**U.S. Wheat and Barley Scab Initiative**
**FY01 Final Performance Report (approx. May 01 – April 02)**
**July 15, 2002**

## Cover Page

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| **Year:** | **FY2001 (approx. May 01 – April 02)** |
| **Grant Number:** | **59-0790-9-038** |
| **Grant Title:** | **Fusarium Head Blight Research** |
| **FY01 ARS Award Amount:** | **$ 83,718** |

## Project

| Program Area | Project Title | Requested Amount |
|---|---|---|
| Biotech | Heredity, Molecular Markers and Selective Breeding for Wheat Scab Resistance | $ 45,000 |
| Variety/Uniform | Assessment and Selection for Scab Resistance in Soft Red Winter Wheat | $ 45,000 |
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| | **Total Amount Requested** | **$ 90,000** |

Carl A. Griffey 6/30/02
Principal Investigator Date

(Form – FPR01)

**Project 1: Heredity, Molecular Markers and Selective Breeding for Wheat Scab Resistance**

1. What major problem or issue is being resolved and how are you resolving it?

Scab epidemics resulted in significant losses in wheat yield and quality in 1998 and were prevalent in Virginia in 2002, particularly in fields planted no-till following maize. Breeding for scab resistance by conventional selection is feasible, but tedious and lacks in efficiency and effectiveness. DNA markers associated with scab resistance will accelerate the introgression and pyramiding of resistance genes into adapted lines or varieties. Recent research has identified a QTL associated with scab resistance in the resistance source Sumai3 on chromosome 3BS (Anderson et al., 2001). This QTL was also identified in resistance source W14 (Chen et al., 2001) and in SRW wheat varieties such as Roane and McCormick, a new release from our program. Therefore, evaluation of effectiveness of 3BS QTL-markers in different genetic backgrounds is imperative for the implementation of molecular marker assisted selection in breeding programs. Marker-QTLs other than 3BS need to be identified in different resistance sources and different mapping populations. A major objective of this project is to saturate the 3BS marker-QTL region and identify additional marker-QTLs in resistance source W14 using both $F_2$ and doubled haploid populations in the cross W14 x Pion2684.

2. What were the most significant accomplishments?

Major emphasis has been placed on the evaluation of type II resistance and verification of identified DNA markers associated with scab resistance in wheat line W14 using doubled haploid (DH) populations this year. Nearly 3,000 plants from 212 wheat DH lines in two mapping populations were evaluated for type II resistance in greenhouse tests during winter 2001 and spring 2002. DNA samples from 122 DH lines of one mapping population were obtained and have been used in mapping studies to verify DNA markers associated with scab resistance in wheat line W14. Two complementary genes with major effects identified in $F_2$ mapping populations last year were confirmed in an $F_1$-derived doubled haploid population for the cross of W14 x Pion2684. A total of 45 loci have been mapped to five chromosomal regions in the $F_2$ population of W14 x Pion2684. A major gene, in addition to the one on chromosome 3BS, has been identified on chromosome 2BS. Fifteen DNA markers on these chromosome regions were significantly ($p < 0.05$) associated with scab resistance, and explained 21%, 36% and 31% of the total variation of disease severity in 82 $F_2$ individuals, 82 corresponding $F_{2:3}$ families, and 122 DH lines, respectively. Analysis of DNA markers in doubled haploid populations this year confirmed that genes on chromosome 3BS contributed most significantly to scab resistance, while those on chromosome 2BS had less effect.

Nine DNA markers associated with scab resistance were used to identify putative genes in 27 advanced wheat lines. VA01W476, an advanced line developed via doubled haploid system, was shown to possess the same resistance genes as the Chinese wheat line W14 and has superior agronomic traits. Advanced line VA00W-562, being developed for potential release, possesses resistance genes on chromosomes 3BS and 5AL. McCormick and VA98W-593, two newly released SRW wheat varieties from the Virginia Tech Small Grains Program, also were found to possess scab resistance genes based on marker and field analyses.

**Project 2: Assessment and Selection for Scab Resistance in Soft Red Winter Wheat**

1. What major problem or issue is being resolved and how are you resolving it?

Most sources of type II scab resistance are of spring habit, low yielding, and susceptible to diseases such as powdery mildew, leaf rust, and glume blotch in Virginia and the mid-Atlantic region. A major objective of our breeding program is to transfer type II resistance from unadapted sources into soft red winter (SRW) wheat backgrounds to develop scab-resistant germplasm and varieties with high yield potential and resistance to other prevalent diseases. Strategies being used to accelerate development of scab-resistant wheat genotypes include: 1) identification and selection of scab-resistant SRW wheat lines derived from crosses between unadapted lines with resistance and adapted lines; 2) transfer of type II resistance into adapted varieties via backcrossing, doubled haploid techniques, and molecular marker-assisted selection; and 3) initiation of pyramiding of resistance genes into SRW wheat backgrounds.

2. What were the most significant accomplishments?

Thirty-six scab-resistant sources have been used as parents in the breeding program and over 500 populations have been developed. In 2001, sixty-eight out of 234 (29%) populations were advanced on the basis of scab incidence and severity. In headrow tests, 2960 $F_5$ lines, derived from populations previously screened for scab resistance, were evaluated for agronomic traits and resistance to diseases other than scab at Warsaw, VA. From these headrows, 47 top-cross derived lines and 3 DH lines were selected for further testing in our scab nursery at Blacksburg, VA and in Observation Yield Tests at two locations. Twenty-three advanced $F_6$ lines and 13 doubled haploid (DH) lines were evaluated simultaneously for scab resistance in a mist-irrigated nursery at Blacksburg, VA and for other agronomic traits in a non-inoculated observation yield test at Warsaw, VA. Among 65 lines from the Virginia Tech Small Grains Program being tested in field trials this year, 13 advanced lines with desirable agronomic traits also possess good scab resistance based on greenhouse tests and DNA molecular marker analysis. These lines include VA00W-562 in the State Test, six lines (VA01W-456, 460, 461, 462, 465, and 476) in the Preliminary Test and six lines in the Observation Test. McCormick and VA98W-593, two newly released SRW wheat varieties, also possess a significant level of scab resistance. Progress in transferring type II resistance into SRW wheat genotypes has been accelerated via use of the wheat by maize doubled haploid (DH) technique. To date, 165 DH lines have been derived from 3-way crosses, comprised of diverse scab-resistant parents. Among these lines, 114 were simultaneously evaluated in the field at Kinston, NC for agronomic traits and assessed for type II scab resistance in the greenhouse. Approximately half of the fifty-four lines selected at Kinston possess type II resistance to scab. Two cycles of backcrossing were conducted in 2001 to accelerate the transfer of scab resistance from five sources into seven adapted SRW wheat backgrounds. Progeny from 54 crosses derived from 1 $BC_4F_1$ and 17 $BC_3F_1$ populations are being assessed for scab resistance this summer before being planted in headrow tests at Warsaw in fall 2002. Selected near-isogenic lines will be released as public germplasm and will be used in crosses to facilitate pyramiding of different types of resistance. Nine DNA markers associated with scab resistance on three chromosome regions have been developed and used in selection of backcross progeny and genotyping of advanced lines.

Include below a list of the publications, presentations, peer-reviewed articles, and non-peer reviewed articles written about your work that resulted from all of the projects included in the grant. Please reference each item using an accepted journal format. If you need more space, continue the list on the next page.

Chappell M., C. Griffey, J. Chen, T. Pridgen, D. Nabati, W. Zhao, and M. Vaughn. 2001. Assessment and reaction of *Triticum aestivum* genotypes to *Fusarium graminearum* and its effects on traits related to grain yield and quality. Poster presentation at 2001 ASA meetings, Charlotte, NC.

Chen J., C.A. Griffey and M.A. Saghai Maroof. 2001. Heredity and Molecular Markers for Wheat Scab Resistance. p.10-13. In: Proceedings of 2001 National Fusarium Head Blight Forum. Dec.8-10, Erlanger, KY, USA.

Chen, J., C.A. Griffey, M.A. Saghai Maroof, W. Zhao, R.M. Biyashev, and W. Xie. 2001. Resistance to *Fusarium* head bight and associated molecular markers. Oral presentation at 2001 ASA meetings. Charlotte, NC.

Chen J., C.A. Griffey, M.A. Saghai Maroof, W. Zhao, J. Wilson and D. Nabati. 2002. Identification and characterization of marker-QTLs for scab resistance in common wheat. Annual Wheat Newsletter 48: (in press).

Griffey, C.A., J. Chen, M. Chappell, T. Pridgen, W. Zhao, D. Nabati, W. Rohrer, and E.L. Stromberg. 2001. Breeding for scab resistance in soft red winter wheat. Annual Wheat Newsletter 47:300-301.

Griffey, C.A., J. Wilson, D. Nabati, J. Chen, T. Pridgen, and W. Rohrer. 2002. Breeding for scab resistance in soft red winter wheat. Annual Wheat Newsletter 48: (in press).

Griffey, C.A., J. Wilson, D. Nabati, J. Chen, T. Pridgen, W. Rohrer, and B. Robinson. 2001. Selective breeding for *Fusarium* head blight resistance in soft red winter wheat. p.235-236. In: Proceedings of 2001 National Fusarium Head Blight Forum. Dec.8-10, Erlanger, KY, USA.