**NCERA 221 Outcomes and impacts summary for 2022**

**Outcomes**

* Collaborative and combined multi-year grant funding supporting turfgrass research in the region exceeded $33 mil, including a new $8 mil project to study winter stresses of cool-season turfgrasses. Research is supported by state, regional, and national sponsors and federal agencies. The research focused on winter stress, soil moisture, turfgrass and soil ecology, cultivar development and pest management.
* Several collaborative research projects were initiated or ongoing, designed to address regionally important turfgrass issues such as best turfgrass management practices, winter injury, salinity tolerance, shade tolerance, establishment practices, cultivar selection, traffic tolerance, and pest management.
* Participants reported sustained student enrollment and some capacity building through new hires, equipment purchases, and expanded field research areas.
* Research-based recommendations were shared through invited presentations, publications, public media outlets, state level turfgrass conferences and field days, and at national and international meetings.
* Research in alternative methods for pest control, including evaluation of biocontrols to manage pests and mechanical pest removal without disrupting turf.
* Impact of management practices on turf and beneficial organisms are being evaluated.
* Multi-state research is underway to optimize best re-seeding techniques following winter injury.

**Impacts**

* Committee members maintain active extension programming and engagement with the turfgrass industry to promote research-based best management practices.
* Minnesota led a collaborative project to develop a new turfgrass cultivar database that is now available for public use, providing information to stakeholders on locally-adapted turfgrass cultivars.
* Purdue led production of an annual turfgrass weed control for professionals publication, considered the most comprehensive guide for managing turfgrass weeds.
* New research provided sod producers the necessary agronomic tools to produce fine fescue sod in the north central U.S. Researchers in Indiana and Minnesota collaborated on research trials that identified best management practice for low-input cool-season turfgrass sod production. In addition, economists developed budget tools to help producers understand costs and benefits associated with producing these species.
* Several projects tested new cultivars and experimental breeding lines throughout the region, helping to decrease maintenance costs and save resources.
* Studies were conducted in 10 states during the summer of 2022 that evaluated the effectiveness of the organic herbicides corn gluten meal and chelated iron for the control of crabgrass compared to a conventional herbicide standard. Preliminary results indicate that some of the combinations tested performed like conventional control, providing practitioners new tools for managing crabgrass. Research is ongoing.

**NC Regional Multistate Project/Committee Annual State Reports**

University: Iowa State University
Official NCERA rep: Nick Christians

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Phone: 515-450-1263

1. Impact statement:

New multistate work has begun investigating WinterTurf reseeding timing and cultivars. Also multistate research with natural products is showing that weeds can be controlled with natural products, but it takes multiple applications and years. *Poa* species with distinct summer dormancy are shown to have great potential as perennial groundcovers for sustainable crop production.

2. New Facilities and Equipment.

ISU has six new acres of three-inch sand-capped and irrigated area for turfgrass research. Some of this area will be used to investigate WinterTurf survival.

3. Unique Project Related Findings.

Humic containing products could maintain the same turfgrass quality at a lower rate of nitrogen than non-humic containing products. Additionally humic containing products can release nitrogen over an extended period.

4. Accomplishment Summaries.

Various natural products were tested for control of common turfgrass weeds across several states compared to traditional herbicide control. These findings are being developed into a publication under the direction of Dr. Bruce Branham.

Turfgrass traffic tolerance was improved with the addition of synthetic fibers into the turfgrass stand. This multistate effort was completed at U. of Tennessee, Michigan State Univ. and Iowa State Univ. and the findings are published.

5. Impact Statements.

Nothing to report.

6. Published Written Works.  Include joint/multistate 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. Lindsey, A.J., A.W. Thoms, M.D. McDaniel, and N.E. Christians. 2021. Plant-available soil nitrogen fluxes and turfgrass quality of Kentucky bluegrass fertilized with humic substances. Crop Sci. doi:10.1002/csc2.20592
2. Mertz, I., A. Thoms, and N. Christians. 2021. Glycerin-based nitrogen applications for turfgrass growth. Intl. Turf. Soc. Res. J. doi:10.1002/its2.83
3. Lindsey, A.J., A.W. Thoms, M.D. McDaniel, and N.E. Christians. 2021. Evaluation of humic fertilizers on a sand-based creeping bentgrass putting green. Crop Sci. doi:10.1002/csc2.20577
4. Lindsey, A.J., A.W. Thoms, J. Dancer, and M. Gross. 2021. Evaluation of algae-based fertilizers produced from revolving algal biofilms on Kentucky bluegrass. Agron. 11(7):1288. doi:10.3390/agronomy11071288
5. Thoms, A.W., R. Bearss, J.N. Rogers, and J.C. Sorochan. 2021. An evaluation of mat hybrid turfgrass systems under simulated traffic. Short Comm. Intl Turf. Soc. Res. J. 1-5. doi:10.1002/its2.58
6. Lindsey, A.J. and A. Thoms. 2021. Soil health solutions. Turf Magazine. Winter. 34(4):16-17, 35.
7. Lindsey, A., and A. Thoms. 2021. Impact of humic fertilizers on putting green turfgrass and soil health. Golf Course Manage. Nov. 89(11):70-74.
8. Thoms, A., S. Lord, and W. Appelfeller. 2021. Selecting and making the most of an internship. SportsField Mgmt. May:14-16.
9. Pease, B., N. Christians, and A. Thoms. 2021. Tank mixing procedures. SportsField Mgmt. May:18-20.
10. Christians, N., B. Pease, and A. Thoms. 2021. The mathematics of tank mixing. SportsField Mgmt. April:26-28.
11. Thoms, A., and N. Christians. 2021. Turfgrass renovation. Iowa State University Extension Publication. HORT 3113. p. 5.
12. Lindsey, A.J., A. Thoms, N. Christians, and R. Adams. 2021. Natural (organic) fertilization for turf. Iowa State University Extension Publication. HORT 3031. p. 7.
13. Thoms, A., N. Christians, and M. Agnew. 2021. Purchasing seed. Iowa State University Extension Publication. HORT 3112. p. 2.
14. Lindsey, A., A. Thoms, and N. Christians. 2021. Turfgrass calendar: warm-season grasses for lawns. Iowa State University Extension Publications. HORT 3105. p. 3.
15. Lindsey, A., A. Thoms, and N. Christians. 2021. Turfgrass biological soil health. Iowa State University Extension Publication. HORT 3111. p. 3.
16. Patton, A.J., M. Elmore, J. Kao-Kniffin, B. Branham, N. Christians, A. Thoms, S. Keeley, T. Shaddox, T.A. Nikolai, M. Reiter, L. Miller, X. Xiong, B. Kreuser, R. Gaussoin, M. Carroll, D. Li, D. Gardner, Z. Raudenbush, P. Landschoot, D. Soldat, and P. Koch. 2021 Turfgrass weed control for professionals. Purdue University Extension Publication. HORT 3066. p. 132.
17. Bartel, C.A., K.J. Moore, S.Z. Fei, A.W. Lenssen, R.L. Hintz, and S.M. Kling. 2022. Evaluating Strip and No-Till Maintenance of Perennial Groundcovers for Annual Grain Production. Crops, 2(3), pp.268-286.
18. Bartel, C.A., K.J. Moore, S.Z. Fei, A.W. Lenssen, R.L. Hintz, and S.M. Kling. 2022. Evaluating Chemical Suppression Treatments to Alter the Red: Far-Red Ratio in Perennial Groundcovers for Maize Production. Agronomy, 12(8), p.1854.
19. Chen, A.A., S.Z. Fei, A.W. Lenssen, and K.J. Moore, 2022. Photothermal controls of vegetative dormancy in Poa secunda. Grassland Research. https://doi.org/10.1002/glr2.12008
20. Chen A, S. Fei, A. Lenssen, and K.J. Moore. 2022. Evaluating cool-season grass species as potential perennial groundcover for maize production. Agronomy J. https://doi.org/10.1002/agj2.21087.
21. Moore, V.M., B. Schlautman, S.Z. Fei, L.M. Roberts, M. Wolfe, M.R. Ryan, S. Wells, and A.J. Lorenz. 2022. Plant Breeding for Intercropping in Temperate Field Crop Systems: A Review. Frontiers in Plant Science, 13, https://doi.org/10.1002/agj2.21087.
22. Xu N, J. Zobrist, K. Wang, and S. Fei. 2021. Genetic transformation of recalcitrant upland switchgrass using morphogenic genes. Frontiers in Plant Science. doi: 10.3389/fpls.2021.781565.
23. Hao J, Y. Yin, and S Fei. 2021. A Novel Method of Generating RNAi Library for High Throughput Gene Function Analysis in Creeping Bentgrass (*Agrostis stolonifera* L.). Intl Turfgrass Res J.
24. Schlautman, B., C. Bartel, L. Diaz-Garcia, S. Fei, S. Flynn, E. Haramoto, K. Moore, and D.R. Raman, 2021. Perennial groundcovers: an emerging technology for soil conservation and the sustainable intensification of agriculture. Emerging Topics in Life Sciences, 5(2):337-347.

7. Scientific and Outreach Oral Presentations.

1. Lindsey, A.J., A. Thoms, C. Hatten, and M. Ramette. 2021. Evaluation of plant proteins on turfgrass growth during establishment. Intl. Agorn. Ann. Meet. Salt Lake City, UT. 8-10 Nov.
2. Gould, T., A. Thoms, G.L. Thompson, and N.E. Christians. 2021. Sports field recovery from unplanned suspension of maintenance activities. Intl. Agron. Ann. Meet. Salt Lake City, UT. 8-10 Nov.

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

Watkins E. et al. USDA-SCRI- WinterTurf: A holistic approach to understanding the mechanisms and mitigating the effects of winter stress on turfgrasses in northern climates total: $8,000,000

Raman R, Moore KJ, Lubberstedt T, Fei S et al., Regenerating America’s Working Landscapes to Enhance Natural Resources and Public Goods through Perennial Groundcover (PGC). USDA-AFRI, 9/15/2021-8/14/2026. $9,978,755. Role: Co-PD

9. Other relevant accomplishments and activities.

Nothing to report.

University: Kansas State University
Official NCERA rep: Jack Fry

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Phone: 785-532-1430

1. Impact Nugget:

K-State is involved in cooperation with other NCERA universities in evaluating organic products for crabgrass control. In addition, USGA-sponsored projects evaluating development of new zoysiagrass cultivars have been conducted since 2012 with Purdue and Texas A&M AgriLife-Dallas.

2. New Facilities and Equipment.

Nothing to report.

3. Unique Project Related Findings.

K-State, Purdue, and Texas A&M AgriLife-Dallas approved release of a new zoysiagrass cultivar (experimental DALZ 1701) which has been evaluated for ten years.

4. Accomplishment Summaries.

*Efficacy of Corn Gluten Meal and Fiesta Herbicide*

Research involving evaluation of organic herbicide products was conducted on bermudagrass in Olathe, KS. The project was initiated in 2021 and little weed suppression occurred. The study in ongoing in 2022, and data will be analyzed in the near future.

*Evaluation of Large Patch Resistance and Cold Hardiness in Experimental Zoysiagrasses Developed for the Transition Zone*

After 10 years, a single zoysiagrass cultivar has been approved for release. Compared to the standard, Meyer zoysiagrass, DALZ 1701 has: better large patch tolerance; better drought tolerance; dark green genetic color; improved tolerance to billbugs; and improved turf quality

*Development of Cold Hardy Zoysiagrass Cultivars for Golf Courses in the Transition Zone*

This project has been underway since 2018 to evaluate experimental zoysiagrasses that have fine texture, and could potentially be used on tees, fairways, or putting greens in the transition zone. Currently, 60 experimental genotypes are being evaluated in nine states, including Kansas, Indiana, and Missouri, part of the North Central region.

5. Impact Statements

Nothing to report.

6. Published Written Works.

Braun, R.C., A.J. Patton, A. Chandra, J. Fry, A.D. Genovesi, M. Meeks, M. Kennelly, M. Xiang, M. Chhetri, M.D. Richardson, D.S. Richmond, M.T. Pudzianowska, and J.H. Baird. 2022. Development of winter hardy, fine-leaf zoysiagrass hybrids for the upper transition zone. Crop Sci.:(in press).

7. Scientific and Outreach Oral Presentations.

Research results for projects mentioned were presented an the annual Kansas Turf and Ornamentals Field Day (August, 2022; attendance 230) and will also be presented at the Kansas Turf and Landscape Conference (December, 2022; expected attendance of 600).

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

USGA funding has been received since 2012 for K-State and Purdue to support zoysiagrass development. Missouri has been another North Central state that receives funds to evaluate gentoypes.

In 2022, K-State, Purdue, and Texas A&M received a three-year USDA grant titled *FARM to LAWN: Enhancing the Production, Establishment, and Marketability Success of Zoysiagrass Sod*

9. Other relevant accomplishments and activities.

Nothing to report.

University: University of Minnesota
Official NCERA rep: Eric Watkins

Email: ewatkins@umn.edu

1. Impact Nugget:

New research results showed that fine fescue sod production is possible in the north central region.

2. New Facilities and Equipment.

Nothing to report.

3. Unique Project Related Findings.

Researchers in Minnesota developed methodology to screen turfgrasses, and other crops, for tolerance to foliar shade. This new approach, which used photoselective filters to mimic shade environments, will accelerate improvement of this important trait.

4. Accomplishment Summaries.

Researchers in Indiana and Minnesota collaborated on research trials that identified best management practice for low-input cool-season turfgrass sod production. In addition, economists developed budget tools to help producers understand costs and benefits associated with producing these species.

UMN led the submission of a successful $8 million project to study winter stresses of cool-season turfgrasses. This work will have wide impact and involves researchers from several north central states: Minnesota, Iowa, Wisconsin, Michigan, and Ohio.

Researchers in Minnesota led the development of a new cultivar performance database that will allow stakeholders easy access to information about well-adapted turfgrass cultivars.

5. Impact Statements.

Sod producers in the north central U.S. now have the agronomic tools necessary to produce fine fescue sod.

A new cultivar database was developed that is now available for public use.

6. Published Written Works.

Braun, R. C., E. Watkins, A.B. Hollman, N.T. Mihelich, and A.J. Patton. 2022. Management, harvest, and storage characteristics of low-input cool-season turfgrass sod mixtures. Agronomy Journal, 00, 1– 17. https://doi.org/10.1002/agj2.21051

Braun, R. C., E.T. Braithwaite, A.R. Kowalewski, E. Watkins, A.B. Hollman, and A.J. Patton. 2022. Nitrogen fertilizer and clover inclusion effects on the establishment of fine fescue taxa. Crop Science 62: 947– 957. https://doi.org/10.1002/csc2.20704

Petrella, D.P., F. Breuillin-Sessoms, and E. Watkins. 2022. Layering contrasting photoselective filters improves the simulation of foliar shade. Plant Methods 18:16 https://doi.org/10.1186/s13007-022-00844-8

Braun, R.C., A.J. Patton, E. Watkins, A.B. Hollman, J.A. Murphy, B.S. Park, A.R. Kowalewski, and E.T. Braithwaite. 2021. Optimal fine fescue mixture seeding dates in the northern United States. Agronomy Journal 113(5):4413-4428. https://doi.org/10.1002/agj2.20859 [Open Access]

Braun, R.C., E. Watkins, A.B. Hollman, N.T. Mihelich, and A.J. Patton. 2021. Investigation of cool-season species, seeding rate, and nitrogen fertilization in sod production: I. Establishment and sod tensile strength. Agronomy Journal 113(5):4176-4189. https://doi.org/10.1002/agj2.20810 [Open Access]

Braun, R.C., E. Watkins, A.B. Hollman, N.T. Mihelich, and A.J. Patton. 2021. Investigation of cool-season species, seeding rate, and nitrogen fertilization in sod production: II. Management and shelf-life. Agronomy Journal 113(4):3460-3474. https://doi.org/10.1002/agj2.20777 [Open Access]

Breuillin-Sessoms, F., D.P. Petrella, J.M. Trappe, N.T. Mihelich, A. Patton, and E. Watkins. 2021. Field evaluation of weed suppression in fine fescue (Festuca spp.). Crop Science 61: 2812– 2826. https://doi.org/10.1002/csc2.20506

Xie, Y, M. Farhadloo, N. Guo, S. Shekhar, L. Kne, H. Bao, E. Watkins, A. Patton, and K. Morris. 2021. NTEP-DB 1.0: A relational database for the national turfgrass evaluation program. Int Turfgrass Soc Res J. https://doi.org/10.1002/its2.76

Yue, C., M. Cui, E. Watkins, and A. Patton. 2021. Investigating factors influencing consumer adoption of low-input turfgrasses. HortScience 56(10): 1213-1220. https://doi.org/10.21273/HORTSCI15981-21

Barnes, M.R., K.C. Nelson, A.R. Kowalewski, A.J. Patton, and E. Watkins. 2020. Public land manager discourses on barriers and opportunities for a transition to low input turfgrass in urban areas. Urban Forestry and Urban Greening https://doi.org/10.1016/j.ufug.2020.126745

Braun, R.C., A.J. Patton, E. Watkins, P.L. Koch, N.P. Anderson, S.A. Bonos, and L.A. Brilman. 2020. Fine fescues: A review of the species, their improvement, production, establishment, and management. Crop Science 60: 1142– 1187. https://doi.org/10.1002/csc2.20122

7. Scientific and Outreach Oral Presentations.

Braun, R.C., A.J. Patton, A.R. Kowalewski, E.T. Braithwaite, E. Watkins, and A. Hollman. 2021. Nitrogen fertilizer and clover inclusion effects on the establishment of fine fescue taxa. ASA-CSSA-SSSA International Meeting. Salt Lake City, UT.

Braun, R.C., A.J. Patton, E. Watkins, A. Hollman, and N.T. Mihelich. 2021. Evaluation of harvest and storage limitations of low-lnput cool-season species mixtures for sod production. ASA-CSSA-SSSA International Meeting. Salt Lake City, UT.

Braun, R.C., A.J. Patton, E. Watkins, P.L. Koch, N.P. Anderson, S.A. Bonos, and L. Brilman. 2020. Recommended taxonomic classifications of fine fescue taxa used in turfgrass systems. ASA-CSSA-SSSA International Meeting. Online.

Patton A.J., R.C. Braun, E. Waktins, N.T. Mihelich, and A. Hollman. 2020. Effect of seeding rate and nitrogen fertility on the production, quality, shelf-life, and harvest limitations of low-input sod. ASA-CSSA-SSSA International Meeting. Online.

Reiter, M., J. Friell, F.S. Rossi, P. Wiringa, and E. Watkins. 2020. Comparing methods for mapping zones of turfgrass adaptation in the contiguous United States. ASA-CSSA-SSSA International Meeting. Online.

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

Watkins, E., M. DaCosta, P. Koch, K. Frank, et al., 2021-2025. WinterTurf: A holistic approach to understanding the mechanisms and mitigating the effects of winter stress on turfgrasses in northern climates. USDA Specialty Crop Research Initiative. $8,000,000.

​​Straw, C., E. Watkins, and C. Yue. 2021-2022. Precision irrigation on golf course fairways using soil moisture sensor and mapping technologies. Irrigation Innovation Consortium. $40,000.

S. Hobbie (PI), Co-PIs: X. Feng, J.C. Finlay, B. Keeler, K. C. Nelson,  Senior Investigators: L. Baker, L. Brandt, K. Brauman, J. Cavender-Bares, M. Davenport, K. Derickson,  M. Dockry, F. Fleischman, J. Gulliver, S. Ishii, N. Jelinski, D. Karwan, C. Kazanski, J. Knight, S. Lerman,  E. Lonsdorf, H. Menninger, R. Montgomery, J. Neiber, G. Small, E. Snell-Rood, T. Twine, E. Watkins. 2021-2027. LTER: The changing nature of cities: Ecological and social dynamics in the Minneapolis-St. Paul urban ecosystem. NSF Division of Environmental Biology LTER. $7,126,200

Aamlid, T., M. DaCosta, E. Watkins, et al.  2020-2021. Reducing the agronomic and economic impact of ice damage on golf courses and other grasslands. Norwegian Golf Federation. $18,360.

DaCosta, M., E. Watkins, J.S. Ebdon, and D. Petrella. 2019-2022. Understanding factors associated with successful creeping bentgrass re-establishment following winterkill. United States Golf Association. $199,999.

9. Other relevant accomplishments and activities.

Nothing to report.

University: University of Missouri
Official NCERA rep: Xi Xiong

Email: xiongx@missouri.edu

1. Impact Nugget:

— Performed a second-year field experiment regarding billbug control, as well as a couple of laboratory experiments studying the possible negative effects of insecticides on beneficial insects. Results were dissipated through a couple of invited presentations, with one to the golf industry during the 2021 GIS show, and one to the CPPM/ARDP project director workshop. A presentation was also made to a joint virtual field day participants.

2. New Facilities and Equipment.

—N/A.

3. Unique Project Related Findings.

—Developed a novel mechanic approach, sweeping, to control billbug populations without damage the turf. A sweeper that is designed for artificial turf surfaces was adopted for this purpose. This approach effectively removes billbug specimens and consequently reduces our reliance on synthetic pesticides.

4. Accomplishment Summaries.

—Through collaboration, we developed genetic tools that could help to identify billbug larvae to species, which in the past was impossible due to lack of morphological traits to ID billbug to species at larval stage.

Field experiments performed demonstrated the feasibility of using a mechanic sweeper for billbug control without damaging the turf. This development shines a new light into control options for turf pest without heavily relying on synthetic pesticides.

5. Impact Statements.

—Through presentations and published written works, our project reached approximately a few hundreds of people.

6. Published Written Works

Rodriguez-Soto, M.M., L.S. Enders, R. Ramirez, X. Xiong, and D.S. Richmond. 2021. Characterizing billbug (*Sphenophorus* spp.) seasonal biology using NDA barcodes and a simple morphometric analysis. Insects. 12 (10), 930. DOI: 10.3390/insects12100930.

7. Scientific and Outreach Oral Presentations.

1. Xiong, X. 2021. Developing a novel mechanical strategy for control of billbug. CPPM/ARDP Project Director Workshop. Webinar. October 13, 2021.
2. Xiong, X. 2021. Developing a novel mechanical strategy for control of billbug. 2021 Golf Industry Show. Webinar. February 2-4, 2021.
3. Barrett, B., and X. Xiong. 2021. Discover the world of hunting billbugs. Joint Virtual Field Day between the University of Missouri and University of Arkansas. August 12, 2021.

University: North Dakota State University
Official NCERA rep: Deying Li

Email: Deying.Li@ndsu.edu

Phone: 701-231-8037

1. Impact Nugget:

Our work focuses on cold hardiness (especially on annual bluegrass) and salinity tolerance which are two common issues in North Dakota. Our findings for management practices and best adapted cultivars help decrease the maintenance cost and save resources.

2. New Facilities and Equipment.

N/A

3. Impact Statements.

Turfgrass industry hires 2595 employees and has a total value-added output of 672 million dollars in North Dakota. This statistic does not include sod production and turfgrass seed production. The state has about 150 golf courses, among the highest per captor in the nation.

4. Published Written Works.

Qian, Y., D. LuChen, and D. Li. 2021. Physiological integration improves mock strawberry [Duchesnea indica (Andr.) Focke] uniformity under heterogeneous saline conditions. Scientia Horticulturae. <https://doi.org/10.1016/j.scienta.2021.110579>

Zhao, X., Y. Zhao, S. Guan, K. Dong, and D. Li. 2021. Seed production and yield components of *Lespedeza davurica* in response to N, P, and K fertilization and plant density. J. Plant Nutrition <https://doi.org/10.1080/01904167.2021.2020825>

He, Q., and D. Li. 2021. Assessing shade stress in leaves of turf-type tall fescue (*Festuca arundinacea* Schreb.). Photosynthetica 59:474-485.

5. Education and Outreach.

One graduate student and twelve undergraduates in the Sports and Urban Turfgrass Management option in Horticulture Program at NDSU.

Our extension conference is February 22-24, 2022 organized by NCTGA. Our field day was Aug 19th, 2021 organized by department of plant sciences of NDSU.

University: Ohio State University
Official NCERA rep: David Gardner

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Phone: 614-292-9002

1. Impact Nugget:

Nothing to report.

2. New Facilities and Equipment

Nothing to report

3. Unique Project Related Findings.

Nothing to report

4. Accomplishment Summaries.

Studies were conducted in 10 states during the summer of 2022 that evaluated the effectiveness of the organic herbicides corn gluten meal and chelated iron for the control of crabgrass compared to a conventional herbicide standard. Our preliminary results indicate that, while there was some variation in efficacy at different locations, that some of the combinations tested were like control provided by the standard herbicide.

5. Impact Statements.

Our results are too preliminary to discuss the multistate crabgrass control project

6. Published Written Works.

Acuna, A; Gardner, DS; Villalobos, L; Danneberger, TK. Plant bio-stimulant effect on seedling turfgrass root and shoot growth of three cool-season turfgrass species grown under a controlled environment. Int Turf Res. J. DOI: 10.1002/its2.97

Nangle, EJ, DS Gardner, “Schedonorus (Festuca) – Tall Fescue” OLCANews Spring 2021: p. 5-6.

Gardner, DS, Nangle, EJ “Biostimulants – What are they and What is their Place in Golf Course Management”. OTF Turf News Spring/Summer 2021: p. 12-15.

Gardner, DS, Nangle, EJ “Water and Field Playability”. OTF Turf News Spring/Summer 2021: p. 16-19.

Nangle, EJ, Gardner, DS, A developing area of turf management – Biostimulants – What are they and how do we use them? Greenside Magazine, Golf Course Superintendents Association of Ireland, Spring 2021.

Nangle, EJ; Gardner, DS; Shetlar, DJ (2021) What to Look for in a Lawn Care Company. OSU extension bulletin HYG-4025-88. <https://ohioline.osu.edu/factsheet/hyg-4025-88>

Nangle, EJ; Gardner (2021) Lawn Grass Cultivar Selection. OSU extension bulletin HYG-4027-02. <https://ohioline.osu.edu/factsheet/hyg-4027>

Nangle, EJ; Gardner, DS (2021) Lime and the Home lawn. OSU extension bulletin HYG-4026. <https://ohioline.osu.edu/factsheet/hyg-4026>

7. Scientific and Outreach Oral Presentations.

Ohio turfgrass foundation conference and show. December 6-9, 2021. 1050 attendees.

Ohio turfgrass foundation conference and show (online). January, 201. 600 attendees.

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

Nothing to report

9. Other relevant accomplishments and activities.

We have posted positions for two faculty members in turfgrass, one housed in Horticulture and Crop Science and the other in either Plant Pathology or Entomology.

Combined WERA011/NCERA221 state report

Official NCERA rep: Roch Gaussoin

Official WERA rep: Keenan Amundsen

Email: kamundsen2@unl.edu (Amundsen)

Phone: 402-472-8390 (Amundsen)

Outreach activities addressing objective 6:

State conference dates: January 4-6, 2022

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

Attendance figure: 540

Research field day held (yes/no): No

If so, when:

Attendance figure:

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 - 600 subscribers

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

Patton, A. 2022. Turfgrass Weed Control for Professionals: Turf-100. Purdue Extension Education Store

Staffing:

Additions/vacancies:

Searching for a campus-based Turfgrass Extension Educator. Interviews scheduled for September, 2022.

Searching for a postdoctoral researcher to work with turfgrass genomes and

Position changes:

Michael Carlson completed his PhD and left his technologist position at UNL for an industry job in 2022.

Luqi Li became a lecturer in the Agronomy and Horticulture Department effective July, 2022 and teaches a turfgrass management lab and serves as a teaching assistant for PLAS327: Turfgrass Science and Management.

Teaching Program

Current undergraduate enrollment: 21

Consistent enrollment and minor growth in collaboration with UNL PGM program.

Placement: 100%

Research (just published/in press pubs in the last 2 years, 2021-22).

1. Stahnke, Gwen K.; Rieke, Paul E.; Cookingham, Pete O.; Shearman, Robert C.; Gaussoin, Roch E.; Kopec, David M. 2022. James B Beard: The father of contemporary turfgrass science. International Turfgrass Society Research Journal. June. 14(1): p. 1-11
2. Williams, Dallas M. 2021. M.S. Thesis: A Method for Visualizing Water Flow Through Modified Root Zones. University of Nebraska. [2], v, 54 pp
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Student projects

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: December 2022

Faculty member: Keenan Amundsen

Current or recently graduated graduate student: Michael Morikone

MS or PhD: PhD

Project(s): Optimizing genome assembly and annotation in buffalograss

Graduation date: May 2023

Research Highlights:

W1: Established seed increase plots for two experimental elite buffalograss populations to have enough seed to support regional evaluation trials. Advanced 10 separate buffalograss breeding populations to the next generation and selected individuals that germinate in the absence of a seed treatment. Established an evaluation trial for 40 elite buffalograss lines suitable for sod production or parental material for developing seeded populations. The plots are evaluated for establishment rate, internode length, genetic color color retention, turfgrass quality, and seed production potential. New buffalograss lines developed from this research will support industry needs for reduced water, fertility and pesticide inputs.

W1: With support from the USGA, using genomic tools to identify genetic elements contributing to the winter dormancy response of buffalograss.

W2: Currently managing the Kentucky bluegrass and tall fescue NTEP evaluation trials, and were awarded the 2022 perennial ryegrass test. The data is analyzed by NTEP and provides regional turfgrass managers with information on regional turfgrass performance, informing species and cultivar selection decisions.

W4: Evaluating buffalograss experimental line performance with no supplemental inputs. Research will lead to development of buffalograss lines that tolerate few management inputs.

W5: Publish TurfInfo on our website and communicate current research and turfgrass management trends through extension outreach and conference presentations.

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

Email: frankk@msu.edu

Phone: 517-353-0147

Teaching

Current undergraduate enrollment for 2022-2023 academic year: 75 total [35 (4 yr.), 40 (2 yr.)]

Trend in student enrollment over last 3 years: slightly upward

Placement: Excellent

Research

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

Current or recently graduated graduate student: Payton Perkinson

MS or PhD: MS student

Project: Winterkill reestablishment, winterkill nutrient response studies

Description:

This spring reestablishment seeding research was conducted at MSU, University of Minnesota, University of Wisconsin, and Iowa State University. On three consecutive weeks in the spring of 2022 four creeping bentgrass cultivars and Two-Putt annual bluegrass were seeded into an existing putting green that was killed with glyphosate the previous fall. The bentgrass cultivars were Penncross, Declaration, Pure Distinction and A4. Previous seed germination research at the University of Minnesota found that some bentgrasses displayed high germination rates at low temperatures while others performed poorly. As a first step in our research we designed a study to compare bentgrass cultivars and Two-Putt annual bluegrass over three seeding dates in the spring in the field.

We will answer the questions:

1) Do cultivars differ in establishment rate, especially in a cold spring

2) Should I seed early or wait until it warms up?

This research is the first step in the first year of the WinterTurf grant. In the spring of 2023 we will repeat this trial and expand with additional research that evaluates the effect of covers on reestablishment and other management practices such as nutrient source and rate, and possibly even using pigments to enhance surface warming and germination rates.

Project: Long-term nitrogen and phosphorus leaching

Description: Nitrogen leaching 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. 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 15 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. July 2019 will mark the beginning of the 21st consecutive year of leachate collection and 29 years since turfgrass was established on the lysimeters. It has been 21 years since the high N rate of 5 lb. N/1000 ft.2/yr was initially applied and resulted in high levels of NO3-N leaching at ten years after turf establishment. Following the N rate reduction, leachate NO3-N concentrations declined over an approximately 15-year period. The turfgrass growing on the lysimeters is now 29 years old and our objective is to determine if a high N rate of 5 lb. N/1000 ft.2/yr will produce a similar result in NO3-N leaching as measured at 10 years after turfgrass establishment.

Project: Evaluating the effects of soil test philosophies on creeping bentgrass and annual bluegrass.

Description: This research evaluates two methods of soil test interpretation and fertilizer recommendations, Sufficiency Level of Available Nutrients (SLAN) and Minimum Levels for Sustainable Nutrition (MLSN). SLAN is an established method for determining fertilizer recommendations based on soil test results. MLSN is a more recent method for determining fertilizer recommendations and when compared to SLAN recommends lower application rates of phosphorus and potassium. Soils were sampled in the spring of 2021. Mehlich 3 soil test extractant was used to determine soil nutrient levels and nutrient recommendations were made according to the formulas used by the MSU Soil and Plant Nutrient Lab for the SLAN method and MLSN nutrient recommendations were determined from published MLSN formulas. The study has three treatments: (1) phosphorus and potassium applied according to MLSN guidelines; (2) phosphorus and potassium applied according to SLAN guidelines; and (3) nitrogen only treatment with no phosphorus or potassium added. These treatments were applied to creeping bentgrass and an annual bluegrass putting green. The nitrogen source for all treatments is liquid urea. Treatments were applied on two blocks: Penn A-4 bentgrass (*Agrostis stolonifera* L.) and mix of Penncross creeping bentgrass and annual bluegrass (*Poa annua*). Half of the plots are trafficked three times a week. Data such as normalized difference vegetation index, turf color and quality are collected biweekly. Soils will be sampled in April 2022 and the third year of treatment applications will commence in May 2022.

Project: NTEP Trials

 Fine leaf fescue fairway height with two N rates

 Fine leaf fescue fairway height with traffic

 Kentucky bluegrass

 Tall fescue

Faculty member (complete for each faculty member): Emily Merewitz-Holm

Current or recently graduated graduate student: Kailey Miller and Meghan Gendjar

MS or PhD: PhD students

Project: Influence of fall mowing height changes on winter survival of annual bluegrass putting greens

Description: In theory for perennial species, the accumulation of sugars from photosynthetic leaf tissues that can go into storage as starches is very important for winter survival and the quantity stored could be influenced by mowing height. The carbohydrates are largely transported from the leaves or root system and stored in crown or other overwintering structure. Theoretically, if annual bluegrass is allowed to develop more leaf surface area for photosynthesis, more carbohydrates could be stored and used for regrowth in the spring; however, annual bluegrass’s unique genetics and flowering capacity calls into question whether annual bluegrass will benefit from increased mowing heights and extra storage carbohydrates. Golf course superintendents may be reluctant to raise cutting heights of putting greens due to slower green speeds and the demand to maintain optimal playing conditions as long into the fall as weather permits play. Typically, if superintendents raise cutting heights at all it is when play is declining. Raising the mowing height would be a viable and cost- effective practice to adopt. But first, superintendents need more information on at what level and on approximately what date the mowing height needs to be raised to for seeing any increase in winter survival. Perhaps there is a minimum height that would photosynthetically compensate for the fact that superintendents would prefer to wait very late in the season to raise the mowing height. Thus, the objective of this study is to determine the effect of mowing height on winterkill survival of annual bluegrass putting greens. We hypothesize that raising mowing heights in September from a 0.125 inch standard height to higher levels of cut will reduce winterkill associated with ice cover on annual bluegrass putting greens.

Project: Soil water content and ethylene effects on annual bluegrass winterkill

Description: Winterkill damage to annual bluegrass putting greens and fairways is a significant issue in the turfgrass industry, costing millions of dollars annually in northern temperate areas. Turfgrass managers have expressed a large need for scientifically based management strategies that can reduce winter damage associated with ice and other stresses. Covers and other current management strategies often result in inconsistent protection or are not feasible on large areas. Our research aims to identify chemical management strategies to improve annual bluegrass survival of winter conditions that can be applied broadly and cost effectively. The goals of this study are to better understand annual bluegrass acclimation and overwintering in response to varied levels of soil moisture, plant protective products, and chemicals that regulate the plant hormone ethylene. The methods will include field -based treatments of chemicals and natural acclimation during the fall followed by turfgrass plugs being transferred into controlled environment low temperature growth chambers to evaluate low temperature and ice in a controlled way. This combined research approach has allowed for successful field evaluation in the fall and spring as well as consistent ice and low temperatures during the winter months in previous research.

Project: Characterization of turfgrass plant induced defenses in response to annual bluegrass weevil (ABW) feeding

Description: This study is in collaboration with Dr. Ben McGraw from Penn State. We will assess induced defense mechanisms in turfgrasses in response to insect herbivory by the annual bluegrass weevil (ABW) at various life stages. Plants being immobile organisms are highly vulnerable to abiotic and biotic stressors throughout their life. Our understanding of how plants protect themselves from insect attack is improving, yet studies in turfgrass are lacking. We will investigate grass hormone and protein responses, which will aid in distinguishing insect defense responses from general mechanical damage. The proposed project would not only improve our knowledge of the turfgrass-insect pest interactions but may identify opportunities for enhancing tolerance within existing turfgrass stands (i.e. priming the stand) or identify desirable plant traits that could be selected for in new cultivars, and thereby reducing the need or amount of insecticide applications and reducing potential insect resistance to pesticides. Currently, turfgrass managers are interseeding CBG into ABW-infestations in hopes of reducing populations over time. This project would provide information as to whether this is a sustainable approach, identify potential resistance/tolerance mechanisms, and cultivars that would be the most effective candidates for defense against ABW. Additionally, the findings of the project would inform management of other turfgrass insect pests with a similar feeding habit or life cycle.

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

Notable research projects led by faculty member:

Project: Lightweight rolling, PGR, green speed and collar research

Description: Research at Michigan State University has made lightweight rolling of the putting green a common mechanical practice. Benefits on lightweight rolling discovered at MSU include decreased turfgrass disease, localized dry spot, and broadleaf weeds while increasing putting green smoothness (green speed). However, some golf courses experience thinning of collars from frequent lightweight rolling. This research will focus upon interactions between PGR's, lightweight rolling, and mowing height on the thinning of turfgrass collars along with the effect on putting green speed.

Project: Lightweight rolling establishment studies

Description: In a study performed at MSU in 2005 it was apparent that lightweight rolling increased the density on newly seeded putting surfaces, however, no data, except digital images, was collected. This study will incorporate timing and frequency of rolling following seeding to collect data regarding percentage turfgrass cover over time. Obviously, the quicker the establishment the faster areas can be open for play which has an economic impact. Lightweight rolling establishment studies will take place on the putting green and on fairways.

Project: Fairway rolling research and customer satisfaction

Description: As mentioned earlier MSU has made lightweight rolling of putting greens a common mechanical practice due to the numerous benefits of the practice. Research performed on fairways has had mixed results and it has become apparent to MSU turfgrass researchers that heavier rollers are required on fairways to see reductions in disease and localized dry spot (please don't start this practice without having a conversation with me). This summer we will attempt to quantify the difference in ball roll length between fairways that are rolled to those that are not rolled. Additionally, we will be performing an establishment study with fairway rolling as well.

Project: NCERA-221 multi-site organic grass and broadleaf weed control trial

Description: Many regions of the world are experiencing bans on pesticide use. Some publications and web-sites advocate the use of "organic" weed control in place of chemical herbicides, however, little if any data supporting any organic weed control exists. With that thought as a catalyst multi-site trials were conducted in the spring and fall of 2018. Applications were made with numerous organic grass and weed control products on four replicated plots (25-50 ft2) treated on rough height grass to test effectiveness on typical broadleaf weeds, i.e. dandelion and white clover. The objective was to determine best applications practices of organic broadleaf weed controls to determine if any can perform adequately to suppress or kill broadleaf weeds. Data analyses from all the sites has not been finished as of the writing of document, but it seems apparent some best application methods have been determined for some organic weed controls though the methods are arduous at best. With that said, it is a start.

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

Current or recently graduated graduate student: Jackie Guevara (PhD), Jake Kilby (MS)

MS or PhD: PhD

Project(s): Sod on plastic establishment practices for cool-season grasses

Description:

Sod grown on plastic, commonly called Sod on Plastic (SOP), isa method of sod production on a thin layer of growing medium on top of a plastic sheet.

Benefits of growing SOP

• Complete control over the growing medium, preventing soil layering issues.

• Ability to harvest the whole rootzone without damaging the roots, avoiding

transplant shock during sod installation.

• Smooth playing surface after sod installation.

• Faster establishment rate, reducing production time from 18 months to 4

months.

• Being able to produce sod on non-arable lands (e.g., concrete).

Expected results and methods:

As an overarching theme for upcoming research, our experiments will focus on the main components of SOP establishment such as species composition, mowing, soil amendments and phosphorus fertilization at establishment:

i) Species Composition and Initial Mowing Study: This research will identify the seeding ratio and initial mowing schedule that produces the strongest sod on plastic in the shortest period. The experimental design will consist of five Kentucky bluegrass: Perennial ryegrass seeding ratios [100:0, 99:1, 97:3, 95:5, 93:7,0:100] subjected to three initial mowing schedules[1,2,3 weeks after seeding]. To answer these questions, researchers will evaluate species composition, percent turfgrass cover, root mass, root density and sod strength.

ii) Soil Amendments and Phosphorus Fertilization at Establishment Study (2022-2023): This research will evaluate a combination of soil amendments and phosphorus fertilization at establishment practices that produce the strongest sod on plastic in the shortest period. The experimental design will consist of Kentucky bluegrass established on four 1-inch depth sand mixes 1 [United States Golf Association (USGA) specification sand, 80% USGA specification sand:20% Peat, Crumb Rubber over USGA specification sand] subjected to five phosphorus fertilization rates at establishment [0, 0.5, 1.0, 1.5, 2.0 lbs 1000ft specification sand:20% Peat, Crumb Rubber over USGA specification sand] subjected to five phosphorus fertilization rates at establishment [0, 0.5, 1.0, 1.5, 2.0 lbs1000ft-2].The best treatment combination will be determined from measurements of soil P levels, percent turfgrass cover, shear strength, root mass, root density and sod strength.

Faculty member: Joe Vargas, Jr.

Project(s): Investigate dew removal and biocontrol on different creeping bentgrass cultivars for the control of dollar spot.

Description:

Obviously, we have known for years that dew removal will reduce dollar spot, but does it work the best on susceptible or on resistant cultivars? Is there any benefit afforded by removing dew from a resistant cultivar? Biocontrols have been tested for many years with little success, but will they work on intermediate cultivars or highly resistant cultivars? Learning more information about these interactions could help reduce fungicide inputs for the control of dollar spot.

We propose to examine the impact of creeping bentgrass cultivar (CBG) including a susceptible

cultivar, Penncross, an intermediate cultivar, Shark, and highly resistant cultivar, Coho, in combination with dew removal and a biocontrol on the development of dollar spot. Techniques to control dollar spot, the most costly disease on golf courses from a management perspective, have been studied at length, but there are still many questions which need to be addressed in order to develop more consistent, economical management strategies.

The study will be set up with three replications of each treatment. The study site has been seeded to large plots of Coho, Shark and Penncross creeping bentgrass. Dew will be removed on a frequent, consistent basis in the plots. Biocontrol treatment applications will be made at 48 GPA or 96 GPA using a CO2-powered backpack sprayer. Fertility will be applied as needed. The study site will be inoculated with a sand-cornmeal mixture infested with the disease pathogen. Treatment applications will be made according to label standards. Plots will be rated visually for percent plot area blighted by disease and for turfgrass quality. Photos will be taken periodically during the trial.

Extension

State conference dates: Jan. 10-12, 2023

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

If so who: Michigan Turfgrass Foundation

Attendance figure: 500 (from 2018 conference)

Research field day held (yes/no): yes

If so, when: Aug. 10, 2022

Attendance figure: 400

Other Extension activities:

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

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

Kevin Frank @msuturf

Trey Rogers @msuturfdoc