United States Department of Agriculture

Progress Report

Title:	Increasing Low-Input Turfgrass Adoption Through Breeding, Innovation, and Public Education

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Program Code: SCRI **Program Name:** Specialty Crop Research Initiative

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Recipient Organization

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Computer Sci and Engineering
Horticulture and Landscape Architecture

Non-Technical Summary

The public desires lower-input turfgrasses that provide functional turf areas while reducing inputs of water, fertilizer, mowing, and pesticides. We propose that the fine fescues, an important group of grasses well-suited to low-input environments, should be able to provide these types of turf areas. Surveys of consumer and public land managers suggests that having knowledge about the positive benefits of fine fescues is not enough to increase adoption. The long-term goal of this project is to increase the use of well-adapted fine fescue cultivars in sustainable landscapes. In our first objective, we will survey consumers, land managers, and seed producers to identify the barriers preventing them from using fine fescues. In the second objective, we will lead a sustained effort of cultivar development focused on improving important traits utilizing new molecular technologies and proven breeding approaches. The third objective will generate new knowledge about complex interactions between turfgrass genetics and management. Our approach in the fourth objective will use 30 years of publically available data in an innovative way to improve consumer turfgrass purchasing decisions for improved fine fescue cultivars. Our fifth objective will identify solutions to several turfgrass management barriers that are preventing stakeholders from seeding fine fescues in landscapes and seed producers from growing this specialty crop. Finally, and most importantly, our sixth objective will deliver research-based information to consumers, seed producers, and land managers using new and innovative outreach methods. We will use plant breeding to improve low-input characteristics and increase the production and profitability of this specialty crop over the long-term.

Accomplishments

Major goals of the project

The long-term goal of this project is to increase the use of well-adapted fine fescue cultivars in sustainable landscapes. In our first objective, we will survey consumers, land managers, and seed producers to identify the barriers preventing them from using fine fescues. In the second objective, we will lead a sustained effort of cultivar development focused on improving important traits utilizing new molecular technologies and proven breeding approaches. The third objective will generate new knowledge about complex interactions between turfgrass genetics and management. Our approach in the fourth objective will use 30 years of publically available data in an innovative way to improve consumer turfgrass purchasing decisions for improved fine fescue cultivars. Our fifth objective will identify solutions to several turfgrass management barriers that are preventing stakeholders from seeding fine fescues in landscapes and seed producers from growing this specialty crop. Finally, and most importantly, our sixth objective will deliver research-based information to consumers, seed producers, and land managers using new and innovative outreach methods. We will use plant breeding to improve low-input characteristics and increase the production and profitability of this specialty crop over the long-term. Output of this research will include new tools for consumers to use when making grass seed purchasing decisions, new turfgrass seed cultivars with improved low-input adaptation, new knowledge about the stress tolerance of fine fescues, new tools for public and private plant breeders to use when selecting fine fescues

What was accomplished under these goals?

Objective 1: Identifying barriers for homeowners and public land managers

Our team completed data analysis for six focus group discussions with public land managers in IN, OR, and NJ related to fine fescue implementation. In addition, we initiated and completed a large national survey of consumers; the choice experiment investigated the major barriers that prevent homeowners from purchasing low-input grasses. Data analysis and reporting is ongoing.

Objective 2: Breeding and genetics

We continued to focus on traits known to be important for successful performance of cool-season low-input turfgrasses. In Minnesota, methods were developed for screening fine fescues under conditions that mimic reductions in light quality common under vegetative shade; these methods will be used to screen breeding material from both public and private breeding programs. In NJ, we found that summer patch in hard fescue is likely controlled by a small number of genes with moderate heritability (0.67 +/- 0.01) from a diallel crossing scheme with three tolerant and three susceptible genotypes. One of the tolerant parents (R7) had a significant negative breeding value. ddRADseq was performed on a mapping population segregating for summer patch resistance. SNP data was analyzed with STACKS and aligned to the reference genome. 7800 SNPs were shared by 90% of the progeny. 200 populations (1000 genoytpes) were inoculated with Magnaporthae poae and meyeri-festucae. Several hundred clones have been identified with improved summer patch tolerance. Also in NJ, we identified physiological traits, metabolic processes, and molecular factors associated with heat tolerance stress in fine fescue. A completed bioinformatic analysis of transcriptomic data was completed and writing the manuscript from the analysis. A number of genes involved in secondary metabolism linked to heat tolerance in hard fescue have been identified. Our USDA-ARS team completed a hard fescue genome assembly using the Mecat assembler, and a second assembly using Canu is underway. There were so many PacBio CLR reads (over 600Gb) that the assemblers struggled to not crash. In the end we filtered out shorter reads and self corrected with 50% of the longest reads in order to even run the assemblers. A 240 genotype diverse hard fescue panel has been propagated and will be used for future marker-trait association studies including those focused on heat stress and snow mold resistance.

Objective 3: Biology research to support breeding efforts

Our team continued to investigate solutions to reduce the impact of summer patch disease. In 2020, we isolated a total of 16 fungal strains from the roots of three fine fescue samples inoculated with summer patch pathogens Magnaporthiopsis poae and M. meyeri-festucae in Adelphia, NJ. Based on the fungal DNA barcode (ITS region) sequences, all 16 isolates were identified as M. poae. The presence of M. poae in the plant tissue was confirmed with a real-time PCR assay. In order to sensitively detect and quantify M. meyeri-festucae from grass tissue, our team in Wisconsin developed a recombinase polymerase amplification (RPA) assay to detect Magnaporthiopsis meyeri-festucae on fine fescue roots and verified it with traditional PCR. The RPA and PCR results came in parallel and showed that the primer set designed specifically produced amplicon at targeted size (304b) from all three strains of Magnaporthiopsis meyeri-festucae but not any other Magnaporthiopsis species and strains. The RPA assay was also tested for root extracts instead of DNA extracted from cultured pathogens which specifically detected the roots infected with Magnaporthiopsis meyeri-festucae visualized using

SYBR-safe under UV-light.

Objective 4: Information delivery

Through multi-disciplinary and multi-sectoral work, we created and designed the first version of the NTEP database - NTEP-DB 1.0 - to reduce the manual efforts and required expert knowledge, which is currently needed to extract meaningful information from the data. Based on Objective 4.3, we validated the design through the implementation of a database using PostgreSQL, one of the most popular open-source platforms for relational databases. The experiments showed that the outputs are correct and the database is flexible in answering various types of user queries ranging from non-technical type query (e.g., query by consumers) to ad-hoc and technical query (e.g., query by researchers). To further improve the convenience of the user queries, we have developed a web-application allowing homeowners to find the most suitable cultivar with a few clicks.

Objective 5: Identifying solutions

Seed production: We completed the final year (year 3) of on-farm trials in the Silverton Hills to evaluate seed yield and yield component effects of different nitrogen (N) and plant growth regulator (PGR) treatments on Chewings and creeping red fescue in the absence of field burning. We also completed a second year of a spring mowing X plant growth regulator trial at Oregon State University Hyslop Research Farm. There are two spring mowing treatments and four PGR treatments on both Chewings and creeping red fescues. Seed yield and seed yield components were determined.

Turf management: We concluded or continued data collection in four field experiments in IN, MN, OR, and NJ with the objectives to determine optimal seeding time of the year, optimal fertility programs during establishment, quantify maintenance inputs, compare new and old cultivars, and quantify mowing requirements of cool-season turf species. A second year of data (turf quality, density and color) were collected from two field trials focused on better understanding summer patch disease: one trial assessed soil pH and the second trial N fertilizer source effects.

Objective 6: Quantifying benefits and informing the public

We published two peer-reviewed publications in Crop Science and created six extension publications. Accounts under the name of "LowInputTurf" across multiple social media platforms were continued to be utilized to inform and educate the public, and earned 133,508 impressions on Twitter, and an average of 81 daily viewers on the Pinterest account has during the last reporting period. In January 2020, we began a blog on our website <https://lowinputturf.umn.edu> to promote current research our project team has been conducting. Fifteen articles were posted in this project period on topics that included heat tolerance in fine fescues, consumer willingness to adopt fine fescues, fine fescue seed production, choosing fine fescues for disease resistance and many others. The website had 3500 pageviews, with 90% of the visitors over this period being new to the site.

What opportunities for training and professional development has the project provided?

Researchers and postdoctoral associates are mentoring graduate students in methodology used in this project.

How have the results been disseminated to communities of interest?

Presentations were given at virtual field days at participating institutions. These field days were viewed by our target audience including turfgrass industry professionals (golf course superintendents, public land managers, athletic field managers, parks managers, seed sales people, etc.), as well as homeowners. Research results were also presented at annual conferences. Several research presentations were given at the Crop Science Society of America annual meeting to inform the scientific community about our work. Students in undergraduate courses were also presented with results from this work during lecture and discussion sessions focused on sustainable turfgrass management.

What do you plan to do during the next reporting period to accomplish the goals?

Objective 1: Identifying barriers for homeowners and public land managers

We will explore homeowners who have and plan to confront the complexities of transitioning to more sustainable landscapes. Increasingly, homeowners' sustainability practices create new insights for how they confront barriers and evaluate trade-offs for distinct benefits. We will purposefully survey homeowners across socioeconomic, ethnic, and racial groups to better understand the values and environmental services of low-input, fine fescue turfgrass in comparison to other vegetation options across the urban landscape. Current scholarship is limited in the ability to speak to practice over time and across

economically and ethnically/racially diverse homeowners. We are also working on developing a grass seed producer survey draft. Once the draft is developed and finalized, data will be collected to investigate the barriers that prevent growers from growing seed of low-input turfgrasses.

Objective 2: Breeding and genetics

We will continue genomics research with the completion of a second genome assembly using Canu, which will then be used for a genetic mapping reference. Gene-association mapping will commence for both heat tolerance and snow mold as data become available.

In NJ, we will generate a genetic linkage map of hard fescue based on SNP marker data, then conduct QTL analysis on summer patch resistance in hard fescue with linkage and phenotype data from the field. We will also identify transcriptional factors that may explain the genetic variations in heat tolerance between fine fescue cultivars. We will continue breeding work in NJ and MN to screen for important traits such as increased seed production, summer patch tolerance, overall summer performance, and shade tolerance.

Objective 3: Biology research to support breeding efforts

Pathogenic isolates of Magnaporthiopsis poae and M. festuca-meyeri will be shared with project members and inoculated into hard fescue field plots in two field trials in NJ: one trial to assess soil pH and the second trial N fertilizer source effects on summer patch disease. We will conduct a third growth chamber screen to confirm the pathogenicity of several fungi obtained from declining hard fescue of unknown etiology along with isolates of Magnaporthiopsis poae and M. festuca-meyeri known to be pathogenic to this host.

We will continue summer patch pathogen collection, pathogenicity testing, and inoculation work to investigate the interaction between the pathogens and the host fine fescue. Finally, we aim to complete development of the culture-independent molecular detection in order to sensitively detect and quantify summer patch pathogens from the grass host tissue.

Objective 4: Information delivery

We plan to investigate the possibility of building a spatial database upon the current design, where we can collect spatial data (e.g., geo-coordinates). Spatial information allows the potential use of advanced spatial data science techniques such as spatial pattern mining. Also, we plan to investigate the potential of developing a real-time data collector application that can directly gather information in the field in a digital format and transform it into a database. The current data collection is done in many steps over a long period and there is a long delay to access the most recent data. We will also investigate creating a recommendation system that offers information to both non-technical users (e.g., consumers) as well as technical users (e.g., researchers) on various cultivars that have been tested and have shown promising performance under varying seasonal conditions. This work relies on integrating the existing data with an auxiliary database containing user preferences.

Objective 5: Identifying solutions

Seed production: We will complete seed cleaning, followed by additional data collection and analysis from all field trials and then begin manuscript preparation.

Turfgrass Management: An additional experiment investigating optimal nitrogen fertility programs for fine fescues during establishment concluded in 2020 and is being repeated in IN and OR in fall 2020. We will publish papers on the field experiments involving optimal seeding timing and quantifying mowing requirements, continue to coordinate field research at three collaborator sites, and collect and analyze data on three current field experiments in Indiana.

Objective 6: Quantifying benefits and informing the public

A master PowerPoint presentation and extension publications on fine fescues will be disseminated among collaborators to edit, use, and share with county and regional extension educators for use in consumer and professional education. Our team will continue publishing extension bulletins and articles related to the fine fescue project, and research trials being conducted as part of this project.

We will continue to write and post blog articles on our project website <https://lowinputturf.umn.edu/>. We anticipate adding

25 new articles over the next project period. We will tweet out links to these articles on our project Twitter account @LowInputTurf that has over 400 followers. We expect both the number of pageviews and Twitter impressions to increase over the next project period.

Participants

Actual FTE's for this Reporting Period

Role	Non-Students or faculty	Students with Staffing Roles			Computed Total by Role
		Undergraduate	Graduate	Post-Doctorate	
Scientist	2	0	0	0	2
Professional	2.9	0	2.9	0.5	6.3
Technical	0	1	0	0	1
Administrative	0	0	0	0	0
Other	0	0	0	0	0
Computed Total	4.9	1	2.9	0.5	9.3

Student Count by Classification of Instructional Programs (CIP) Code

Undergraduate	Graduate	Post-Doctorate	CIP Code
	2		11.07 Computer Science.
5		1	01.11 Plant Sciences.
	1		45.11 Sociology.
	3		45.06 Economics.

Target Audience

Target audiences include professional turfgrass managers, home lawn care professionals, homeowners, Master Gardeners, and seed producers. These groups have been reached through various means including presentations and online communication. We have also reached a significant scientific audience through peer reviewed publications and research seminars at conferences.

Products

Type	Status	Year Published	NIFA Support Acknowledged
Websites	Published	2020	YES

Citation

Anderson, N. and B. Donovan. 05/12/2020. Fine fescue seed production: An Oregon overview. https://lowinputturf.umn.edu/fine-fescue-seed-production-oregon-overview

Type	Status	Year Published	NIFA Support Acknowledged
Journal Articles	Published	2020	YES

Citation

Barnes, M, K.C. Nelson, A. Kowalewski, A. Patton, 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, 53, 126745, https://doi.org/10.1016/j.ufug.2020.126745

Accession No. 1013078 **Project No. MIN-21-G11**

Type	Status	Year Published	NIFA Support Acknowledged
Conference Papers and	Published	2019	YES

Citation

Braun, R.C., A.J. Patton, A.R. Kowalewski and E.T. Braithwaite. 2019. Evaluation of Low-Input Turfgrass Patch and Repair Ingredients. ASA-CSSA-SSSA International Meeting. Poster and 5 Minute Rapid Oral Presentation 418-4. San Antonio, TX.

Type	Status	Year Published	NIFA Support Acknowledged
Other	Published	2020	YES

Citation

Braun, R.C., A.J. Patton, E. Watkins, P. Koch, N.P. Anderson, S.A. Bonos, & L.A. Brilman. 2020. Use of fine fescues on golf courses: III. Abiotic stresses. Golf Course Management. August, p.64-69.

Type	Status	Year Published	NIFA Support Acknowledged
Other	Published	2020	YES

Citation

Braun, R.C., A.J. Patton, E. Watkins, P. Koch, N.P. Anderson, S.A. Bonos, & L.A. Brilman. 2020. Use of fine fescues on golf courses: II. Availability, establishment, and management. Golf Course Management. July, p.52-58.

Type	Status	Year Published	NIFA Support Acknowledged
Other	Published	2020	YES

Citation

Braun, R.C., A.J. Patton, E. Watkins, P. Koch, N.P. Anderson, S.A. Bonos, & L.A. Brilman. 2020. Use of fine fescues on golf courses: I. Introduction and history. Golf Course Management. May, p. 60-64.

Type	Status	Year Published	NIFA Support Acknowledged
Journal Articles	Published	2020	YES

Citation

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

Type	Status	Year Published	NIFA Support Acknowledged
Websites	Published	2020	YES

Citation

Braun, R., and A. Patton. What are the fine fescues? 1/23/2020. Low Input Turf Using Fine Fescues Project Website. https://lowinputturf.umn.edu/news/what-are-fine-fescues

Type	Status	Year Published	NIFA Support Acknowledged
Conference Papers and	Published	2019	YES

Citation

Braun, R.C., A.J. Patton, A. Kowalewski, & E.T. Braithwaite. 2019. Evaluation of low-input turfgrass patch and repair ingredients. Abstract 418-4 of the ASA, CSSA and SSSA International Meetings, San Antonio, TX. https://scisoc.confex.com/scisoc/2019am/meetingapp.cgi/Paper/119988

Accession No. 1013078 **Project No. MIN-21-G11**

Type	Status	Year Published	NIFA Support Acknowledged
Websites	Published	2020	YES

Citation

Braithwaite, E., and A. Kowalewski. 8/26/2020. Low Input Species on High End Golf Courses – Using Fine Fescues. https://lowinputturf.umn.edu/low-input-species-high-end-golf-courses

Type	Status	Year Published	NIFA Support Acknowledged
Websites	Published	2020	YES

Citation

Huang, B. Heat tolerance in fine fescue species. 07/29/2020
https://lowinputturf.umn.edu/heat-tolerance-fine-fescue-species

Type	Status	Year Published	NIFA Support Acknowledged
Websites	Published	2020	YES

Citation

Koch, P. 06/15/2020. Choosing fine fescues for summer patch and snow mold resistance
https://lowinputturf.umn.edu/choosing-fine-fescues-summer-patch-and-snow-mold-resistance

Type	Status	Year Published	NIFA Support Acknowledged
Websites	Published	2020	YES

Citation

Kowalewski, A., E. Braithwaite and B. McDonald. 3/23/2020. The Many Faces of Fine Fescue. Low Input Turf – Using Fine Fescues. https://lowinputturf.umn.edu/news/many-faces-fine-fescue

Type	Status	Year Published	NIFA Support Acknowledged
Websites	Published	2020	YES

Citation

Luo, J. and N. Zhang. 05/13/2020. What are the causal agents of summer patch disease of fine fescues?
https://lowinputturf.umn.edu/what-are-causal-agents-summer-patch-disease-fine-fescues

Type	Status	Year Published	NIFA Support Acknowledged
Other	Published	2020	YES

Citation

Luo, J. and N. Zhang. 2020. The Rice Blast Fungus and Allied Species: A Monograph of the Fungal Order Magnaporthales. https://magnaporthales.sebs.rutgers.edu/

Type	Status	Year Published	NIFA Support Acknowledged
Conference Papers and	Published	2019	YES

Citation

Mihelich, N., D. Petrella, F. Sessoms, L. M. Shannon and E. Watkins. Assessment of Tillering and Rhizomatous Growth in Strong Creeping Red Fescue. ASA-CSSA-SSSA Annual Meeting, November 10-13, 2019, San Antonio, TX.

Accession No. 1013078 **Project No. MIN-21-G11**

Type	Status	Year Published	NIFA Support Acknowledged
Conference Papers and	Published	2019	YES

Citation

Nelson, K.C. and M. R. Barnes. 2019. Transformation for Sustainable Campus Turf: A framework for institutional change analysis, examination of four U.S. case studies, CSSA, SSA, ASSA Meetings, San Antonio, TX, November 11-13, 2019; 5-min rapid talk & poster.

Type	Status	Year Published	NIFA Support Acknowledged
Other	Published	2019	YES

Citation

Petrella D. and E. Watkins. October 2019. Evaluating fine fescue shade tolerance Golf Course Management magazine.

Type	Status	Year Published	NIFA Support Acknowledged
Websites	Published	2019	YES

Citation

Petrella, D. 10/16/2019. Different shade, different results. https://turf.umn.edu/news/different-shade-different-results

Type	Status	Year Published	NIFA Support Acknowledged
Websites	Published	2020	YES

Citation

Petrella, D. 01/30/2020. Out of the shadows: Using data to breed better turfgrasses for shade. https://lowinputturf.umn.edu/news/out-shadows-using-data-breed-better-turfgrasses-shade

Type	Status	Year Published	NIFA Support Acknowledged
Conference Papers and	Published	2019	YES

Citation

Petrella, D. and E. Watkins. Improving Our Approach on How We Analyze Turfgrasses for Tolerance to Foliar Shade. ASA-CSSA-SSSA Annual Meeting, November 10-13, 2019, San Antonio, TX.

Type	Status	Year Published	NIFA Support Acknowledged
Journal Articles	Published	2019	YES

Citation

Qiu, Y., C.D. Hirsch, Y. Yang and E. Watkins. 2019. Towards Improved Molecular Identification Tools in Fine Fescue (Festuca L., Poaceae) Turfgrasses: Nuclear Genome Size, Ploidy, and Chloroplast Genome Sequencing. Frontiers in Genetics 10:1223. https://doi.org/10.3389/fgene.2019.01223

Type	Status	Year Published	NIFA Support Acknowledged
Theses/Dissertations	Published	2020	YES

Citation

Qiu, Y. 2020. Leveraging High Throughput Sequencing For Fine Fescue (Festuca Spp.) Breeding And Genetics. PhD Dissertation to the University of Minnesota.

Accession No. 1013078 **Project No. MIN-21-G11**

Type	Status	Year Published	NIFA Support Acknowledged
Journal Articles	Published	2020	YES

Citation

Qiu, Y, Hamernick, S, Ortiz, JB, Watkins, E. 2020. DNA content and ploidy estimation of Festuca ovina accessions by flow cytometry. Crop Science 60: 2757– 2767. https://doi.org/10.1002/csc2.20229

Type	Status	Year Published	NIFA Support Acknowledged
Websites	Published	2019	YES

Citation

Qiu, Y. Using flow cytometry for fine fescue taxa identification and determination. 10/09/2019. https://turf.umn.edu/news/using-flow-cytometry-fine-fescue-taxa-identification-and-determination

Type	Status	Year Published	NIFA Support Acknowledged
Websites	Published	2020	YES

Citation

Qiu, Y. March 2020. Molecular Breeding In Turfgrass Hole Notes online magazine. https://issuu.com/mgcsa/docs/2020_march_hole_notes__

Type	Status	Year Published	NIFA Support Acknowledged
Other	Published	2019	YES

Citation

Qiu, Y. 2019. Improved methods for fine fescue identification. MTGF Clippings. Vol 7 No 2, Fall/Winter 2019.

Type	Status	Year Published	NIFA Support Acknowledged
Conference Papers and	Published	2019	YES

Citation

Qiu, Y., C. Hirsch and E. Watkins. Unveiling Transcriptome Composition in Hexaploid Hard Fescue (Festuca brevipila) through Pacbio Isoform Sequencing. ASA-CSSA-SSSA Annual Meeting, November 10-13, 2019, San Antonio, TX

Type	Status	Year Published	NIFA Support Acknowledged
Conference Papers and	Published	2019	YES

Citation

Trappe, J., E. Watkins, D. Petrella and F. Sessoms. Natural Weed Suppression of Crabgrass Varies By Genotype and Field Management Practices. ASA-CSSA-SSSA Annual Meeting, November 10-13, 2019, San Antonio, TX.

Type	Status	Year Published	NIFA Support Acknowledged
Websites	Published	2020	YES

Citation

Watkins, E. Thank you to our funders! 05/07/2020 https://turf.umn.edu/news/thank-you-our-funders

Accession No. 1013078 **Project No. MIN-21-G11**

Type	Status	Year Published	NIFA Support Acknowledged
Websites	Published	2020	YES

Citation

Watkins, E. and Y. Qiu. Fine fescue forensics. 05/29/2020 https://lowinputturf.umn.edu/fine-fescue-forensics

Type	Status	Year Published	NIFA Support Acknowledged
Conference Papers and	Published	2020	YES

Citation

Wu, D.S., A.L. Grimshaw, H.Y. Qu, P.L. Vines, E. N. Weibel, W.A. Meyer and S.A. Bonos. Inheritance of summer patch disease resistance in hard fescue. p. 53. In Proceedings of the 29th Rutgers Turfgrass Symposium. January 10, 2020.

Type	Status	Year Published	NIFA Support Acknowledged
Websites	Published	2020	YES

Citation

Xie, Y., M. Farhadloo, S. Shekhar, and L. Kne. 06/08/2020. New tools simplify searching for suitable turfgrass using the NTEP data.
https://lowinputturf.umn.edu/new-tools-simplify-searching-suitable-turfgrass-using-ntep-data

Type	Status	Year Published	NIFA Support Acknowledged
Websites	Published	2020	YES

Citation

Yue, C., Y. Lai, and E. Watkins. 02/19/2020. Are consumers willing to adopt low-input turfgrasses for their home lawns? https://lowinputturf.umn.edu/news/are-consumers-willing-adopt-low-input-turfgrasses-their-home-lawns

Type	Status	Year Published	NIFA Support Acknowledged
Conference Papers and	Published	2020	YES

Citation

Yue, C., Y. Lai and E. Watkins. 2020. Are Consumers Willing to Adopt Low-Input Turfgrasses for Their Home Lawns? Poster Presentation at American Society of Horticulture Science 2020 Annual Conference.

Other Products

Product Type

Audio or Video

Description

Braithwaite, E. 2020. Specialty Crops Research Initiative - Low-Input Turfgrass Using Fine Fescues. Oregon State University Virtual Field Days. https://www.youtube.com/watch?v=-ngwFc2ifjg

Product Type

Audio or Video

Description

Braithwaite, E. 2020. Specialty Crops Research Initiative - Low-Input Turfgrass Using Fine Fescues. Oregon State University Virtual Field Days. pg 8.

Product Type

Audio or Video

Description

Braun, Ross. What are fine fescues and how can you use them? Illinois Landscape Contractors Association Turf Education Day, 17-27 August 2020, Online.

Product Type

Audio or Video

Description

Braun, Ross. Steps for successful fine fescue establishment. Golf Course Superintendents Association of America (GCSAA) Webinar Series, 11 August 2020, Online.

Product Type

Audio or Video

Description

Braun, Ross. Fine fescue establishment and management: Research updates. Purdue Turf and Landscape Field Day, 13-21 July 2020, Online.

Product Type

Other

Description

Braun, Ross. Steps to successful fine fescue establishment. Indiana Green Expo, 13 February 2020, Indianapolis, IN.

Product Type

Other

Description

Braun, Ross. The art of knowing your turfgrass seed label, and identification, calculation, and establishment tips. Purdue Turf & Landscape Seminar, 20 November 2020, West Lafayette, IN.

Product Type

Audio or Video

Description

Kne, L. and E. Watkins. July 2020. National Turfgrass Evaluation Program Database and App Update. Zoom webinar. https://umn.zoom.us/rec/play/6MB4JbqtqG43ToaQsgSDBvArW9S7fays2iQW-_dfzUfkUSMENAeiNLFAY7QxtM6A89G3cGlnkxAhfm1X?continueMode=true&_x_zm_rtaid=ieh8my8zQMidutOmiW5FBA.1595256307727.326f945ecd845d813ac0929b1c68550e&_x_zm_rhtaid=420

Product Type

Other

Description

Kowalewski, A. 2020. OSU Turf Research Update. OSU Winter Turf Field Day. Oregon State University, Lewis-Brown Farm. Corvallis, OR. February 27, 2020. Attendees 75.

Product Type

Audio or Video

Description

Kowalewski, A. 2020. Oregon State University Turf Program Overview (Turf Hunter). Oregon State University Virtual Field Days. Retrieved Sept 1, 2020. https://www.youtube.com/watch?v=gPvO3rdonOU

Accession No. 1013078 **Project No. MIN-21-G11**

Product Type

Audio or Video

Description

Kowalewski, A. 2020. National Turfgrass Evaluation Program Trials (Turf World). Oregon State University Virtual Field Day Proceedings. pg 4.

Product Type

Other

Description

Watkins, E. UMN Turfgrass Science Update. Mega Seminar 2019. December 5, 2019. Hazeltine National Golf Club, Chaska, MN.

Product Type

Other

Description

Watkins, E. University of Minnesota Turf Research Update. January 15, 2020
Northern Green Conference. Minneapolis Convention Center.

Changes/Problems