

Breeding Spring Wheat for Disease Resistance

(Approved July 2012)

Principal Investigator: Karl Glover, Spring Wheat Breeding and Genetics, Plant Science Dept., SDSU, Brookings

Fusarium head blight (FHB or scab) and Bacterial leaf streak (BLS) are both serious diseases of wheat. Scab epidemics on spring wheat in 1993 caused losses of approximately \$80 million within South Dakota alone. In an attempt to reduce the threat of future scab epidemics, a major focal point within the South Dakota State University Spring Wheat Breeding and Genetics program is the development of scab resistant cultivars.

Though it has not gained the same level of notoriety as FHB, BLS has recently emerged as a disease capable of similar devastation. As an example, in 2010 the Spring Wheat Breeding and Genetics program was in the process of preparing to release SD4011. In mid-June the 160-acre increase field looked impressive and all signs pointed in the direction of a successful release. By early- to mid-July, however, it was already decided that the line should not be released as a cultivar. BLS caused very premature leaf senescence which significantly decreased yield and test weight. Unfortunately, some of our other previously released cultivars are also quite susceptible to BLS, though not to the extent of SD4011, which may hinder their potential popularity. Both 'Advance' and 'Forefront' seem moderately resistant.

During the 2000 crop year, over 50 percent of the acres within our three state (SD, ND, MN) spring wheat production region were sown to cultivars developed by this program. The intent of the entire breeding program is to continue releasing cultivars that have high levels of grower acceptance throughout the region. To be successful in accomplishing this, and among other requirements, a continual increase in the level of disease resistance associated with future cultivar releases is essential. In this proposal time and resource expenditures focused on disease resistance screening will expand significantly.

Background:

The Spring Wheat Breeding and Genetics program commenced an effort to elevate scab resistance levels in 1995. Joint funding from the South Dakota Wheat Commission, Minnesota Wheat Research and Promotion Council, and the South Dakota Agricultural Experiment Station was used to initiate the program. A mist-irrigated greenhouse and field-screening nursery were established and disease evaluation methods were developed. Breeding materials are currently evaluated for scab resistance using three generations per year: two generations in the greenhouse and one generation in the field.

Because BLS has more recently become problematic, efforts to combat the disease are still in their infancy compared to the FHB work. The disease was first noted as being more than just a sporadic nuisance in South Dakota by the extension Plant Pathologist during 2008. It became more prominent in 2009 and 2010. Symptoms were also apparent in 2011. By 2010 a joint effort by the South Dakota Wheat Commission and Minnesota Wheat Research and Promotion Council was initiated to study several facets of the disease.

Germplasm Evaluation

Fusarium Head Blight

A great deal of time and energy within the program is devoted to screening and selecting for resistance to FHB. In the end, one of the most important outcomes from this effort is the identification of parents for use in crossing schemes. This is accomplished, in large part, through

the accumulation of resistance data from several years of observation on experimental populations and breeding lines. Eventually, several of the lines perceived to be the best are placed within the Uniform Regional Scab Nursery -- a cooperative regional effort to identify, share, and utilize sources of scab resistance.

In 2011, this program selected five experimental breeding lines (SD4313, SD4331, SD4337, SD4338, and SD4343) for evaluation at four regional test locations. Results are presented in Table 1. Interestingly, four submissions from this program fell within the top eight of the 24 test entries when average ranks of Index, FDK, and DON values were considered. Of particular interest is the line SD4343, which ranked #1 for all variables, except DON concentration (though the line with the lowest DON concentration was only tested at one site). Although this level of performance may be difficult to replicate in the future, it is clear that progress is being made from this resource investment. Each of these experimental lines has been shared with other public wheat breeding programs for use as parental germplasm. Some has also been used extensively as parents within this program.

Bacterial Leaf Streak

Not as much time and labor within the program has been devoted to screening and selection for resistance to BLS as is the case with FHB. Our immediate goal will, however, be to initiate BLS screening nurseries within the program. As with FHB resistance screening, one of the most important outcomes will be the identification of parents for use in crossing. This will be initiated on a substantial scale and carried out by Mr. Yuba Kandel in 2012 as a portion of his other BLS research work. We anticipate that by this time in 2013, we will have a good level of knowledge on which early-generation populations possess some level of resistance as well as which more-advanced experimental lines are most promising in terms of BLS resistance. This will be in addition to other work being carried out by Yuba to estimate BLS impacts on yield and quality and his main goal, the identification of molecular markers linked to BLS resistance quantitative trait loci (QTLs).

Disease Diagnostics

Questionable plant samples from yield trial plots grown throughout the state will be submitted to Ms. Connie Tande, director of the Plant Disease Diagnostic Clinic, for positive identification. Additionally, approximately 100 samples will be provided to the clinic to establish a pathogen collection that will be useful for future germplasm screening procedures. Samples from this collection will be made available for use by other breeding programs and plant pathologists.

TABLE 1. 2011 UNIFORM REGIONAL SCAB NURSERY FOR SPRING WHEAT PARENTS.
MEANS AND RANKS OVER LOCATIONS.

ENTRY	DISEASE INDEX		FDK		DON	
	%	Rank	%	RANK	ppm	RANK
No. of Locations	4	4	4	4	4	4
SD4343	22.1	1	5.9	1	2.2	2
ND2710	27.9	2	9.4	10	5.0	19
SD4313	32.4	3	13.2	18	3.0	4
SD4338	32.6	4	8.4	6	3.5	6
10EXP13-44	34.5	5	12.4	14	3.1	5
10EXP13-24	36.3	6	7.2	3	3.7	7
BW 928	37.9	7	9.0	7	4.6	15
SD4331	38.2	8	18.7	22	5.5	21
MN09092	38.6	9	7.6	4	3.8	8
SD4337	39.3	10	9.3	8	3.8	8
10 EXPSW13-28	39.5	11	15.4	20	2.9	3
10EXP13-87	40.0	12	10.2	11	4.5	14
X00009-16	40.8	13	10.4	12	4.7	17
10EXP13-16	41.0	14	12.7	15	5.0	19
MN09023	43.1	15	6.1	2	4.1	11
2375	47.3	16	14.4	19	4.9	18
Bacup	47.9	17	12.8	16	4.6	15
MN07167W-2-1	49.5	18	7.7	5	7.5	23
MN07057-6-4	49.5	18	9.3	8	3.8	8
10 EXPSW13-19	57.2	20	12.9	17	4.4	13
10 EXPSW13-9	58.5	21	11.3	13	8.6	24
BW429*	69.0	22	.	.	0.7	1
Wheaton	75.7	23	56.1	23	6.7	22
Oslo	77.5	24	18.3	21	4.3	12
Mean	44.8		13.0		4.4	

* = evaluated at a single location.