compost tea, compost topdressing and cultivation on turf color, quality and weed encroachment. 5th European Turfgrass Society Conference, Albufeira Portugal

*Outreach*

*Presentations by Carroll*

Compost and microclover inclusion in lawns. Mid-Atlantic Turfgrass Expo.

Compost and microclover inclusion in lawns: performance, weed issues, and fertility effects. Pesticide and nutrient management recertification session. Annapolis, MD.

Compost and microclover inclusion in lawns: performance, weed issues, and fertility effects. Pesticide and nutrient management recertification session. College Park, MD

*Presentations by Turner:*

Organic Options for Use in Lawn Maintenance – Mid-Atlantic Turf Expo

Low-Input Turfgrass Management for Sod Production – Mid-Atlantic Turf Expo

Basic Turfgrass Seminar: Species and Cultivar Properties and Selection, Turfgrass Fertility, and Turfgrass Diseases – Mid-Atlantic Turf Expo

What University of MD Research is doing to Help Sod Production – Maryland Sod Producers Association

Fertility and Management Practices to Reduce Turfgrass Pest Problems – MDA Nutrient Management and Pesticide Recertification

Selecting Species and Cultivars for Athletic Fields – Sports Turf Equipment University

The Impact of Kentucky Bluegrass in Tall Fescue Sod Mixtures – Maryland Sod Producers Association

Strategies to Reduce Fertilizer Use While Maintaining Turfgrass Quality - FALCAN

University of Maryland Turfgrass Research Update – Mid-Atlantic Sports Turf Managers Association

Turfgrass Selection for Mid-Atlantic Athletic Fields (panel) - Mid-Atlantic Sports

Turf Managers Association

Nitrogen Fertility Research: What is too Little and What is too Much – Turfgrass Nutrient Management Certification Program Seminar

**Fund leveraging**: None with regards to other members of this project.

**Other relevant accomplishments and activities**

Our program turfgrass pathogists, Dr. Joseph Roberts, who is not a member of this project, has several on-going research activities that are closely allied with the goals of NCERA 221. In the past year Dr. Roberts played an instrumental role in formation NE1602 (Explorations in the Turfgrass Phytobiome: Understanding Microbial Associations and Developing Tools for Management). He also hosted the first meeting of this newly approved regional project in January of 2017.

**NC Project Station Report Content: University of Minnesota**

*1. Impact Nugget:  A concise statement of advancements, accomplishments and impacts.  (Limit to 1-2 sentences)*

We have continued to lead in the area of low-input turfgrass research through peer reviewed publications, newly funded research grants, and outreach efforts aimed at diverse stakeholder groups.

*2. New Facilities and Equipment. Include production areas, sensors, instruments, and control systems purchased/installed.*

A new weather station was installed at our turfgrass research center.  We installed a new NTEP drought area with individual irrigation control and also an irrigation demonstration area with five different smart controllers, soil moisture sensors, and matched precipitation rate nozzles.

*3. Unique Project Related Findings.  List anything noteworthy and unique learned this year.*

Our roadside irrigation system research has found that it is practical to establish sod in these environments by the use of fire hydrants.  We continue to be successful in generating dollars from grants, and most recently received a collaborative SCRI grant in the amount of $5.5 million.

The University of Minnesota Science of the Green initiative established a long-term partnership with the United States Golf Association to drive innovation in all aspects of a golf facility.  This 5-yr renewable partnership provides project specific funding up to $2.5M.  Current projects are focused on the natural capital value of golf course properties, a comparative analysis of public policy and economics of water policies in the Southwestern and North Central U.S, and the impact of course set up on pace of play and the economics of those decisions.

*4. Accomplishment Summaries.  Draft one to three short paragraphs (2 to 5 sentences each) that summarize research or outreach accomplishments that relate to the project objectives.  Please use language that the general public can readily comprehend.*

We have continued to lead projects related to roadside turfgrasses. During the past year, we began leading a new project that involves turfgrass researchers at Universities in four other states (Wisconsin, Nebraska, Michigan, and New Jersey). This collaborative project is studying a number of turfgrasses for performance on both rural and urban roadside sites.

We are in the final year of our USDA-NIFA Specialty Crops Research Initiative project focused on improvement of fine fescues. This has been a fruitful partnership between the University of Minnesota, the University of Wisconsin, and Rutgers University. We continue to learn more about important traits that must be improved in order for fine fescues to gain wider adaptation. We are also learning about consumer preferences for these low input grasses.

Home lawn irrigation- in a joint project with the Metropolitan Council, we are assessing the irrigation practices of residents it the Twin Cities Metro area.  This work is ongoing and initially we’ve determined that there is a large potential for water savings in home lawns.

Minnesota Golf Course Superintendent’s Association research- through this work we are evaluating wetting agent use on golf courses and other practical studies.

*5. Impact Statements.  Please draft 2 or 3 impact statement summaries related to the project objectives.  Statements should be quantitative when possible and be oriented towards the general public.  This is perhaps the most difficult yet most important part of the report.*

We have conducted research that is beginning to inform us about the best ways to establish salt-tolerant grasses on roadsides (watering needs, date of seeding/sodding, soil amendments, etc.).  This information is being communicated to stakeholders and should improve the success of roadside turf installations.

We continue to evaluate a number of grass species for use in lower-input environments, including fine fescues for both golf greens and golf fairways.  We have identified a number of cultivars that do well in Minnesota under these conditions and hope to test these at a larger scale in the future.

*6. Published Written Works.  Include scientific publications, trade magazine articles, books, posters, websites developed, and any other relevant printed works produced.  Please use the formatting in the examples below.*

Peer reviewed

Friell, J., E. Watkins, B.P. Horgan, M. Cavanaugh. 2016. Sod strength characteristics of 51 cool-season turfgrass mixtures. Agronomy Journal doi:10.2134/agronj2016.05.0295.

Hugie, K.L. and E. Watkins. 2016. Performance of low-input turfgrass species as affected by mowing and nitrogen fertilization in Minnesota. HortScience 51:1278-1286.

Yue, C., J. Wang, E. Watkins, S. Bonos, K. Nelson, J. Murphy, W. Meyer, and B. Horgan. 2016. Heterogeneous consumer preferences for turfgrass attributes in the United States and Canada. Canadian Journal of Agricultural Economics. doi:10.1111/cjag.12128

Reiter, M. J. Friell, B. Horgan, and E. Watkins. Drought response of fine fescue mixtures maintained as a golf course fairway. International Turfgrass Society Research Journal. *Accepted pending revision*.

Yue, C., J. Wang, E. Watkins, S.A. Bonos, K.C. Nelson, J.A. Murphy, W.A. Meyer, and B. Horgan. Consumer preferences for information sources of turfgrass products and lawn care. Agronomy Journal: *Accepted*.

Yue, C., J. Wang, E. Watkins, S.A. Bonos, K.C. Nelson, J.A. Murphy, W.A. Meyer, and B. Horgan. 2017. An investigation of trait prioritization in turfgrass breeding programs. HortScience: *Accepted*.

Hollman, A., Heineck, G., Frank, K., Bauer, S., Bryan, J., Horgan, B. 2016. Effects of De-Icing Products on Putting Green Turf. International Turfgrass Society Research Journal. *In press.*

Bauer, S., Horgan, B. and Cavanaugh, M. 2016. Wetting Agent Influence on Putting Green Surface Firmness.  International Turfgrass Society Research Journal. *In press*.

Koch, P., Soldat, D., Bauer, S. and Patton, A. 2016. The Great Lakes School of Turfgrass Science: A Nine-State Online Collaboration to Improve the Turfgrass Short Course. Journal of Extension. *In press*.

Bauer, S., Horgan, B., Soldat, D., Gardner, D. and Lloyd, D. 2016. Effects of Low Temperatures on Nitrogen Uptake, Partitioning, and Utilization in Creeping Bentgrass Putting Greens. Crop Science (i*n press*) doi: 10.2135/cropsci2016.09.0767

Trade publications

Bauer. S. 2016. Soil Wetting Agents for Water Conservation. MTGF Clippings. Fall/Winter. 24(2): p. 6.

Bauer, S. 2016. A multitude of portable moisture meters. Hole Notes. 51(8): p. 44-55.

Bauer, S., and B. Horgan. 2016. Wetting agent influence on surface firmness and winter injury of putting greens. Hole Notes. April. 50(3): p. 42-45, 47-50.

Bauer, S. A new face at the U of M: Jonah Reyes joins the turfgrass science program. 2016. Hole Notes. April. 50(3): p. 51.

Watkins, E., Horgan, B., Bauer, S. and Orshinsky, A. 2016. Turfgrass program support. MTGF Clippings. Spring/Summer. 24(1): p. 11.

Horgan, B., Bauer, S. and Cavanaugh, M. 2016. Evaluation of creeping bentgrass variety germination differences at various temperatures. Hole Notes. January/February. 50(1): p. 16-23.

*7. Scientific and Outreach Oral Presentations.  Include workshops, colloquia, conferences, symposia, and industry meetings in which you presented and/or organized.  See below for formatting.*

Bauer, S., E. Watkins, B. Horgan, and J. Reyes. 2016. Establishment of roadside turfgrasses with modular irrigation systems. ASA-CSSA-SSSA International Meeting. Phoenix, AZ.

Grimshaw, A.L., S.A. Bonos, W.A. Meyer, and E. Watkins. 2016. Heritability estimates for fine fescue species (Festuca spp.) in response to wear. ASA-CSSA-SSSA International Meeting. Phoenix, AZ.

Heineck, G., E. Watkins, and N.J. Ehlke. 2016. Exploring the possibility of multi-year perennial ryegrass seed production in Minnesota. ASA-CSSA-SSSA International Meeting. Phoenix, AZ.

Qiu, Y., A. Orshinsky, M. Reiter, and E. Watkins. 2016. Use of real-time PCR for determining species proportions in a mixed fine fescue turfgrass community. ASA-CSSA-SSSA International Meeting. Phoenix, AZ. ASA-CSSA-SSSA International Meeting. Phoenix, AZ.

Trappe, J.M., E. Watkins, A. Hollman, S. Bauer, and M. Cavanaugh. 2016. Determining optimum watering regimes for establishment of Kentucky bluegrass sod and fine fescue sod. ASA-CSSA-SSSA International Meeting. Phoenix, AZ.

Watkins, E., S. Bauer, J. Friell, and B. Horgan. 2016. Roadside turfgrass research in Minnesota. ASA-CSSA-SSSA International Meeting. Phoenix, AZ.

Watkins, E. Perennial ryegrass breeding and cultivar selection. NFL Sports Field Manager Educational Symposium. Bloomington, MN. March 7, 2017.

Watkins, E. Fine fescues as an input reduction strategy on golf courses. Ontario Turfgrass Symposium: A Changing Landscape. Guelph, Ontario, Canada. February 22, 2017. 100 participants.

Watkins, E. Selecting low-input turfgrasses for sustainable landscapes. Ontario Turfgrass Symposium: A Changing Landscape. Guelph, Ontario, Canada. February 22, 2017. 50 participants.

Watkins, E. , S. Bauer, and B. Horgan. Turfgrass research update. Co-presented with Sam Northern Green Expo. Minneapolis, MN. January 11, 2017. 100 participants.

Watkins, E. Developing sustainable turfgrass mixtures for roadsides in Minnesota. CTS Transportation Research Conference. University of Minnesota. November 3, 2016. 25 participants.

Watkins, E. The potential of tall fescue in Minnesota. Minnesota Turf and Grounds Field Day. August 11 , 2016. 175 participants

Watkins, E. Low-input turfgrass selection and management. University of Minnesota Bee Lawn Field Day. June 9, 2016. 75 participants.

Bauer, S. Winfield Academy Innovation Tour. “Turfgrass Nutrition: The Basics.” (Oak Marsh Golf Club, Oakdale, MN). March 15th, 2017.

Bauer, S. University of Minnesota Extension Shade Tree Short Course. “Turfgrass for Tree Professionals.” (Bethel University, St. Paul, MN). Two presentations- March 14th and 15th, 2017.

Bauer, S. Minnesota Park and Sports Turf Manager’s Association Spring Workshop. “The Ins and Outs of PGR Use in Sports Turf” and “Annual Bluegrass Management for the Sports Turf Manager.” (Northwestern University, Roseville, MN). March 8th, 2017.

Bauer, S. North Central Turfgrass Association Annual Conference. “Turfgrass Nutrition: The Basics” and “Getting the Most out of Soil Wetting Agents.” (Ramada, Fargo, ND). March 1st, 2017.

Bauer, S. Gertens Spring Expo. “Understanding Liquid and Granular Fertilizer Technology.” (Mystic Lake Casino, Prior Lake, MN). February 24th, 2017.

Bauer, S. SiteOne University. “Understanding Liquid and Granular Fertilizer Technology” and “Use of Tall Fescue in Lawns and Grounds (Canterbury Downs, Shakopee, MN). February 23rd, 2017.

Bauer, S. Golf Course Superintendents Association of America. “Advantages of Tall Fescue- Drought Resistance.” GCSAA Webcast. November 15th, 2016.

Bauer, S. University of Minnesota Extension Shade Tree Short Course. “I’m Tired of Mowing- Alternatives to High Maintenance Turfgrass Species.” (Bethel University, St. Paul, MN). Two presentations- March 15th and 16th, 2016.

Bauer, S. Winfield Academy Innovation Tour. “Lawn Renovations, Selecting the Right Grass Seed, and Weed Control Strategies.” (Cabelas, Woodbury, MN). August 24th, 2016.

Bauer, S. Northern Seed Trade Association Annual Conference. “Alternative Grasses for Midwest Lawns.” (Double Tree, St. Paul, MN). July 14th, 2016.

Bauer, S. First Tee Life Skills and Leadership Academy. “Careers in the Turfgrass Industry and Turfgrass Identification.” (National Sports Center, Blaine, MN). July 10th, 2016.

Bauer, S. Minnesota Turf Association. “Roadside Turfgrass Research.” (Majestic Oaks Golf Club, Andover, MN). March 31st, 2016.

Bauer, S. Gerten’s Spring Expo. “Fertilization of Turfgrass- The Unalterable Basics.” (Mystic Lake Casino, Prior Lake, MN). February 26th, 2016.

Bauer, S. North Central Turfgrass Association. “Considerations for Converting Golf Course Fairway Species.” (Ramada Plaza Suites, Fargo, MN). February 23rd, 2016.

Bauer, S. John Deere Landscapes University. “Turf Renovation 101” and “Diagnosing Turfgrass Problems.” (Mystic Lake Casino, Prior Lake, MN). February 18th, 2016.

Bauer, S. Association of Montana Turf, Ornamental and Pest Professionals. “Turfgrass Weed Management- New Options and Strategies” and “Choosing Turfgrass Species and Varieties for Different Situations.” (Fairmont Hot Springs Resort, Fairmont, Montana). January 25th, 2016.

Bauer, S. Wisconsin Turfgrass Association. “Weed Management for Sports Turf.” (University of Wisconsin-Madison). January 5th, 2016.

Bauer, S. 3M Home Improvement Club. “Irrigation Considerations for Healthy Lawns and Water Savings.” (3M Center, Building 225, Lake Elmo, MN). March 9th, 2017.

Bauer, S. Department of Horticultural Science. “University of Minnesota Extension- Resources at Your Fingertips and Down the Hall.” (Alderman Hall, St. Paul, MN). Co-taught with Julie Weisenhorn. March 8th, 2017.

Bauer, S. Minnesota Home and Garden Show. “Ten Tips for a Healthy Lawn.” (Minneapolis Convention Center, Minneapolis, MN). Taught two 1-hr sessions. February 24th and March 3rd, 2017.

Bauer, S. Minnesota State Fair- Dirt Stage. “Low Maintenance Lawn Care.” (Horticulture Building, St. Paul, MN). September 2nd, 2016.

Bauer, S. Gopher Adventures Career Day. “Turfgrass Science Research and Education.” (St. Paul Campus Display and Trial Garden, St. Paul, MN). August 9th, 2016.

Bauer, S. Nine Mile Creek Watershed District. “Weed Management in Lawns.” (Nine Mile Creek Discovery Point, Eden Prairie, MN). June 29th, 2016.

Bauer, S. Cold Spring Fall Lawn Care Festival. “Lawn Fertility.” (North Point Park, Cold Spring, MN). May 17th, 2016. Joint program with the Minnesota Department of Agriculture.

Bauer, S. U of M Landscape Arboretum Earth Day Workshop. “Wise Watering Practices- Lawns.” (U of M Landscape Arboretum, Chaska, MN). April 22nd, 2016.

Bauer, S. 3M Lunch and Learn. “Lawn Care- A Calendar for Success.” (3M Menominee Plant, Menominee, WI). April 18th, 2016.

Bauer, S. Longfellow Garden Club. “Sustainable Lawn Care.” (Epworth United Methodist Church, Minneapolis, MN). April 13th, 2016.

Bauer, S. 3M Home Improvement Club. “Lawn Care- A Calendar for Success.” (3M Center, Building 225, Lake Elmo, MN). April 12th, 2016.

Bauer, S. Mickman Brothers Garden Center. “Lawn Care- A Calendar for Success.” (Mickman Brothers Garden Center, Ham Lake, MN). April 9th, 2016.

Bauer, S. Northern Gardener. “Lawn Rehabilitation 101.” (Northern Gardener, Roseville, MN). April 5th, 2016.

Bauer, S. Health Partners and Park Nicollet Clinics. “Low Maintenance Turfgrasses.” (Health Partners, Bloomington, MN). March 24th, 2016.

Bauer, S. Mickman Brothers Garden Center. “Spring Lawn Care.” (Mickman Brothers Garden Center, Ham Lake, MN). March 19th, 2016.

Bauer, S. Hennepin County Horticulture Society. “Minnesota Home Lawn Care.” (Faith-Lilac Way Lutheran Church, Robbinsdale, MN). March 14th, 2016.

Bauer, S. Mickman Brothers Garden Center- Employee Lunch and Learn. “Spring Lawn Care.” (Mickman Brothers Garden Center, Ham Lake, MN). March 10th, 2016.

Bauer, S. Minnesota Home and Garden Show. “Sustainable Lawn Care.” (Minneapolis Convention Center, Minneapolis, MN). Taught two 1-hour sessions. February 27th and March 3rd, 2016.

Bauer, S. Great Lakes School of Turfgrass Science. 12-week online national and international training program.  School coordinator and instructor.  Co-taught with 12 professors. January 2nd-March 22nd, 2017.

Bauer, S. Hennepin County Sentenced to Serve Crew Leader Horticulture Training Program. “Turfgrass Management.” (Community Offender Management Division, Minneapolis, MN). Training coordinator and instructor. March 16th, 2017.

Bauer, S. Your Sustainable Yard. “Lawns and Turfgrass.” (UMN Landscape Arboretum, Chaska, MN). March 11th, 2017.

Bauer, S. Capital Region Watershed District and St. Paul Parks. 1-day Turfgrass Training Program. (Turfgrass Research, Outreach, and Education Center, St. Paul, MN). Training coordinator and instructor. July 19th, 2016.

Bauer, S. Your Sustainable Yard. “Lawns and Turfgrass.” (UMN Landscape Arboretum, Chaska, MN). March 12th, 2016.

Bauer, S. Hennepin County Sentenced to Serve Crew Leader Horticulture Training Program. “Turfgrass Management.” (Community Offender Management Division, Minneapolis, MN). Training coordinator and instructor. March 3rd, 2016.

Bauer, S. Great Lakes School of Turfgrass Science. 12-week online national and international training program.  School coordinator and instructor.  Co-taught with 12 professors. January 6th-March 23rd, 2016.

Bauer, S. University of Minnesota and Minnesota Turf and Grounds Foundation Research Field Day. 1-Day Field Day on St. Paul Campus with 18 presenters.  Field Day coordinator and presenter. August 11th, 2016.

Bauer, S. University of Minnesota Bee Lawn Field Day. Afternoon field day on St. Paul Campus with 9 presenters.  Field Day coordinator and presenter. June 9th, 2016.

Bauer, S. Minnesota Shade Tree Advisory Committee Field Day. “Establishing Low Mow Turfgrass.” (U of M UFORE Nursery). August 24th, 2016.

*8. Fund leveraging, specifically, collaborative grants between stations and members.*

Watkins, E., S. Bauer, and A. Hollman. 2017-2020. Establishment and maintenance practices for no-mow fine fescue golf course roughs. United States Golf Association. $44,272.

Watkins, E., M. Renz, D. Soldat, K. Frank, W. Kreuser, and J. Murphy. 2016-2019. Regional roadside testing program. Minnesota Department of Transportation $200,000. (total funding was result of contributions from five state departments of transportation)

Spivak, M., E. Watkins, and K. Nelson. 2016-2019. Bee pollinator habitat enhancement – phase 2. Minnesota Environment and Natural  Resources Trust Fund. $387,015.

Watkins, E. and N.J. Ehlke. 2016-2019. Fine fescue: A new grass seed crop for Minnesota. Minnesota Crop Research Grant Program. $240,217.

Watkins, E., S. Bauer, and J. Friell. 2016-2018. Regional optimization of roadside turfgrass seed mixtures. Minnesota Department of Transportation/Local Road Research Board. $142,346.

9. Other relevant accomplishments and activities.

**BRIEF State Report for NCERA211 (formerly 192)**

University: Michigan State University  
Official NCERA rep: Kevin W. Frank

Email: [frankk@msu.edu](mailto:frankk@msu.edu)

Phone: 517-353-0147

**Teaching**

Current undergraduate enrollment: 57 total [25 (4 yr.), 32 (2 yr.)]

Trend in student enrollment over last 3 years: flat

Placement: Excellent  
Joint teaching activities with other regional collaborators:

**Research**

Faculty member (complete for each faculty member): **Kevin W. Frank**

Project: Long term nutrient leaching  
Description: Nitrogen fate research was initially conducted at Michigan State University in 1991. The initial research conducted from 1991 through 1993 indicated that there was minimal risk of nitrate-nitrogen leaching from turfgrass. Subsequent years of research on the same lysimeters indicate the risk of nitrogen leaching changes as the turf ages. Since the summer of 1998 percolate samples have been collected from the same monolith lysimeters and analyzed for nitrate-nitrogen. As of 2016, the turfgrass area has now been under continual fertilization practices for 26 years with percolate collection for the last 18 years consecutively. From July 1998 through 2002, lysimeters were treated annually with urea at a low N rate 2 lb. N/1000 ft.2 and a high N rate 5 lb. N/1000 ft.2. In 2003 the N rate was reduced to 4 lb. N/1000 ft.2 for the high N rate while the low N rate remained at 2 lb. N/1000 ft.2. During the first year (2003) of reducing nitrogen application rates from 5 to 4 lb. N/1000 ft.2 there was no reduction in nitrate-N concentrations in leachate. However, after 13 years of annual 4 lb. N/1000 ft.2 applications there was a significant and sustained reduction in the amount of nitrate-N leaching to the point that the mean leaching concentrations are now approximately equivalent to when the research was initiated in 1998. A paper summarizing the research results from 1998-2013 was published in Crop Science in 2016.

Project: Refining Phosphorus Recommendations for Turfgrass Grown on Sand Based Rootzones

Description: A prior fertilizer program research trial on an A4 creeping bentgrass putting green at the Hancock Turfgrass Research Center has resulted in soil phosphorus deficiency levels in a USGA specification sand based rootzone. Phosphorus deficiency symptoms have been observed since 2013 and soil testing levels using the Olsen extractant from the site are classified as very low (< 6 ppm) and recommend a phosphorus application. The objective of our research is to fine tune MSU phosphorus soil testing recommendations to ensure that the recommendations meet turfgrass needs without overestimating the amount of phosphorus the plant requires.

Project: NTEP Trials

Description: Current trials under evaluation

Creeping bentgrass green

Creeping bentgrass fairway

Fine leaf fescue lawn height

Fine leaf fescue fairway height with traffic

Low input sustainable turf

Perennial ryegrass fairway

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Faculty member (complete for each faculty member): **Emily Merewitz**

Current or recently graduated graduate student: Kevin Laskowski

MS or PhD: PhD student

Project: Winterkill research in a low temperature growth chamber

Golf courses were subject to extremely cold temperatures and snow/ice cover for long durations during the winters of 2013/2014 and 2014/2015 which killed part or entire putting greens. Our research aims to determine whether commonly use fungicides and plant growth regulators can alleviate these extreme winter conditions effects on putting greens. Field plots were treated in late summer through the fall with Civitas One, Embark T&O, Banner Maxx, or Primo Maxx at label recommended rates. A golf course cup cutter was then utilized to take samples from these treated research plots and transferred to a low temperature growth chamber for controlled conditions at -4°C. One half of the samples were subject to an ice cover while the other half was not. After 20, 40, and 60 days, samples were removed from the chamber and put in optimal growth conditions for regrowth evaluations. Results indicate that ice covered plugs treated with Embark T&O, Banner Maxx, and Civitas One all had more regrowth than Primo Maxx and untreated control plugs after 20 and 60 days in the low temperature growth chamber. In the spring of 2015, field plots treated with Banner Maxx had lower quality in early spring when compared with other treatments and the control on creeping bentgrass. Primo Maxx and Embark T&O treated plots had the highest quality in early spring on creeping bentgrass whereas Embark T&O treated plots resulted in the lowest quality on annual bluegrass.

Project: Polyamines and Abiotic Stress of Turfgrasses

Current or recently graduated graduate student: Yingmei Ma

MS or PhD: PhD graduated spring 2017

Polyamines (spermidine, spermine, and putrescine) are compounds that are known to accumulate in some plants during stress conditions to promote stress tolerance. If and how these compounds play a role in abiotic stresses of common turfgrass species is not yet known. We have conducted a series of growth chamber studies including one hydroponic and two soil based GC studies with creeping bentgrass ‘Penncross’ (*Agrostis stolonifera*) and ‘Penn-G2’ to determine whether exogenous application of PAs may affect plant growth and drought stress tolerance. Application of relatively low concentrations of spermidine (500 or 750 µM) or spermine (500 µM) promoted tillering rates under optimal growth conditions in hydroponics. The same levels of polyamine treatments moderated the damages associated with drought stress in the soil based growth chamber studies. The most notable differences in drought response associated with polyamine treatment were increased membrane health. This was observed as greater photochemical health and less membrane damage in polyamine treated plants compared to control plants. The relatively low level of exogenous polyamines used in this study did not have a major effect on plant water relations under drought stress. Canopy temperatures and soil moisture content were not affected by any polyamine treatment; however, on some days during early drought stress relative water content was significantly higher in polyamine treated plants compared to controls. Polyamines could play a major role in protecting photosynthetic and cellular membranes during drought stress of creeping bentgrass. Further research is ongoing related to gene changes due to polyamine treatment under drought and responses of creeping bentgrass to polyamines under salt stress conditions.

Project: Physiological Responses of Creeping Bentgrass to Infection by a Bacterial Pathogen (*Acidovorax avenae* subsp. *avenae*)

Current or recently graduated graduate student: Sha Liu

MS or PhD: MS graduated spring 2017

Description: Bacterial etiolation caused by *Acidovorax avenae* subsp. *Avenae* (*Aaa*) results in significant decline in creeping bentgrass putting greens. Plant-bacterial interactions in this disease system are not well understood. Here we performed phytohormone analysis of multiple *Aaa* isolates (MSU-1, MSU-4 and MSU-13). Creeping bentgrass (*Agrostis stolonifera*) ‘Tyee’ and ‘Penn A-4’ were grown in hydroponics under optimal and heat stress conditions in growth chambers and infected with MSU-13. In pure culture of *Aaa*, gibberellic acid isoforms (GA1, GA3, GA4) and indole-3-acetic acid (IAA) were found. At high temperature, ‘Penn-A4’ exhibited lower turf quality, lower chlorophyll content, and higher electrolyte leakage compared to ‘Tyee’. ‘Tyee’ infected with *Aaa* at high temperatures showed higher SA which is related to plant defense system in stems and roots, and less GA3 and GA20 in leaf and stem tissues compared to ‘Penn-A4’ under same conditions. The study showed that gibberellic acid produced by *Aaa* could be the contributor to etiolation symptom. High temperature can exacerbate disease and ‘Tyee’ is more resistant to *Aaa* infection than ‘Penn A-4’. This pathogen is also being evaluated under field conditions.

Project: Cultivar screening and transcriptome evaluation of creeping bentgrass exposed to drought stress

Description: Golf course putting greens of creeping bentgrass are particularly susceptible to drought stress due to the genetic sensitivity of creeping bentgrass to drought, due to the low mowing height and the tendency of turf managers to maintain putting greens on the dry side for optimal golf play conditions. The genetic sensitivity combined with cultural management practices of creeping bentgrass turf areas make the species particularly susceptible to drought stress. 19 cultivars of creeping bentgrass are currently being screened for variation in drought tolerance in both field and growth chamber settings. The screening will include turf quality ratings, relative water content and other physiological health indicators of both leaves and roots. These cultivars include: Alpha, V-8, T-1, Flagstick, Crenshaw, Mackensie, PennA1, PennG2, Tyee, Seaside II, Penncross, Mariner, PSG1SLTZ, 007, PSG1RH733, L-93, Declaration, Pure distinction, Pure selection. The top and bottom performing cultivar based on all physiological data will be used for RNA seq analysis to identify differentially expressed genes in both leaves and roots at early, moderate and severe drought levels. This project will produce valuable, widely usable data that is both basic and applied in nature that will have impact locally to Michigan and worldwide. The field and chamber screening results will produce highly informative data to use for recommendations to turfgrass managers on proper cultivar selection for drier field sites or climates. The transcriptome data related to drought stress will have numerous future applications for turfgrass physiologists, breeders, and pathologists. This project will greatly enhance the gene information available for creeping bentgrass and will also be useful for other turfgrass species and other abiotic stresses.

Project: Effect of Shade on creeping bentgrass physiology and hormone regulation

Description: The maintenance of quality turf in shaded areas present problems for even the most competent turfgrass managers. It is estimated that 20% of the turf grown in United States is subjected to some degree of shade. Common physiological and morphological symptoms of shade stress include thinner leaves, reduced shoot density, root growth, tillering, increased leaf length, longer internodes and upright growth habits and reduced photosynthesis and increased Gibberellic acid production. The objective of this study is to better understand the shade stress physiology in bentgrass under normal and shaded conditions in growth chamber settings. Plants will be covered with silver cloth with 50% light reduction to simulate shade stress conditions. The study will focus on the physiology and hormonal regulation of bentgras plants treated with Primo (GA inhibitor), Phenidone (JA inhibitor) and n-Propyl gallate (JA inhibitor) under shaded and non-shade conditions. This study will provide better understanding of shade stress physiology and will help in providing better management strategy involving plant growth regulators for shade stress adaptation.

Project: Chemical priming for creeping bent grass stress tolerance

Current or recently graduated graduate student: Francois X. Rucamumihigo

MS or PhD: MS

Description: Priming of plants means that a given treatment makes plants readier to take on a subsequent stress. Information from controlled research studies available on priming chemicals for turf grass species to abiotic stress is lacking. Many new turf grass products contain ingredients that may affect the systemic acquired resistance (SAR) or induced systemic resistance (ISR) pathways, which are the pathways that are associated with plant priming. Salicylic acid (SA) and Jasmonic acid (JA) are the two plant hormones that signal ISR and SAR responses. Another important plant metabolite that can be used for priming is gamma amino butyric acid (GABA). Plant growth regulators (PGR) that inhibit gibberellic acid (GA) biosynthesis are widely used in turf grass management and can have a significant effect on the content of other hormones in the plant such as JA, SA, and GABA. A PGR, Primo, promoted a greater level of SA accumulation and decreased JA in plants under drought stress (1). Thus, is an application of Primo combined with SA an unnecessary practice? Would an exogenous application of JA in combination with Primo be beneficial? Plant health promoting products that contain SA are specialty products and can be quite costly for turf managers. Therefore, this study aimed to determine whether JA, SA, or GABA alone or in combination with Primo are effective treatments to promote creeping bent grass drought tolerance. physiological, hormonal and genetic mechanisms behind this drought tolerance will be evaluated in this study. The first part of the study was conducted in controlled conditions in growth chamber and the second is being conducted in field at the Hancock Turfgrass Research Center at Michigan State University on a field equipped with a rainout shelter.

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Faculty member (complete for each faculty member): **Thomas A. Nikolai**

Notable research projects led by faculty member:

Title: The impact of putting green management on visible wear caused golf cleat/sole designs

Description: Michigan State University has been performing golf shoe cleat studies since the mid 1990’s. Early research on alternative cleats focused on visible wear on the putting surface (green friendliness), traction under various conditions, and impact on infrastructure in comparison with metal spikes. Since the demise of the metal spikes around the turn-of-the century research has primarily been driven by manufacturers (primarily FootJoy) desiring data regarding the green friendliness of their prototypes among current lines of their and competitor models. In recent years certain golf cleat/sole designs have caused some superintendents to note that many new designs are too aggressive on their putting surfaces to the point of believing banned metal spikes caused less visible wear. However, superintendents in similar regions are not concerned with the indentations caused by newer golf cleats/soles and do not perceive them to be a problem. The objectives of proposed research are to:

1) Identify particular components of golf cleat sole designs that result in the least to greatest perceived differences in regard to green friendliness.

2) Identify putting green management practices that minimize or negate the visible damage caused by trafficking several turfgrass species with the most intrusive and/or destructive of current golf cleat/sole designs identified in 1 above.

Title: Management of Naturalized Secondary Roughs

Description: Naturalized secondary roughs have become more common on Michigan golf courses over the last 20 years. Whether designed by the architect, or implemented by existing golf courses, these ‘out-of-play’ areas now appear on all styles of golf courses. Theoretically, these areas require fewer inputs then finely maintained primary rough. However, we have learned that they do require some inputs in order to look and perform as desired. Research at MSU is exploring ways to most effectively and efficiently maintain these areas with minimal chemical and cultural inputs. The goal is to maintain the ornamental quality (i.e. inflorescence, adequate turf cover) and playability (i.e. thin enough so golf balls can be found and played). The main focus will be weed control, investigating a variety of weed control programs with differing herbicides and timings.

Title: Annual Bluegrass (ABG) Control

Description: Control of Annual Bluegrass is an annual endeavor. Products with potential for selective control come and go from year to year. Four trials were initiated in 2015 to evaluate new and old herbicide including PGRs for ABG control in creeping bentgrass (CBG) and Kentucky bluegrass (KBG). PoaCure (methiozolin) and Trimmit (paclobutrazol) were applied to a CBG putting green and fairway at the Hancock Turfgrass Research Center (HTRC) and were also applied to a nursery CBG green at Forest Akers West Golf Course. Some treatments were applied throughout the growing season while others were applied in the late fall. The differences in ABG biotypes are apparent even from sites just a mile apart as ABG control was much better at Forest Akers than at HTRC. We will begin to see if fall treatments differed this spring. PoaCure and Tenacity were applied to a KBG fairway – Tenacity applied 5 times, at 7 day intervals, was an excellent program, providing 90% of the ABG in an area that started with 50-70% ABG cover.

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Faculty member (complete for each faculty member): **John N. Rogers, III**

Current or recently graduated graduate student: Thomas Green

MS or PhD: PhD

Project(s): EFFECTS OF GRAVEL LAYER PARTICLE SIZE AND SUB-GRADE SLOPE ON THE MAGNITUDE AND SPATIAL PATTERN OF SOIL WATER IN A VARIABLE-DEPTH USGA-SPECIFICATION PUTTING GREEN

Graduation date: 2019

Description: Uniform distribution of soil water in high-sand content putting greens is a major concern for golf course superintendents. Although gravel is commonly used as a component of a sand-based root zone in order to increase moisture retention in the root zone, the contour and slope in putting greens significantly affect moisture retention due to gravity. As a result, coarse-textured soils become prematurely dry in higher elevations, and excessively wet in lower elevations. This non-uniform wetting of soil not only could hamper putting green performance, but also, could increase water and labor inputs. The objective of this study is to assess the impact of gravel layer particle size and slope on soil water content in a variable-depth (shallower at the slope apex yet deeper at the slope base) high-sand content root zone. Due to lack of published research and the United States Golf Association’s (USGA) wide-ranged specification for selection of a gravel based on the root zone material, determining the optimal bridging, filtering, permeability, and uniformity factors capable of increasing root zone soil moisture uniformity across the undulations of a variable-depth, high-sand content putting green is critical. Our objective is to evaluate the effects of gravel layer particle size and sub-grade slope on the magnitude and spatial pattern of soil water in a variable-depth, USGA-specification putting green. Our hypothesis is the following: increasing the particle size difference between the gravel and root zone layers, in combination with a variable-depth rootzone, will improve soil moisture uniformity in an undulating putting green.

Current or recently graduated graduate student: Eric Chestnut

MS or PhD: MS

Project(s): Establishment Strategies for Creeping Bentgrass Putting Greens

Graduation date: December 2017

Description: Ongoing research at Michigan State University is examining the effects of various chemical treatments and cultural practices on the rate of establishment of a creeping bentgrass putting green. Recent breeding efforts have focused on creating bentgrass cultivars (like ‘Pure Distinction’, the bentgrass used in these studies) that are more tolerant to the stresses of a putting green situation (i.e. low height of cut, frequent traffic, summer heat). These grasses are in many ways more desirable than older creeping bentgrass cultivars and annual bluegrass (the other common putting green grass in the northern United States). Investigating factors that will expedite the establishment process can provide golfers with a quality playing surface as soon as possible while saving golf courses money. While these projects are not yet completed, there are some conclusions that can be drawn from them. Traditionally, the initial mowing height was suggested to be at least 0.200”, if not higher. Our research has shown that it can be initiated at 0.150” with no detrimental effects to plant health. Nitrogen fertilizer rates of up to 0.25 lb N/1000 sq. ft. have been shown to be beneficial to plants on a high sand content root zone. Bi-weekly vertical mowing treatments were too aggressive on the new seedings and had a detrimental effect on plant health. Plant growth regulator (Primo Maxx) treatments increased plant color and quality late in the growing season. Results from brushing before mowing and wetting agent applications are still under investigation.

Current or recently graduated graduate student: Jacob Bravo

MS or PhD: MS

Project(s): Dazomet (Basamid) as a soil sterilant for re-grassing putting greens and fairways

Graduation date: Spring 2018

Description: With the popular soil sterilant methyl-bromide becoming outlawed, a need for a suitable replacement has become necessary. Basamid (dazomet) is the primary product in line to take the position of methyl-bromide. As a possible replacement, dazomet is distributed in a granular formulation as opposed to a gas. Research will take place in 2016-2107 on a bentgrass/annual bluegrass mixed stand at putting green height to evaluate best rates for annual bluegrass control and times for reseeding creeping bentgrass. These plots will be covered with plastic. For fairway studies, coverage with a tarp is not feasible, and the incorporation of the basamid will be controlled through irrigation applications, with the same objectives as above.

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Faculty member: **Joe Vargas, Jr.**

Current or recently graduated graduate student:

MS or PhD: Liu Yan

Project(s): Bacterial Disease of Perennial Ryegrass

Graduation date: Spring 2017

Description: Perennial ryegrass is widely used on golf course fairways and roughs as well as athletic fields. In spite of good management programs, during warm summers, significant turf can be lost that is difficult to explain. We have been able to isolate a bacterium from the infected areas, identified as *Xanthomonas translucens*. It is a known pathogen of *Poa annua* and *Poa trivialis*. However, this is the first known occurrence of the *X. translucens* on perennial ryegrass. *Xanthomonas translucens* *pv poae* has been identified as the pathogen occurring on the *Poa* species. We are attempting to identify the pathovar attacking perennial ryegrass and to compare it to the *Poa* pathovars to see how similar they are to the one on perennial ryegrass. We also plan on developing probes that can be used by diagnostic laboratories for rapid identification of perennial ryegrass samples with suspected bacterial infection.

Since this is a new disease, we are in the process of identifying the temperature range over which infection takes, place as well as the optimum temperatures for symptom development. The initial studies will be conducted in controlled environment growth chambers. It is highly unlikely that we will be able to identify a chemical control for the disease since it is a bacterial disease for which there are no registered products for use on turfgrass. The best approach for controlling the disease could be the use of resistant cultivars. Some of the most commonly available perennial ryegrass cultivars will be tested to determine whether there is any resistance among them that could possibly be used in future breeding programs. Based on the information from the growth chamber studies, field studies will be initiated at the Hancock Turfgrass Research Center. The plots will be inoculated with *X. translucens* to ensure symptom development and various management strategies will be investigated.

Title: Flagstick, a new dollar spot resistant creeping bentgrass cultivar

Description: A significant milestone was reached recently in our turf pathology lab with the development of a creeping bentgrass cultivar which is resistant to dollar spot. This cultivar, called Flagstick, was developed in a partnership between MSU and Seed Research of Oregon, a subsidiary of Pickseed USA. Flagstick represents a great improvement in dollar spot resistance among commercially available creeping bentgrass cultivars. Researchers across the US have praised the performance of this new creeping bentgrass cultivar for its tremendous improvement in the standard for dollar spot resistance. A limited supply of seed was commercially available in 2015, with a more significant quantity available in 2016. The importance of the first truly dollar spot resistant commercial turfgrass is enormous. Most of the fungicide applications throughout the season in the Northeast and Midwest are for control of dollar spot. Having a dollar spot resistant cultivar on golf course greens, tees and especially fairways, which encompass numerous acres of turf, will result in financial savings to golf courses in addition to reduced environmental impact due to fewer fungicide applications being made.

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**Extension**

State conference dates: Jan. 3-5, 2017

Collaborating with other organizations on conference (yes/no): Yes

If so who: Michigan Turfgrass Foundation

Attendance figure: 500 (from 2016 conference)

Research field day held (yes/no): yes

If so, when: Aug. 16, 2017

Attendance figure: 400 (from 2016 field day)

Other Extension activities:

Web (yes/no): [www.turf.msu.edu](http://www.turf.msu.edu) [www.gddtracker.net](http://www.gddtracker.net) [www.msuturfweeds.net](http://www.msuturfweeds.net) [www.msuturfinsects.net](http://www.msuturfinsects.net) [www.msuturfdiseases.net](http://www.msuturfdiseases.net)

FaceBook/Twitter/social networking (yes/no): yes (Twitter)

Kevin Frank @msuturf

Trey Rogers @msuturfdoc

Aaron Hathaway @turficidal

Joint Extension publications with other regional collaborators:

**General turf program comments**

Dr. Gilstrap’s online ‘World of Turf’ course had 1933 students enrolled for the 2016-17 academic year.

**BRIEF State Report for NCER221-2016**

University: University of Missouri  
Official NCERA rep: Xi Xiong

Email: [xiongx@missouri.edu](mailto:xiongx@missouri.edu)

Phone: 573-882-1824

**Teaching Program**

Current undergraduate enrollment: 5-8.

Trend in undergraduate enrollment over last 3 years: 5-10

Placement: golf courses, sports fields, lawn-care companies, graduate colleges, and others.  
Brief comments on teaching: Introductory Turfgrass Management and Advanced Turfgrass Management have been offered every year in fall and spring semester, respectively. An 8-week course on Horticultural Drainage & Irrigation Systems (2 credits) is being offered during spring semester as well.

**Research**

Faculty member: Xi Xiong

Current or recently graduated graduate student: Xiaowei (Natalie) Pan

MS or PhD: PhD

Project(s): Effect of organic amendment for control of large patch on zoysiagrass fairway

Graduation date: May, 2016

Current or recently graduated graduate student: Enzhan (Steve) Song

MS or PhD: PhD

Project(s): Soil hydrophobicity and wetting agent application on turf

Graduation date: May, 2017

Current or recently graduated graduate student: Michael Patterson

MS or PhD: MS

Project(s): IPM strategies for control of billbug on zoysiagrass fairway

Graduation date: May, 2018

Current or recently graduated graduate student: Matt Fleetwood

MS or PhD: MS

Project(s): Effect of soil surfactant on infiltration

Graduation date: May, 2019

Other notable research projects led by faculty member:

Title: Herbicide options to postemergence control of windmillgrass on warm- and cool-season turf

Description: We carried out greenhouse-base experiments to evaluate herbicide options to control of windmillgrass, which has become an emerging problem in various turf areas in Missouri and surround states.

Collaborators (name, institution): Jim English (University of Missouri), Reid Smeda (University of Missouri), Steve Anderson (University of Missouri), Keith Goyne (University of Missouri), Carl Sams (University of Tennessee), Justin Moss (Oklahoma State University), and Mike Richardson (University of Arkansas).

Faculty Member: Lee Miller

Current or recently graduated graduate student: John Koehler

MS or PhD: MS

Project(s): Evaluation of fertilizer strategies for preventing or recovering from large patch of zoysiagrass

Graduation date: August 2017

Current or recently graduated graduate student: Kyle Robertson

MS or PhD: MS

Project(s): Assessment of hormetic responses in *Sclerotinia homoeocarpa* isolates to sublethal doses of DMI fungicides.

Graduation date: December 2017

Other notable research projects led by faculty member:

1. NTEP: We are presently conducting the 2012 Tall Fescue trials, two ancillary trials - the 2013 Bermudagrass trial for Spring Dead Spot Resistance and the 2013 Zoysiagrass trial for Large Patch Resistance, the 2014 Creeping Bentgrass Putting Green trial, the 2014 Creeping Bentgrass Fairway trial, the 2014 Fine Fescue trial, the 2015 Low Input trial and a 2015 Ancillary Low Input trial. These trials are conducted at the University of Missouri Turfgrass Research Facility.  
NCERA Collaborators (name, institution): Brad Fresenburg, University of Missouri; Mike Richardson, University of Arkansas

2. Integration of fraze mowing into an IPM approach for spring dead spot control on bermudagrass

3. Impact of post-application and pigment on the efficacy of spring fungicide applications targeted for large patch control

4. Evaluation of fertilizer strategies for preventing or recovering from large patch of zoysiagrass

NCERA collaborators on grad projects

Megan Kennelly, Kansas State University, Brad Fresenburg, University of Missouri

**Extension Program**

State conference dates: December 7, 2016 (November 29, 2017)

Collaborating with other organizations on conference (yes/no): Yes

If so who: Gateway Irrigation Association (GIA), the Gateway Chapter of STMA, the Missouri Turf & Ornamental Council (MoTOC), the Mississippi Valley Golf Course Superintendents Association (MVGCSA) and a new partner – the Missouri Landscape & Nursery Association (MLNA)

Attendance figure: over 500 with participants, vendors and speakers.

Research field day held (yes/no): Yes

If so, when: July 19, 2016 (August 1, 2017)

Attendance figure: 200

Faculty Member: Lee Miller

Other Extension activities:

Lawncare Workshop Series

In cooperation with regional extension horticulture specialists, a planned series of lawn care workshops was held in 2013 - 2016 for 50 attendees each in St. Charles, Jackson, and Greene counties. The workshops are targeted towards homeowners and lawn care operations in metropolitan areas and are planned again in 2017. A small handbook entitled “Pest Management for Home Lawns” is completed and designed as a basis for this curriculum. This booklet - <http://extension.missouri.edu/p/IPM1035> - was coauthored by Bruce Barrett, Brad Fresenburg, and Lee Miller and is currently available. Outreach specifically to homeowners has also been accomplished in association with regional extension specialists through the Master Gardener training program, or in association with the Extension and Agricultural Office in the form of press releases to news media outlets.

Plant Diagnostic Laboratory

The MU Turfgrass Diagnostic Lab merged with the newly reopened MU Plant Diagnostic Clinic in 2014, which had been out of operation for 2 years due to a lack of funding. Patricia Hosack is the Director of the Plant Diagnostic Clinic, but will soon be leaving the position and a search is underway for a replacement. Lee Miller serves as faculty supervisor of the Clinic. Over 400 samples were submitted in 2016, with 72 from turfgrass areas.

Missouri Pesticide Applicator Program  
The Commercial Pesticide Applicator Program in Missouri is mandated by the USA-EPA with the main educational role provided by University of Missouri Extension and enforcement provided by the Missouri Department of Agriculture. Brad Fresenburg and Lee Miller teach classes for the certification and recertification of pesticide applicators in Category 3: Turfgrasses and Ornamental Pest Control. Recently, an updated version of the training manual for these classes was co-authored by Fresenburg and Miller, and used in 2014 and 2015. In 2013 and 2014, we educated over 2000 commercial turfgrass managers through this program in Springfield, Cape Girardeau, Columbia, St. Louis, and Kansas City.

Website (yes/no): Yes  
If yes, please list website address(es): [www.turfpath.missouri.edu](http://www.turfpath.missouri.edu) - One hundred and twelve disease reports have been written from March 2011 – June 2017 on a biweekly basis during the season. In 2016, the website had over 14,000 page views from 4,927 users, with each disease report garnering ~ 450 – 600 views each.

FaceBook/Twitter/social networking (yes/no): Yes

If yes, please list info: @muturfpath – 1,132 followers, 622 messages

Faculty member: Brad Fresenburg

Dr. Fresenburg will be in July 2017.

**NC Project Station Report Content: North Dakota State University**

1. Impact Nugget:  A concise statement of advancements, accomplishments and impacts.  (Limit to 1-2 sentences)

2. New Facilities and Equipment. Include production areas, sensors, instruments, and control systems purchased/installed.

3. Unique Project Related Findings.  List anything noteworthy and unique learned this year.

4. Accomplishment Summaries.  Draft one to three short paragraphs (2 to 5 sentences each) that summarize research or outreach accomplishments that relate to the project objectives.  Please use language that the general public can readily comprehend.

5. Impact Statements.  Please draft 2 or 3 impact statement summaries related to the project objectives.  Statements should be quantitative when possible and be oriented towards the general public.  This is perhaps the most difficult yet most important part of the report.

6. Published Written Works.  Include scientific publications, trade magazine articles, books, posters, websites developed, and any other relevant printed works produced.  Please use the formatting in the examples below.

Chandra, A., J.D. Fry, A.D. Genovesi, M. Meeks, M.C. Engelke, **Q. Zhang**, D. Okeyo, J.Q. Moss, E. Ervin, X. Xiong, S. Milla-Lewis, J.T. Brosnan, J. Griffin, and L. Parsons. 2017. Registration of ‘KSUZ 0802’ zoysiagrass. J. Plant Regist. DOI:10.3198/jpr2016.03.0010cc.

Yuan, L., Y. Gao, and **D. Li**. 2016. Reestablishment of perennial ryegrass in lawn damaged by diesel and hydraulic fluid spills. HortTechnology 26:250-253.

**Zuk, A. J., Q. Zhang**, T. Helms, and H. Hatterman-Valenti. 2016. Cold Hardiness and the Effects of a Low-Input Regime on 15 Tall, Warm-Season, Native and Ornamental Grasses in the Upper Midwestern United States. HortTechnology. 26(6):735-741.

7. Scientific and Outreach Oral Presentations.  Include workshops, colloquia, conferences, symposia, and industry meetings in which you presented and/or organized.  See below for formatting.

Zuk, A.J. Interpreting the NDSU Soil Test for Turf Managers. North Central Turfgrass Growers Assn. Fargo, ND. Mar. 2, 2017.

Zuk, A.J. Spring Lawn Care. NDSU Extension - 2017 Spring Fever Extension Teleconference. Morrill Hall 5B. Fargo, ND. Mar. 20, 2017.

Zuk, A.J. Pink and Gray Snow Mold. Jesse Ostrander’s Plant Pathology class (PLSC 457). Walster 315. Fargo, ND. Apr. 19, 2017.

Zuk, A.J. Weed Control. Dakota Garden Expo. Bismarck, ND. Apr. 22, 2017.

8. Fund leveraging, specifically, collaborative grants between stations and members.

9. Other relevant accomplishments and activities.

Graduate students:

Kevin Rue - Kentucky bluegrass establishment under saline, waterlogging, and saline-waterlogging conditions

Liqi Yang - Sensitivity and physiological responses to chloride and sulfate salinity in Kentucky bluegrass

Thomas Drietz- Using organic fibers to stabilize sand based sports fields.

**BRIEF State Report for NCERA221 and WERA011**

University: University of Nebraska Lincoln  
Official NCERA rep: Bill Kreuser

Email: wkreuser2@unl.edu

Phone: 402-472-1869

Official WERA rep: Keenan Amundsen

Email: kamundsen2@unl.edu

Phone: 402-472-8390

*Below are the current objectives for NCERA221 and WERA011. Faculty research projects addressing one of the WERA (W) or NCERA (N) objectives are reported.*

***NCERA OBJECTIVES:***

1. *A search of the CRIS database identified much turfgrass sustainability research being conducted by NCERA 221 members… In addition, these, and other NCERA 221 members conduct collaborative and institutionally based turfgrass sustainability research that will advance our understanding of how to maintain the millions of acres of turfgrass in the region in more sustainable approaches.*
2. *Members of NCERA 221 will deliver the findings of this research to academic, professional, and citizen stakeholders through a variety of approaches including academic publications, field days, printed media, and online information.*

***WERA OBJECTIVES:***

1. *Develop improved turfgrass cultivars resistant to biotic and abiotic stresses important to the western states and identify genetic components conferring drought resistance and salinity tolerance to improve the efficiency of stress resistant germplasm identification and selection.*
2. *Exchange information on features and importance of newly developed cultivars and coordinate research to develop and evaluate optimal low-input management practices.*
3. *Develop, refine and disseminate sustainable turfgrass management protocols for turfgrass managers throughout the western United States*
4. *Coordinate reduced input turfgrass management practices  
   Comments: a. Reduce turfgrass water use and improve irrigation management practices b. Evaluate the use of non-potable water sources. c. Identify germplasm and management practices to reduce salinity stress d. Coordinate research on nutrient and pesticide fate e. Develop integrated pest management strategies to address new and emergent pest issues. f. Evaluate the use of turfgrasses for bioremediation of contaminated soils*
5. *Assess environmental impacts of turf management*
6. *Communicate research results and promote sustainable practices to the public through workshops, conferences, websites, extension publications, social media, and research publications  
   Comments: WERA011 is beginning to evaluate the feasibility of joint education delivery to broaden educational opportunities throughout the region, taking advantage of regional expertise.*

**Extension**

State conference dates: January 10-12, 2017

Collaborating with other organizations on conference (yes/no): No

Attendance figure: 550

Research field day held (yes/no): Yes

If so, when: July 20, 2016

Attendance figure: 198

Other Extension activities: Backyard Farmer TV, Thursday nights ~20,000 viewers/episode

Web (yes/no): Yes

FaceBook/Twitter/social networking (yes/no): Yes

Turf iNfo - 1,059 subscribers

Joint Extension activities/publications with other regional collaborators over in the last two years: none

**Staffing:**

Additions:

Benjamin Van Ryzin, Research Technologist.

Craig Ferguson, Assistant Farm Manager

Retirements/vacancies:

None

**Teaching Program**

Current undergraduate enrollment: 36

Trend in undergraduate enrollment over last 3 years: steady

Placement: 100%

**Research**

1. Amaradasa, B.S., and K. Amundsen. 2016. Characterization of defense-related genes of buffalograss challenged with the leaf spot pathogen Curvularia inaequalis. Frontiers in Plant Science DOI: 10.3389/fpls.2016.00715.
2. Amundsen, K.L., L. Li, R. Shearman, R. Gaussoin. 2017. Addressing misperceptions regarding buffalograss tolerance to sandy soils, traffic, and shade. International Turfgrass Research Journal (in press).
3. Amundsen, K., G. Sarath, T. Donze-Reiner. 2017. Genomic approaches for improvement of understudied grasses. Frontiers in Plant Science doi: 10.3389/fpls.2017.00976
4. Baldin, E.L.L., L. Marchi-Werle, L.E.R. Pannuti, A.L. Lourenção, T. Heng-Moss and T.E. Hunt. 2016. Evaluating Categories of Resistance in Soybean Genotypes from the United States and Brazil to *Aphis glycines* (Hemiptera: Aphididae). Florida Entomologist 99:487-495.
5. Bushman, S., K. Amundsen, S. Warnke, J. Robins, P. Johnson. 2016. Transcriptome Profiling of Kentucky bluegrass (Poa pratensis L.) Accessions in Response to Salt Stress. BMC Genomics 17:48. DOI: 10.1186/s12864-016-2379-x (Bushman and Amundsen are co-first authors).
6. Cruz, P., E.L.L., Baldin, L.R.P Guimaraes, L. Pannuti, G. Lima, T. Heng-Moss, and T. Hunt. 2016. Tolerance of KS-4202 soybean to the attack of Bemisia tabaci biotype B (Hemiptera: Aleyrodidae) Florida Entomologist 99:600-607.
7. Donze-Reiner, T., Palmer, N.A., Scully, E.D., Prochaska, T.J., Koch, K.G., Heng-Moss, T, Bradshaw, J., Twigg, P., Amundsen, K., Sattler, S.E., Sarath, G. 2017. Transcriptional analysis of defense mechanisms in upland tetraploid switchgrass to greenbugs. BMC Plant Biology 17(1):46. doi: 10.1186/s12870-017-0998-2.
8. Koch, K. G., Chapman, K., Louis, J., Heng-Moss, T., Sarath, G. (2016). Plant Tolerance: A Unique Approach to Control Hemipteran Pests. *Frontiers in plant science, 7*, 1363.
9. Kreuser, K, G. Sarath, W. Kreuser, K. Amundsen. 2016. Potassium nitrate effect on buffalograss bur dormancy. HortScience 51(12):1566-72. doi: 10.21273/HORTSCI11126-16
10. Kreuser, W. C., J. R. Young, and M. D. Richardson. 2017. Modeling performance of plant growth regulators. Agricultural and Environmental Letters. 2:1-4.
11. Li, L., M.D. Sousek, K.L. Amundsen, Z.J. Reicher. 2016. Cultivar, seeding rate, or date has little effect on establishment of dormant seeded buffalograss. HortScience 51(6):750-53.
12. Li, L., M.D. Sousek, K.L. Amundsen, Z.J. Reicher. 2016. Seeding date and bur treatment affect establishment success of dormant-seeded buffalograss. Agronomy Journal 109:1-6. doi:10. 213 4/ag ronj2016 .03.016 4
13. Li, L., M. Sousek, R, Gaussoin and Z Reicher. 2017. Herbicide Tolerance of Established Buffalograss. Applied Turfgrass Science. Crop Forage Turfgrass Manage.3: doi:10.2134/cftm2016.10.0065
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15. Obear, G.R., M. Pedersen, and W.C. Kreuser. 2017. Genesis of clay lamella in golf course soils of Mississippi, USA. Catena 150:62-70.
16. Pedersen, M., C. Wegner., P. Phansak, G. Sarath, R. Gaussoin, and V. Schlegel. 2017. Monitoring wheat mitochondrial compositional and respiratory changes using Fourier transform mid-infrared spectroscopy in response to agrochemical treatments. Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy, 173, 727-732.
17. Scully, E., T. Donze-Reiner, H. Wang, T. Eickhoff, F.Baxendale, P. Twigg, F. Kovacs, T. Heng-Moss, S. Sattler, and G. Sarath. 2016. Identification of an orthologous clade of peroxidases that respond to feeding by greenbugs (*Schizaphis graminum*) in C4 grasses. *Functional Plant Biology* 43:1134-1148.
18. Thompson, C., J. Fry, R. Braun, and M. Kennelly. 2017. Rough bluegrass incidence in a new tall fescue sward as affected by seeding rate and mowing height. Crop Forage Turfgrass Manage. 3:1-4. doi:10.2134/cftm2016.11.0074.
19. Thompson, C., M. Kennelly, J. Fry, M. Sousek, and Z. Reicher. 2017. Physiological and pathogenic contributors to summer decline of roughstalk bluegrass. Int. Turfgrass Soc. Res. J. 13:1-9. doi:10.2134/itsrj2016.05.0304.
20. Thompson, C., M. Sousek, Z. Reicher, J. Fry, and M. Kennelly. 2016. Evaluation of selective herbicide combinations for rough bluegrass control. Crop Forage Turfgrass Manage. doi:10.2134/cftm2015.0213.
21. Wang, H., C. Zhang, Y Dou, B. Yu, Y. Liu, T. Heng-Moss, G. Lu, M. Wachholtz, J. Bradshaw, P. Twigg, E. Scully, N. Palmer, and G. Sarath. 2016. Insect and plant-derived miRNAs in greenbug (*Schizaphis graminum*) and yellow sugarcane aphid (*Sipha flava*) revealed by deep sequencing. Gene 599:68-77.
22. Warnke S., C. Thammina, K. Amundsen, P. Miljanic. 2017. Simple sequence repeat markers for interspecific hybrid detection in Agrostis. International Turfgrass Research Journal (accepted).
23. Warnke S., C. Thammina, K. Amundsen, P. Miljanic, H. Hershman. 2017. High resolution melt analysis of simple sequence repeats for bentgrass species differentiation. International Turfgrass Research Journal (in press).
24. Zhang, Q., C. Thompson, M. Kennelly, J. Stier, C. Blume, N. Christians, K. Diesburg, K. Frank, B. Fresenburg, J. Fry, D. Gardner, D. Martin, J. Ostrander, K. Rincker, D. Settle, D. Soldat, and X. Xiong. 2017. Dollar spot susceptibility of 25 creeping bentgrass cultivars maintained under golf course putting green and fairway conditions in the central United States. Crop Forage Turfgrass Manage. (*accepted*).

**Faculty member: Keenan Amundsen**

Current or recently graduated graduate student: Elizabeth Niebaum

MS or PhD: MS

Project(s): Resolving mechanisms of buffalograss seed dormancy

Graduation date: May 2019

Faculty member (complete for each faculty member): Keenan Amundsen

Current or recently graduated graduate student: Jesse Marshall

MS or PhD: MS

Project(s): Expand and characterize Nebraska buffalograss germplasm

Graduation date: May 2019

Research Highlights:

W1: Actively breeding for improved turf type buffalograss that is resistant to chinch bugs, tolerant of shade and traffic, and has minimal winter injury. Adapted cultivars will reduce management inputs. Research is sponsored by Todd Valley Farms, The Native Turf Group, and the USGA.

W1: Leading two additional USGA funded projects. One is designed to identify the genetic components conferring seed dormancy in buffalograss. Seed dormancy is an issue with many native grass species, and buffalograss could serve as a model to overcome dormancy as other native grasses are explored for use as turf. The other study is to develop drought tolerant and Midwest adapted bentgrass cultivars suitable for golf course putting greens or roughs. Alternative bentgrass species have not been studied much for their use as turf, but there is great potential. A two year study was completed evaluating performance of 69 alternative bentgrasses, and pre-breeding is now being done to develop regionally adapted germplasm.

W2: Managed three NTEP trials (Tall Fescue, Cool-season low input, perennial ryegrass). Reported data to NTEP. Data is publicly available and can be used to make turf selection decisions.

N1/W3: While not in the region, collaborating with Doug Karcher at the University of Arkansas to optimize buffalograss establishment into existing turf (tall fescue in Nebraska and bermudagrass in Arkansas). The information will provide homeowners interested in converting their lawn to a low input native grass species the necessary tools for successful conversion.

WERA or NCERA Collaborators (name, institution):

Shaun Bushman, USDA, Logan, UT

**Faculty member: Roch Gaussoin**

Current or recently graduated graduate student: Matt Pederson

MS or PhD: PhD

Project(s): Strobilurin fungicide secondary plant stress alleviation effects August 2016

Current or recently graduated graduate student: Luqi Li

MS or PhD: PhD

Project(s): Ecology and Genetics of Yellow Nutsedge (*Cyperus esculentus* L.) May 2018

Research Highlights:

Initiating Turf phytobiome research

**Faculty member: Tiffany Heng-Moss and Fred Baxendale**

Current or recently graduated graduate student:  Kyle Koch (co-advised with Jeff Bradshaw, UNL)

MS or PhD: Ph.D.

Project(s): Evaluation of tetraploid switchgrasses for resistance to phloem-feeding insects

Graduation date: August 2017

**Faculty member: Bill Kreuser**

Current or recently graduated graduate student: Mark Keck

MS or PhD: MS

Project(s): Soil surfactant influence on vertical water distribution in sand greens

Graduation date: December 2018

Current or recently graduated graduate student: Joe Foral

MS or PhD: MS

Project(s): Thermal imagery to assess water status and estimate crop coefficients

Graduation date: December 2018

Current or recently graduated graduate student: Jacob Fuehrer

MS or PhD: MS

Project(s): Influence of growing environment and management on gibberellin production

Graduation date: May 2019

Current or recently graduated graduate student: Glen Obear

MS or PhD: PhD

Project(s): Rapid soil pedogenesis in sand-based root zones

Graduation date: May 2019

Research Highlights:

N1: Development of growing degree day models for plant growth regulators (PGRs) applied cool and warm-season turfgrass. Precision PGR application technology and adaptive rate algorithm creation. Hormones, products and fertilizers to mask and mitigate excessive growth suppression in turfgrass.

N2: Development of growth potential models in turf. Influence of management and environment on turfgrass growth rate and gibberellin production.

N3: Modeling and managing water loss and distribution in sand-based root zones. Thermal imagery to estimate crop coefficients. Models to predict vertical distribution of water following soil surfactant applications to sand-based turf soils.

N4: Factors that influence iron and clay lamella pedogensis in sand-based turfgrass soils.

N5: Grass species and cultivar evaluation along urban and rural roadsides following disturbance.

NCERA Collaborators (name, institution):

Doug Soldat, University of Wisconsin-Madison; Eric Watkins, University of Minnesota-Twin Cities; Kevin Frank, Michigan State University; James Murphy, Rutgers; Jared Hoyle, Kansas State University; Aaron Patten, Purdue University

**Faculty member: Cole Thompson**

Current or recently graduated graduate student: Zhengxiong Li

MS or PhD: MS

Project(s): Undecided

Graduation date: Anticipated May 2020

Research Highlights:

N1/W4: Leading a USGA funded project investigating consumer perceptions of input-limited fairway management in the northcentral U.S. Buffalograss, creeping bentgrass, and Kentucky bluegrass are being managed at various irrigation, fertilizer, and pest management levels. Consumers will be surveyed to determine their turf preferences when inputs are known and unknown.

N1/W4: Conducting various integrated turf weed management studies with NCERA cooperators at Kansas State, Iowa State, the Chicago District Golf Association, and Ohio State ATI. These studies are also conducted in cooperation with researchers at Rutgers. Two studies are evaluating best management for mowing/defoliation following applications of common herbicides. A third study is revisiting soil temperature triggers for spring applications of preemergence herbicides for the control of crabgrass, and is complimented by an investigation of the effects of early spring applications of PRE on eventual goosegrass control. Another herbicide study is designed to evaluate the ability of PRE and POST herbicide programs to reduce crabgrass seed in the soil seed bank. Finally, a cultural crabgrass management study is underway to investigate the effects of aeration timing on crabgrass establishment.

N2/W6: Presenting research with NCERA cooperators at ITS and at CSSA meetings in 2017; Co-coordination, of and speaker at, Nebraska Extension field days and conferences; panelist on Backyard Farmer; compose Turf iNfos weekly during the growing season; showcase research and current turf challenges via twitter; contributed to the 2017 edition of Turfgrass Weed Control for Professionals (by Aaron Patton and Daniel Weisenberger), an annual Purdue Extension publication that is being adapted for greater impact in the NCERA region.

WERA or NCERA Collaborators (name, institution):

Adam Thoms, Iowa State University, Ames, IA; Aaron Patton, Purdue University, West Lafayette, IN; Jared Hoyle, Kansas State University, Manhattan, KS; Zane Raudenbush, Ohio State ATI, Wooster, OH;

**Station Report**

University: The Ohio State University

Official NCERA rep: David Gardner

Email: gardner.254@osu.edu

Phone: 614-292-9002

1. Impact Nugget:

Ohio State University provided training and education to pesticide applicators in the state of Ohio. This has the potential to reduce environmental contamination caused by pesticide misapplication.

2. New Facilities and Equipment. Include production areas, sensors, instruments, and control systems purchased/installed.

Nothing to Report

3. Unique Project Related Findings.

4. Accomplishment Summaries.  Draft one to three short paragraphs (2 to 5 sentences each) that summarize research or outreach accomplishments that relate to the project objectives.  Please use language that the general public can readily comprehend.

Our field days and continuing education programs (35 presentations by Gardner, in addition to presentations made by Danneberger, Sherratt, Rimelspach, Shetlar and the rest of the OSU turf team) were delivered to over 5000 attendees

5. Impact Statements.

Rough bluegrass (*Poa trivialis* L.) is turfgrass species that is generally considered a weed. Naturally manipulating the growing environment of this species lends the ability for this grass to produce large quantities of red pigment (anthocyanin). These red pigments are used as natural food coloring and for other coloring purposes. The increasing demand for natural coloring agents cannot be met by the current supply. In order to meet growing demand new plant sources, like perennial turfgrasses, need to be used.

This research is investigating the precise conditions needed for anthocyanin production in rough bluegrass, and it’s investigating the molecular mechanism of anthocyanin production for this species. Currently, it has been shown that rough bluegrass can produce as much anthocyanin as most berries. The chemical properties of the anthocyanins produced by this species render them relatively stable, meaning they could be used as food coloring. However, current FDA regulations prohibit anything other than fruit and vegetable juices to be used as natural food coloring. The impact this research could have may be a ways down the road, but using turfgrasses to produce natural food coloring is a sustainable practice that could have a large economic impact. This research will not only affect those in the United States, but it also has the potential to impact the rest of the world, where the push for natural products is overwhelming.

In recent years, a new disease has emerged in creeping bentgrass (*Agrostis stolonifera* L.) turf, particularly in the North American transition zone. *Acidovorax avenae* subsp. *avenae*, a bacterial pathogen has been identified as the culprit and is associated with creeping bentgrass etiolation and decline. *A. avenae* outbreaks in creeping bentgrass have also been associated with turfgrass stress. Speculation is that physical stresses such as frequent mowing and heavy traffic may lead to a creeping bentgrass stand that is susceptible to *A. avenae* infection. Currently, the use of antibiotic controls for *A. avenae* in turfgrass systems are not practical, leaving researchers to find alternative controls. In 2013, Ohio State University researchers were conducting chemical evaluation trials including a plant growth regulator trial that included trinexapac-ethyl and paclobutrazol as treatments. An outbreak of *A. avenae* occurred including the area where research trials were located. The plots that had been treated with trinexapac-ethyl and paclobutrazol were asymptomatic and the differences, compared to other plots, were quite striking. Research plots were established at several golf courses in Ohio 2014 and again in 2015. Over the winters of 2014/2015 and 2015/2016 creeping bentgrass pots were prepared in the greenhouse and are currently being treated with several plant growth regulators. Other hormones, particularly auxin, may be involved in *A. avenae* pathogenicity and this will be investigated as well in conjunction with cultural practices. Plant growth regulators are widely used on golf courses for a variety of reasons including plant stress reduction.  These chemistries may be a simple effective solution for preventing bacterial disease in turf grass by reducing plant stress and thus susceptibility by either mechanical or physiological means.

6. Published Written Works.

1. Petrella, DP, Metzger, JD, Blakeslee, JJ, Nangle, EJ, and Gardner, DS, "Effects of Blue Light and Phenotype on Anthocyanin Accumulation in Accessions and Cultivars of Rough Bluegrass". Crop Science. Vol. 57, 1-9. 2016.

2. Petrella, DP, Metzger, JD, Blakeslee, JJ, Nangle, EJ, and Gardner, DS, "Anthocyanin Production Using Rough Bluegrass Treated with High-Intensity Light". HortScience. Vol. 51, no. 9: 1111-1120. 2016.

3. Nangle, EJ, Gardner, DS, Metzger, JD, Petrella, DP, and Danneberger, TK, "Cool-season Turfgrass Color and Growth Habit Response to Elevated Levels of Ultraviolet-B Radiation". HortScience. Vol. 51, no. 4: 439-443. 2016.

4. Petrella, DP, DS Gardner, Metzger, JD and Blakeslee, JJ. "Halotropism in Turfgrass". ASA Abstracts. Madison: American Society of Agronomy. 2016

5. Mundim, R, Sherratt, PJ, Gardner, DS and Danneberger, TK. "Enhancement of golf course management online classes through instructor videos". Abstracts of the European Research Society. Vol. 5, Quinto Vicentino: European Turfgrass Society. 2016: 69-70.

6. Gardner, DS, "Choosing the Correct Herbicide" SportsField Management. 12(1):8-11.2016.

7. Gardner, DS, "Managing Bermudagrass in the North" SportsField Management. 11(12):22-24, 26.2016.

8. Gardner, DS, "Weed Control For Synthetic Surfaces" SportsField Management. 11(11):22-25.2016.

9. Gardner, DS, "The Need to Winter Overseed" SportsField Management. 11(10):24-26.2016.

10. Gardner, DS, "The Science of Soil Amendments" SportsField Management. 11(9):24-26.2016.

11. Gardner, DS, "Examining Options for Thatch Management" SportsField Management. 11(8):24-26.2016.

12. Gardner, DS, "A Top Priority for your Turfgrass" SportsField Management. 11(7):22-24, 26.2016.

13. Gardner, DS, "Bring Forth the Biostimulants" SportsField Management. 11(6):20-24.2016.

14. Gardner, DS, "Working With Wetting Agents" SportsField Management. 11(5):22-26.2016.

15. Gardner, DS, "Frustrations For Field Managers" SportsField Management. 11(4):22-24, 26.2016.

16. Gardner, DS, "Pondering PGR's and Athletic Fields" SportsField Management. 11(3):22-25.2016

17. Gardner, DS and Street, JR, "Broadleaf Weed Control Update" OLCA News. Spring. p. 12-15.2016.

18. Gardner, DS and Street, JR, "Broadleaf Weed Control Update" OTF Turf News. Spring. p. 30-33.2016.

19. Gardner, DS and Street, JR, "Control of Annual Bluegrass on Athletic Fields" OTF Turf News. Spring. p. 19-21.2016.

20. Gardner, DS and Street, JR, "Grassy Weed Control Update" OLCA News. Spring. p. 16-18.2016.

21. Gardner, DS, "Mixing it Up: The Ins and Outs of Cool-Season Turfgrass Blends and Mixtures" SportsField Management. 11(2):22-26.2016.

7. Scientific and Outreach Oral Presentations.

1. Gardner, D.S. 2016. Achieving Success with Natural and Organic Herbicides and Insecticides. The Ohio Turfgrass Foundation Conference and Show. 75 attendees
2. Gardner, D.S. 2016. Best Herbicide Management Strategies for Ornamental Bed Weed Control. The Ohio Turfgrass Foundation Conference and Show. 75 attendees.
3. Gardner, D.S. 2016. Catching Pest Problems Before They Occur. The Ohio Turfgrass Foundation Conference and Show. 50 attendees
4. Gardner, D.S. 2016. Educating and Communicating with the Public About Pesticides, Fertilizers and Other Environmental Issues. The Ohio Turfgrass Foundation Conference and Show. 50 attendees
5. Gardner, D.S. 2016. Grass ID for Landscapers and Arborists - Those That Are Usually Looking Up. The Ohio Turfgrass Foundation Conference and Show 25 attendees
6. Gardner, D.S. 2016. Top 10 Key Factors in Developing and Efficient and Cost Effective Lawn Care Weed Control Program. The Ohio Turfgrass Foundation Conference and Show. 75 attendees
7. Gardner, D.S. 2016. Fall Weed Control in Ornamental Beds. Columbus Landscape Association. 12 attendees
8. Gardner, D.S. 2016. Weed Control in Ornamental Beds. Urban Landscape Pest Management Workshop. 216 attendees
9. Gardner, D.S. 2016. Weed Control in Turfgrass. Urban Landscape Pest Management Workshop. 216 attendees
10. Gardner, D.S. 2016. How to Identify and Manage Weeds in Turf. Northwest Ohio Green Industry Summer Session. 40 attendees
11. Gardner, D.S. 2016. Lawn Weed Control - Identify, manage, and product update. Ohio Lawn Care Association. 40 attendees
12. Gardner, D.S. 2016. Weed ID, Control Products, Review and Quiz. Ohio State Turfgrass Research Field Day. 60 attendees
13. Gardner, D.S. 2016. Weed Identification and Control in Turf. Ohio State Turfgrass Research Field Day. 40 attendees
14. Gardner, D.S. 2016. When is a Pine not a Pine? Northwest Ohio Green Industry Summer Session. 30 attendees
15. Gardner, D.S. 2016. Lawn Weed Control - Identify, manage, and product update. Ohio Lawn Care Association. 30 attendees
16. Gardner, D.S. 2016. Climate Change, Weeds, and Control Measures. Ask a Master Gardener Webinar. 25 attendees
17. Gardner, D.S. 2016. Spring Weed Control Update. Central Ohio Golf Course Superintendents Association. 40 attendees
18. Gardner, D.S. 2016. Broadleaf Weed Control in Turfgrass. Commercial Pesticide Applicator Recertification Conference. 200 attendees
19. Gardner, D.S. 2016. Grassy Weed Control in Turfgrass. Commercial Pesticide Applicator Recertification Conference. 300 attendees
20. Gardner, D.S. 2016. Postemergence Weed Control in Landscape Beds. Commercial Pesticide Applicator Recertification Conference. 242 attendees
21. Gardner, D.S. 2016. Preemergence Weed Control in Landscape Beds. Commercial Pesticide Applicator Recertification Conference. 239 attendees
22. Gardner, D.S. 2016. Spring Weed Control Update. Northwest Ohio Golf Course Superintendents Association. 40 attendees
23. Gardner, D.S. 2016. Annual Bluegrass Prevention and Control. Ohio State University Sports Turf Short Course. 80 attendees
24. Gardner, D.S. 2016. Broadleaf Weed Control in Turfgrass .Commercial Pesticide Applicator Recertification Conference. 475 attendees
25. Gardner, D.S. 2016. Grassy Weed Control in Turfgrass. Commercial Pesticide Applicator Recertification Conference. 450attendees
26. Gardner, D.S. 2016. How to Manage Weeds in The Landscape. Tri State Green Industry Conference. 75 attendees
27. Gardner, D.S. 2016. Natural Weed Control Products For Organic Lawn Care. Tri State Green Industry Conference. 75 attendees
28. Gardner, D.S. 2016. Postemergence Weed Control in Landscape Beds. Commercial Pesticide Applicator Recertification Conference. 169 attendees
29. Gardner, D.S. 2016. Preemergence Weed Control in Landscape Beds. Commercial Pesticide Applicator Recertification Conference. 167 attendees
30. Gardner, D.S. 2016. Broadleaf Weed Control in Turfgrass. Commercial Pesticide Applicator Recertification Conference. 275 attendees
31. Gardner, D.S. 2016. Grassy Weed Control in Turfgrass. Commercial Pesticide Applicator Recertification Conference. 275 attendees
32. Gardner, D.S. 2016. Natural Weed Control Products and Organic Lawn Care. Central Environmental Nursery Trade Show. 75 attendees
33. Gardner, D.S. 2016. Pesticide and Nutrient Fate in Lawns. Central Environmental Nursery Trade Show. 75 attendees
34. Gardner, D.S. 2016. Postemergence Weed Control in Landscape Beds. Commercial Pesticide Applicator Recertification Conference. 137 attendees
35. Gardner, D.S. 2016. Preemergence Weed Control in Landscape Beds. Commercial Pesticide Applicator Recertification Conference. 156 attendees

8. Fund leveraging, specifically, collaborative grants between stations and members.

9. Other relevant accomplishments and activities.

State conference dates: December 5-8, Attendance: 1600

Research field days, August 11, 13, Attendance: 175 + 200

Spring Tee Off/OSU Sports Turf Short Course in February. Total attendance ~150

Website: buckeyeturf.osu.edu, hcs.osu.edu/plantscienceonline

Facebook: Buckeye Turf, Turfopps

Twitter: @osuturf @grassybrit @globalturf

**BRIEF State Report for NCER221**

University: Wisconsin  
Official NCERA rep: Doug Soldat/Paul Koch/Chris Williamson

Email: djsoldat@wisc.edu/plkoch@wisc.edu/rcwilliamson@wisc.edu

Phone: 608-263-3631

1. Impact Nugget:

The University of Wisconsin turfgrass team continues to be a leader in researching sustainable turfgrass management through the prudent use of fertilizer and reduced-impact pesticides.

2. New Facilities and Equipment. Include production areas, sensors, instruments, and control systems purchased/installed.

3. Unique Project Related Findings.  List anything noteworthy and unique learned this year.

4. Accomplishment Summaries.  Draft one to three short paragraphs (2 to 5 sentences each) that summarize research or outreach accomplishments that relate to the project objectives.  Please use language that the general public can readily comprehend.

Soldat:

The focus of my extension program is on improving nutrient and water use efficiency in turfgrass systems and urban landscapes. I conduct applied research in these areas and communicate the results to a large clientele group that includes: professional turf managers, homeowners, state agencies, county extension staff, and others. I made over 2,000 face-to-face contacts during 2016, and had a very successful year with the harder to quantify indirect contacts from articles, television, and radio. Our turfgrass field day and winter conference had approximately 400 attendees, combined. Recently my extension program has expanded into the area of soil contamination and safety of urban gardening.

Koch:

The primary goal of my extension program is to conduct highly applied research and disseminate research-based recommendations for the sustainable management of turfgrass landscapes out to the turfgrass industry and the general public. Dissemination from my program (all my staff combined) occurred through multiple vehicles, including 55 extension presentations, 19 extension articles (including 3 national trade journals), and 17 technical research reports posted on our website ([www.tdl.wisc.edu/research](http://www.tdl.wisc.edu/research)). Fourteen of the above presentations were out-of-state, four were international, eleven were for county extension agents, and 14 were for the Pesticide Applicator Training program. Dissemination of information also occurred through direct contacts like email, phone calls, and text messages. I had approximately 199 extension-related emails in 2015, while Turfgrass Diagnostic Lab Manager and Associate Researcher Bruce Schweiger reported 593 extension-related emails, 474 phone calls, 596 texts, and 77 in-person meeting in 2015. Additional means of dissemination were also used and included connecting with clientele via Twitter (615 ‘tweets’ to 692 ‘followers’), contributing columns to a national ‘Turf Diseases’ blog, producing a video with the Golf Course Superintendents Association of America, and partaking in multiple interviews with various national trade publications. The Turfgrass Diagnostic Lab also diagnosed 266 samples in 2015, including 29 samples from Minnesota, 24 samples from Illinois, and samples from locations as far as away as California and Washington.

5. Impact Statements.  Please draft 2 or 3 impact statement summaries related to the project objectives.  Statements should be quantitative when possible and be oriented towards the general public.  This is perhaps the most difficult yet most important part of the report.

Soldat:

My research on soil testing and potassium fertilization of bentgrass is changing the way that potassium fertilizer is applied on golf courses, lawns, and other turf areas in the North Central Region and beyond.

Koch:

My development of reduced-toxicity pest management programs for both golf courses and home lawns is aimed at reducing pesticide active ingredient input into the environment and has been effective during multiple contentious situations between the turfgrass industry and anti-pesticide activists.

6. Published Written Works.  Include scientific publications, trade magazine articles, books, posters, websites developed, and any other relevant printed works produced.  Please use the formatting in the examples below.

Soldat:

Obear, G.R., P. Barak, and D.J. **Soldat**. 2016. Soil inorganic carbon accumulation in sand putting green soils II: Acid-base relationships as affected by water chemistry and nitrogen source. Crop Sci. 56:851-861.

Johnson, S., D. Cardona, J. Davis, B. Gramling, C. Hamilton, R. Hoffman, S. Ruis, D. **Soldat**, S. Ventura, and K. Yan. 2016. Using community-based participatory research to explore soil lead concentrations in urban neighborhoods. Progress in Community Health Partnerships: Research, Education, and Action. 10(1):9-17.

Obear, G.R., and D.J. **Soldat**. 2016. Soil inorganic carbon accumulation in sand putting green soils I: Field relationships between climate, irrigation water quality, and soil properties. Crop Sci. 56:452-462.

**Soldat**, D. 2016. Determining soil potassium requirements of sand-based putting greens: A research update. GreenMaster. 51(3):30-34.

**Soldat**, D. 2016. Performance of coated nitrogen fertilizers. Grass Roots. 45(4):6, 8-11.

**Soldat**, D. 2016. Are you in compliance with NR-151?. Grass Roots. 45(3):10.

**Soldat**, D. 2016. Tissue testing for potassium. Grass Roots. 45(2):34.

**Soldat**, D., and B. Kreuser. 2016. Getting the most from your Primo Maxx Program: How to use Primo Maxx growth regulation most effectively on putting greens. Mt. West Turf. 2(2):106-111.

**Soldat**, D. 2016. Cultural and chemical weed management in non-mowed fine fescue roughs. Grass Roots. 45(1):6-9.

Koch:

Koch, P. L. 2016. Optimal Fungicide Timing for Suppression of Typhula Blight under Winter Covers. Agronomy Journal 108: 1-6. doi: 10.2134/agronj2016.04.0241

Koch, P. L. 2016. Preventative fungicide applications for the control of dollar spot at fairway height, 2015. Plant Disease Management Reports 10 (T016).

Koch, P. L. 2016. Preventative fungicide applications for the control of Typhula blight on creeping bentgrass, 2014-2015. Plant Disease Management Reports 10 (T017).

Koch, P. L. 2016. Preventative fungicide applications for the control of Microdochium patch on creeping bentgrass, 2014-2015. Plant Disease Management Reports 9 (T018)

Karakkat and Koch. 2016. Rapid diagnostic assay development for detecting patch diseases on turf (Abstract). Submitted to American Phytopathological Society Annual Meeting, Jul 30 – Aug 3.

Townsend and Koch. 2016. The impact of nitrogen application rates, nitrogen source, and ambient pH on Sclerotinia homoeocarpa on Agrostis stolonifera putting greens (Abstract). Submitted to Crop Science Society Annual Meeting, Nov 6-9.

Soldat and Koch. 2016. Potassium fertilization increases Microdohium patch incidence and severity on creeping bentgrass (Abstract). Submitted to Crop Science Society Annual Meeting, Nov 6-9.

Koch, P. L. 2016. Snow mold lessons learned from last winter. Golfdom. 72(8): 28-30.

Koch, P. L. 2016. The Common Ground Initiative. The Grass Roots. 45(6): 6-9.

Koch, P. L. 2016. The Benefits of Fall Disease Cleanup. The Grass Roots. 45(5): 32-35.

Koch, P. L. 2016. 2015-2016 Snow Mold Review. The Grass Roots. 45(4): 18-25.

Koch, P. L. 2016. Money matters: which cultural disease management practices make the most financial sense. The Grass Roots. 45(3): 18-21.

Koch, P. L. 2016. Precision Disease Management: The Wave of the Future. The Grass Roots. 45(2): 42-44.

Koch, P. L. 2016. Influence of Temperature on Fungicide Persistence. The Grass Roots. 45(1): 44-49.

Koch, P. L. Revisiting Leaf Mulching, Lawns, and Snow Mold. Wisconsin Turfgrass Association Newsletter. 30(3): 6.

Koch, P. L. Turf Pathologists Meet in Tampa for the American Phytopathological Society Annual Meeting. Wisconsin Turfgrass Association Newsletter. 30(2): 9.

Koch, P. L. Disease Profile: Red Thread. Wisconsin Turfgrass Association Newsletter. 30(3): 7.

Williamson:

Larson, J. L., Dale, A., Held, D., McGraw, B., Richmond, D. S., Wickings, K., Williamson, R. C. 2017. Optimizing pest management practices to conserve pollinators in turf landscapes: Current practices and future research needs. Journal of Integrated Pest Management 8(1): 1-10.

Williamson, R. C., Obear, G. R. 2017. Organic Fertilizer deters vertebrate pests from white grub-infested turf. Int. Turfgrass Soc. Res. J. 13: 1-3.

Larson, J. L., Held, D., Williamson, R. C. 2017. Best Management Practices for Turf Care and Pollinator Conservation.

Larson, J. L., Held, D., Williamson, R. C. 2017. Best Management Practices for Turf Care and Pollinator Conservation Fact Sheet.

7. Scientific and Outreach Oral Presentations.  Include workshops, colloquia, conferences, symposia, and industry meetings in which you presented and/or organized.  See below for formatting.

Soldat

Soldat, D.J. and P.L Koch. 2016. Potassium fertilization increases microdochium patch incidence and severity on creeping bentgrass. Crop Science Society of America International Meeting. 6-9 Nov. 2016, Phoenix, AZ.

Plunkett, S.A. and D.J. Soldat. 2016. Evaluation of traditional soil testing methods to estimate lead (Pb) hazard. Soil Science Society of America International Meeting. 6-9 Nov. 2016, Phoenix, AZ.

Bero, N.J. and D.J. Soldat. 2016. Using yard waste compost, compost tea, organic and synthetic fertilzers on urban turfgrass. Crop Science Society of America International Meeting. 6-9 Nov. 2016, Phoenix, AZ.

Obear, G.R.; W. Kreuser, K. Hubbard, B. DeBels, and D. Soldat. 2016. Plant colorants interfere with reflectance-based vegetation indices. European Turfgrass Society Conference. Albufeira, Portugal. 5-8 June 2016.

Soldat, D.J. 2016. The ecosystem services and environmental consequences of turfgrass management. University of Nebraska-Lincoln Department of Agronomy and Horticulture Seminar. Lincoln, NE. 1 Apr. 2016.

“Introduction to Soils.” *Master Gardener Training*, 27 Sept. 2016, Hales Corners, WI. (75 participants).

“Introduction to Soils.” *Master Gardener Training*, 26 Sept. 2016, Waukesha, WI. (50 participants).

“Tour of selected soils research studies” *Wisconsin Turfgrass Field Day*, 26 July 2016, Madison, WI (250 participants).

“Lawn care for lake-front properties” Green Lake County Extension Train-the-Trainers Event. 29 June 2016. Green Lake, WI (6 participants).

“Garden Talk with Larry Meiller” *Wisconsin Public Radio*, 10 June 2016. (listening audience of 100,000).

“Soil testing simplified” Southern California Golf Course Superintendents Association Meeting, 2 May 2016, Redlands, CA (75 participants).

“Sodium, bicarbonate, and iron: Should you be concerned?” Southern California Golf Course Superintendents Association Meeting, 2 May 2016, Redlands, CA (75 participants).

“Is your potassium program helping or hurting your turf?” *TurfNet.com Webinar.* 21 Apr. 2016, (150 registered).

“Turfgrass and lawn management.” *Master Gardener Training*, 19 Apr. 2016, Juneau, WI. (25 participants).

“Nitrogen management” *Golf Course Superintendents Association of Mexico Conference*, 5 Apr. 2016, Toluca, Mexico. (30 participants).

“Practical soil microbiology” *Golf Course Superintendents Association of Mexico Conference*, 5 Apr. 2016, Toluca, Mexico. (30 participants).

“Maximizing irrigation performance” *Golf Course Superintendents Association of Mexico Conference*, 5 Apr. 2016, Toluca, Mexico. (30 participants).

“Sustainable turfgrass production using biosolids” *Wisconsin Wastewater Operators’ Association Spring Biosolids Symposium*. 22 March 2016. Stevens Point, WI. (200 participants).

“Getting the most out of your growth regulators” *Inland Empire Golf Course Superintendents Association Conference*, 14 Mar. 2016, Wenatchee, WA. (50 participants).

“Trends in golf course fertility” *Inland Empire Golf Course Superintendents Association Conference*, 14 Mar. 2016, Wenatchee, WA. (50 participants).

“Practical turfgrass microbiology” *Inland Empire Golf Course Superintendents Association Conference*, 14 Mar. 2016, Wenatchee, WA. (50 participants).

“Turfgrass nutrition from the ground up” Nutrite Seminar, 2 Mar. 2016, Guelph, Ontario. (20 participants).

“Managing turfgrass for environmental health” Nutrite Seminar, 2 Mar. 2016, Guelph, Ontario. (20 participants).

“Understanding fertilizer technology” *ProSource One Conference*, 16 Feb. 2016, Waukesha, WI (50 participants).

“Progressive annual bluegrass and creeping bentgrass management” *Golf Industry Show*, half day workshop, 9 Feb. 2016, San Diego, CA (200 participants).

“Practical turfgrass microbiology” *Golf Industry Show*, half day workshop, 9 Feb. 2016, San Diego, CA (200 participants).

“Sure fire ways to increase plant health” *Golf Industry Show*, half day workshop 8 Feb. 2016, San Diego, CA (200 participants).

“Basic soil management for growing healthy turf” *Northern Green Expo*, 15 Jan. 2016, Minneapolis, MN (50 participants).

“Soils 101” *Great Lakes School of Turfgrass Management* (webinar), 13 Jan. 2016, (75 participants).

“Is your potassium program helping or hurting your turf?” *Canadian Golf Course Management Conference*, 12 Jan. 2016, Toronto, Ontario (150 participants).

“Fundamentals of nutrient management for healthy turf” *Landscape Ontario Congress*, 11 Jan. 2016, Toronto, Ontario (300 participants).

“Practical turfgrass microbiology” *Canadian Golf Course Management Conference*, Half day workshop 11 Jan. 2016, Toronto, Ontario (15 participants).

“Soil testing simplified” Winfield Academy, 7 Jan. 2016 Seattle, WA (50 participants).

“Soil science research update” *Wisconsin Turfgrass Association Research Day*, 5 Jan. 2016, Madison, WI (150 participants).

Koch

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| Presentation Title | Conference/Meeting | Audience Size | Date | Location |
| Fusarium control and new ways to look at disease control | Oregon Pest Management Conference | 100 | Dec 8 | Portland, OR |
| Anthracnose and brown ring patch control with new technology | Oregon Pest Management Conference | 100 | Dec 8 | Portland, OR |
| Buttoned up for winter? Green Cover Impacts on Turf Health and Snow Mold Development | Wisconsin Turf Symposium | 150 | Nov 30 | Kohler, WI |
| The Common Ground Initiative | Wisconsin Turf Symposium | 150 | Nov 30 | Kohler, WI |
| A Greener Future: strategies for developing a reduced-risk turf management plan | Wednesday Night at the Lab | 15 + WI public television | Oct 19 | Madison, WI |
| Lawn Care 101 | Master Gardeners – Milwaukee County | 50 | Oct 18 | Hales Corners, WI |
| Lawn Care 101 | Master Gardeners – Waukesha County | 50 | Oct 17 | Waukesha, WI |
| Year in Review | Reinders | 25 | Sep 22 | Stevens Point, WI |
| A Greener Future: strategies for developing a reduced-risk turf management plan | Maple Bluff Community Meeting | 20 | Sep 20 | Madison, WI |
| Snow mold control: What works and why didn’t it work at my place | BASF | 50 | Sep 1 | Denver, CO |
| The Common Ground Initiative | Wisconsin Golf Course Superintendents Association | 75 | Aug 15 | Green Bay, WI |
| University of Wisconsin Summer Field Day | University of Wisconsin | 200 | Jul 26 | Madison, WI |
| Fun with Microscopes | Grandparents University | 100 | Jul 22 | Madison, WI |
| Turf Species | Grandparents University | 100 | Jul 21 | Madison, WI |
| A Greener Future: strategies for developing a reduced-risk turf management plan | Sustainable Stoughton Monthly Meeting | 20 | May 26 | Stoughton, WI |
| Identification and Management Strategies for Midwest Lawn Diseases | Master Gardeners – Jefferson County | 25 | May 12 | Fort Atkinson, WI |
| Pesticide Applicator Training Program, Cat 3.0 | Pesticide Applicator Training Program | 75 | Apr 20 | Oconomowoc, WI |
| University of Wisconsin Snow Mold Field Days | University of Wisconsin | 25 | April 13 | Wausau, WI |
| Pesticide Applicator Training Program, Cat 3.0 | Pesticide Applicator Training Program | 75 | Apr 17 | Wausau, WI |
| The Skinny on Plant Defense Activators | Reinders | 25 | April 7 | La Crosse, WI |
| Pesticide Applicator Training Program, Cat 3.0 | Pesticide Applicator Training Program | 75 | Apr 6 | Oconomowoc, WI |
| Pesticide Applicator Training Program, Cat 3.0 | Pesticide Applicator Training Program | 75 | Mar 30 | Eau Claire, WI |
| Pesticide Applicator Training Program, Cat 3.0 | Pesticide Applicator Training Program | 75 | Mar 24 | Oconomowoc, WI |
| Identification and Management of Turfgrass Rusts | Wisconsin Sod Producers Association | 25 | Mar 22 | Des Plaines, IL |
| Pink Snow Mold: Midwest vs Northwest | Oregon State University Snow Mold Field Day | 25 | Mar 10 | Corvalis, OR |
| Pesticide Applicator Training Program, Cat 3.0 | Pesticide Applicator Training Program | 75 | Mar 7 | Oconomowoc, WI |
| Pesticide Applicator Training Program, Cat 3.0 | Pesticide Applicator Training Program | 75 | Mar 2 | Green Bay, WI |
| Snow mold control: What works and why didn’t it work at my place | Northern Great Lakes Golf Course Superintendents Association Winter Meeting | 50 | Mar 2 | Green Bay, WI |
| Reduced-Risk Disease Control: How to do it and why it’s important | Northern Great Lakes Golf Course Superintendents Association Winter Meeting | 50 | Mar 2 | Green Bay, WI |
| Reduced-Risk Disease Control: How to do it and why it’s important | MidAtlantic Golf Course Superintendets Association Winter Meeting | 150 | Feb 24 | Baltimore, MD |
| Reduced-Risk Disease Control: How to do it and why it’s important | Wisconsin Assistant Golf Course Superintendents Meeting | 50 | Feb 3 | Fond du lac, WI |
| Identification and Management Strategies for Midwest Lawn Diseases | Iowa Turfgrass Foundation Winter Meeting | 125 | Jan 25 | Iowa City, IA |
| The danger lurking below: how patch diseases can ruin your summer | Iowa Turfgrass Foundation Winter Meeting | 125 | Jan 25 | Iowa City, IA |
| Reduced-Risk Disease Control: How to do it and why it’s important | Iowa Turfgrass Foundation Winter Meeting | 125 | Jan 25 | Iowa City, IA |
| The White Menace: Winter injury on turfgrass | Illinois Turf Foundation Winter Meeting | 50 | Jan 13 | Chicago, IL |
| Pesticides and Endocrine Disruptors: What you need to know | Illinois Turf Foundation Winter Meeting | 50 | Jan 13 | Chicago, IL |
| Identification and Management of Turfgrass Rusts | Illinois Turf Foundation Winter Meeting | 50 | Jan 13 | Chicago, IL |
| Money matters: Chemical and Chemical Control Strategies to get the most bank for your fungicide buck. | Connecticut Area Golf Course Superintendents Association | 100 | Jan 12 | Providence, RI |
| Reduced-Risk Disease Control: How to do it and why it’s important | Connecticut Area Golf Course Superintendents Association | 100 | Jan 12 | Providence, RI |
| The danger lurking below: how patch diseases can ruin your summer | Wisconsin Turfgrass Association Winter Conference | 115 | Jan 5 | Madison WI |

8. Fund leveraging, specifically, collaborative grants between stations and members.

9. Other relevant accomplishments and activities.