

FY21 Performance Progress Report

Due date: July 26, 2022

Cover Page

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Fiscal Year:	2021
USDA-ARS Agreement ID:	59-0206-0-137
USDA-ARS Agreement Title:	Development of FHB Resistant Wheat Genotypes Adapted to the Gulf Coast and use of DHs to Expedite Variety Development
FY20 USDA-ARS Award Amount:	\$98,776
Recipient Organization:	Louisiana State University Agricultural Center School of Plant, Environmental, & Soils Sciences 104 MB Sturgis Hall, Baton Rouge, LA 70803-2110
DUNS Number:	783201833
EIN:	72-6000848
Recipient Identifying Number or Account Number, if any:	AWD-003029
Project/Grant Period:	6/1/21 - 5/31/23
Reporting Period End Date:	5/31/2022

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
VDHR-SWW	Development of FHB Resistant Wheat Varieties for the Gulf Coast	\$82,364
VDHR-SWW	Double Haploids to Expedite Development of FHB Resistant Soft Winter Wheat Varieties	\$16,412
FY21 Total ARS Award Amount		\$98,776

I am submitting this report as an: Annual Report Final Report

I certify to the best of my knowledge and belief that this report is correct and complete for performance of activities for the purposes set forth in the award documents.



Principal Investigator Signature

July 26, 2022

Date Report Submitted

† BAR-CP – Barley Coordinated Project
 DUR-CP – Durum Coordinated Project
 EC-HQ – Executive Committee-Headquarters
 FST-R – Food Safety & Toxicology (Research)
 FST-S – Food Safety & Toxicology (Service)
 GDER – Gene Discovery & Engineering Resistance
 HWW-CP – Hard Winter Wheat Coordinated Project

MGMT – FHB Management
 MGMT-IM – FHB Management – Integrated Management Coordinated Project
 PBG – Pathogen Biology & Genetics
 TSCI – Transformational Science
 VDHR – Variety Development & Uniform Nurseries
 NWW – Northern Soft Winter Wheat Region
 SPR – Spring Wheat Region
 SWW – Southern Soft Red Winter Wheat Region

Project 1: Development of FHB Resistant Wheat Varieties for the Gulf Coast

1. What are the major goals and objectives of the research project?

Fusarium Head Blight (FHB) is an important disease of wheat along the Gulf Coasts and has significantly contributed to reduced acreage. Losses to FHB occur because of heavy rainfall during anthesis, more corn acres, and a lack of adapted varieties with FHB resistance. Our goal is to accelerate development of FHB resistant wheat varieties adapted to this unique environment and to provide resources to help growers deal effectively with FHB. This proposal addresses all three VDHR research priorities and has the overall goal of encouraging growers to plant high-yielding, FHB resistant varieties that lead to reduced DON content in the grain trade. Objective 1 is to screen available varieties and breeding lines to document the number of released varieties from public and private programs with improved FHB resistance. Objective 2 is to increase efficiency of coordinated research activities to develop and release FHB resistant varieties. Objective 3 is to implement modern breeding technologies to enhance rate of gain in development of FHB resistant varieties.

2. What was accomplished under these goals or objectives?

GOAL 1: Document FHB resistance in varieties and breeding lines.

a) What were the major activities?

Misted inoculated nurseries totaling 4,000 rows were grown in replicated, paired headrows at Alexandria, Baton Rouge and Winnsboro. The statewide variety trial was screened at three locations and regional nursery yield trials were screened at two locations. LSU preliminary yield trial entries and segregating populations were screened at one location. All rows were rated for FHB severity (0-9), hand harvested, and threshed with low wind speed. FDK was determined on carefully cleaned samples, which were then ground to produce 30 grams of flour per sample. Approximately 2,000 samples were shipped to the USDA DON under direction of Yanhong Dong in St. Paul in early July.

b) What were the significant results?

FDK and DON ranged from 2% to 63% and 2.2 ppm to 35.7 ppm, respectively, in the state variety trial averaged over two north Louisiana misted nurseries. All three misted nurseries were effective in identifying resistance to FHB, FDK and DON accumulation. The annual Wheat Research Summary (variety trials data) published in August includes FHB severity, FDK incidence and DON concentration on all variety trial entries. FHB Index value is calculated as a weighted function of FHB, FDK and DON. The data is included in tables for each location along with a summary table of FHB reaction type and FHB index across environments. The FHB index was used to classify varieties and develop the list of resistant and moderately resistant varieties published on the USWBSI web site. FHB data from two nurseries was included in USDA regional and SunGrains nursery reports to assist collaborating breeders in developing FHB resistant varieties.

c) List key outcomes or other achievements.

FHB, FDK and DON data for state variety trials from three misted nurseries was presented in a variety of ways to growers, consultants and extension agents to encourage them to only plant varieties with an acceptable level of FH resistance.

GOAL 2: Increase efficiency of coordinated research activities to develop and release FH resistant varieties

a) What were the major activities?

SunGrains and regional replicated yield trials and LSU advanced breeding lines were grown at two Louisiana locations in yield plots and misted nursery plots. Seed of DHs selected as headrows by each VDHR-SWW participating program were shared with all cooperating universities for evaluation, selection, and advancement. The 590 new crosses made in spring 2022 combined parents containing desired QTL for FHB, high yield, and other essential traits. Head selections were made from segregating plots grown at two locations and in a misted nursery.

b) What were the significant results?

The SunGrains nurseries decrease the breeding cycle by providing extensive phenotypic and genomic data, and imputed QTL presence used to make informed release decisions and to rapidly recycle genotypes back as parents. Most crosses made in 2022 were made between parents with characterized FHB QTL and with FHB resistance as a major priority. 5102 yield plots were evaluated over three locations. The LSU Genomic Selection Prelim grown in two locations included 570 advanced breeding lines that were also screened in a misted nursery and subjected to the SunGrains genomic selection protocol and QTL imputation. Advancement was based on field phenotype, genomic estimated breeding value, and imputed presence of important FHB QTK. The SunGrains multi-state genomic selection program evaluated about 4,000 lines and entries in five regional nurseries.

FHB, FDK, and DON ratings from all regional nurseries were distributed to breeders and published in nursery reports in July to aid breeders in development and release of FHB resistant varieties. Six crosses containing a desirable pyramid of effective FHB QTL in a high-yielding background have been submitted to develop DHs. The three entries in the southern regional scab nursery with the lowest DON concentration were LSU breeding lines.

c) List key outcomes or other achievements.

The regional genomic selection program, collaborative yield and screening nurseries, and shared double haploids provide the data and germplasm necessary to increase productivity and efficiency of the regional breeding programs.

GOAL 3: implement modern breeding technologies to enhance rate of gain in development of FHB resistant varieties

a) What were the major activities?

A summer SunGrains F1 nursery was grown in Aberdeen, ID in 2021 and Denver, CO in 2022 to save a year in the breeding cycle. Seed of selected DHs from each VDHR-SWW program were shared with all other cooperators for selection and variety development to obtain maximum benefit from the expenditure of resources. Phenotypic data, marker assisted selection, imputed QTL presence, and POPVAR were used to select

parents that combine multiple QTL and have a good probability of producing elite populations and varieties. Genomic selection was used in advancement decisions and to select parents.

b) What were the significant results?

The genomic selection (GS) protocol included imputation of major QTL for FHB resistance and calculation of GEBVs for yield, FHB resistance and other important traits. The ability to accurately determine presence of major FHB QTL from GBS markers significantly increases the utility of genomic selection and reduces the resource limitations constraining running markers on large numbers of breeding lines. GS data was heavily weighed in advancement decisions of 44 lines from the genomic selection prelim that will be in replicated yield trials in 2023. Shared DHs were evaluated in headrows and yield plots.

c) List key outcomes or other achievements.

The use of off-season nurseries and DHs have substantially decreased the length of the variety development cycle. For example, AGS 3022 (LA16020) was released in six years through the DH channel of the breeding program. Sharing of DHs improves the efficiency of all VDHR-SWW programs and maximizes return from investment.

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

Graduate students participated in all FHB project activities. They inoculated plots, rated field symptoms, scored FDK and processed samples for DON determination. A post-doc ran FHB Kasp markers on the genomic selection prelim.

4. How have the results been disseminated to communities of interest?

A Wheat Field Day was held in person and also presented virtually in April 2022 to highlight FHB research. The LSU wheat breeding program maintains two wheat websites for data and state trials and one for the SunGrains breeding collaborative group. Completed variety trial reports are posted on the LSU AgCenter variety trial website. Data on FHB severity, FDK, and DON for the regional nurseries are published in the official reports. A Fusarium article targeted to growers, with data on variety reaction and fungicide efficacy, was published (<https://lsuagcenter.com/articles/page1628783805876>) in the August 2021 issue of Louisiana Crops and on the USWBSI website.

Project 2: Double Haploids to Expedite Development of FHB Resistant Soft Winter Wheat Varieties

1. What are the major goals and objectives of the research project?

Each year the southern VDHR breeding programs make multiple single and three way crosses to pyramid validated FHB QTL and other traits of interest. The goal of this project is to collectively develop and share DHs that lead to release of FHB resistant varieties more quickly than possible using traditional breeding protocol. The objective of this project is to increase the rate of genetic gain by decreasing the cycle time using double haploids. This will be accomplished by creating DHs from crosses that combine multiple effective FHB QTL in high yielding adapted backgrounds and sharing selection from those among all collaborators.

2. What was accomplished under these goals or objectives?

a) What were the major activities?

Double Haploids were created from three crosses in 2021 that have Fhb1 parents on one or both sides of the pedigree, include four recently released and highly productive Fhb resistant varieties, and combine multiple other Fhb QTL with QTL for Hessian Fly resistance, soil borne mosaic virus resistance, stripe rust resistance, leaf rust resistance and other genes important to the success of varieties in the southeastern US. These DHs will be planted as headrows at two locations in fall 2022. Six crosses were submitted from 2022 crosses (Table below).

Selected DHs from each VDHR-SWW institution were shared with all other cooperators for selection and variety development to obtain maximum benefit from the expenditure of resources. DHs in the LSU program were evaluated at every stage of testing from headrows to regional yield trials.

Crosses submitted for DH development in 2022.

CROSS		Pedigree / Genes
LA22109	Ped	GA15VDH---07ADH33F/LA1602LDH-22
	Genes	RHT2, FHB1, F1BJT, LR18, YR17, YR4BL, SBM1, //RHT2, Fhb1BJT, Fhb4AN, YR17, LR9, 1RS.1AL, SBM1
LA22121	Ped	GA161240LDH-113 -20LE6/LA1602LDH-22
	Genes	,Rht-D1b, Sbm1, Fhb1, FHB1AN, Yr17., Sr24/Lr24?, Sr_6D, Yr_4BL,Pm1a, //RHT2, Fhb1JT, Fhb4AN, YR17, LR9, 1RS.1AL, SBM1
LA22274	Ped	LA1602LDH-22/LA15005GBB-4-1-3
	Genes	RHT2, Fhb1BJT, Fhb4AN, YR17, LR9, 1RS.1AL, SBM1//FHB1, FHB1BJT, H13, SR36, SBM1,
LA22438	Ped	LANC11558-33/AR15V25-19-2174N
	Genes	RHT2, F1BJT, F1AN, YR4BL, H13H, SBM1//,Rht-D1b,Sbm1,Fhb1_het,FHB5AN_het,FHB1BJT,Yr17.,Lr18,Yr_4BL_het,H13_het
LA22440	Ped	LANC11558-33/GA151313-LDH-192 -20E48
	Genes	RHT2, F1BJT, F1AN, YR4BL, H13H, SBM1//,Rht-D1b, Sbm1, FHB1BJT, FHB1AN, Yr17.Lr9?, Lr18, H13
LA22491	Ped	NC14704-37/GA161240LDH-113 -20LE6
	Genes	??? //,Rht-D1b, Sbm1, Fhb1, FHB1AN, Yr17., Sr24/Lr24?, Sr_6D, Yr_4BL,Pm1a,

b) What were the significant results?

The LSU genomic selection preliminary yield trial included 149 DHs from 2018 and 2019 crosses and selected from headrows the previous year. These DHs included shared lines that originated at Arkansas, North Carolina State, Georgia, LSU AgCenter, and Virginia Tech. AGS 3022 (LA16020-LDH22) is a DH derived variety released just five years after the cross was made. It was the second-highest yielding variety across south Louisiana in 2022 and had below average FDK and DON. AGS 3022 had 7.4 ppm DON in the Winnsboro misted nursery compared to 35.7 ppm for the FHB susceptible variety, AGS 2055.

c) List key outcomes or other achievements.

There were 45 LSU DHs in advanced yield trials in 2022 derived from crosses made between 2015 and 2018. In the first year SunPre regional yield for 2022 30% of the entries came from DHs and the DHs entered the trial almost four years sooner (13.8 years vs 17.5 years) than non-DHs. This will result in quicker release of FHB resistant varieties and greater genetic gain due to shortening of the cycle time. AGS 3022 is a productive, FHB resistant variety well adapted to the Gulf Coast region.

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

Graduate students participated in all FHB project activities including making crosses to pyramid FHB genes. They inoculated plots, rated field symptoms, scored FDK and processed samples for DON determination. A post-doc ran FHB Kasp markers on the genomic selection prelim that included a large number of DH lines.

3. How have the results been disseminated to communities of interest?

A Wheat Field Day was held in person and also presented virtually in April to highlight FHB research. The LSU wheat breeding program maintains two wheat websites for data and state trials and one for the SunGrains breeding collaborative group. Completed variety trial reports are posted on the LSU AgCenter variety trial website. Data on FHB severity, FDK, and DON for the regional nurseries are published in the official reports. A Fusarium article targeted to growers, with data on variety reaction and fungicide efficacy, was published (<https://lsuagcenter.com/articles/page1628783805876>) in the August 2021 issue of Louisiana Crops and on the USWBSI website.

Publications, Conference Papers, and Presentations

Please include a listing of all your publications/presentations about your FHB work that were a result of funding from your FY21 grant award. Only citations for publications published (submitted or accepted) or presentations presented during the **award period** should be included.

Did you publish/submit or present anything during this award period?

- Yes, I've included the citation reference in listing(s) below.
 No, I have nothing to report.

Journal publications as a result of FY21 grant award

List peer-reviewed articles or papers appearing in scientific, technical, or professional journals. Include any peer-reviewed publication in the periodically published proceedings of a scientific society, a conference, or the like.

Identify for each publication: Author(s); title; journal; volume: year; page numbers; status of publication (published [include DOI#]; accepted, awaiting publication; submitted, under review; other); acknowledgement of federal support (yes/no).

Books or other non-periodical, one-time publications as a result of FY21 grant award

Report any book, monograph, dissertation, abstract, or the like published as or in a separate publication, rather than a periodical or series. Include any significant publication in the proceedings of a one-time conference or in the report of a one-time study, commission, or the like.

Identify for each one-time publication: Author(s); title; editor; title of collection, if applicable; bibliographic information; year; type of publication (book, thesis or dissertation, other); status of publication (published; accepted, awaiting publication; submitted, under review; other); acknowledgement of federal support (yes/no).

Stephen Harrison, Arceneaux, Kelly J., Price, III, Paul P, Padgett, Guy B. Development of Wheat and Oat Varieties with Improved Yield and Disease Resistance. June 2021. Louisiana Agriculture Magazine. Acknowledgement of federal support - no.

Other publications, conference papers and presentations as a result of FY21 grant award

Identify any other publications, conference papers and/or presentations not reported above. Specify the status of the publication.