

Developing high yielding winter wheat varieties with excellent end-use quality for South Dakota

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Reporting period: July 1, 2014 – June 30, 2015.

Total Project Period: Continuous

Report type: Annual progress report.

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Research Summary:

The objective of the winter wheat breeding program at South Dakota State University is to develop high-yielding winter wheat varieties with excellent disease resistance and suitable end-use quality for the domestic and export markets. In 2013, a new hard red winter wheat variety 'Redfield' was released. It has picked up significant area in South Dakota in 2015. It is very similar in appearance to Wesley, with similar lodging resistance, higher yield potential, and higher test weight. Several advanced breeding lines with high yield potential and excellent disease resistance were also evaluated across South Dakota and in the Northern Great Plains. The most promising of these lines are being increased for potential release. Inoculated field nursery was implemented to evaluate resistance to bacterial leaf streak among advanced breeding lines. This is expected to lead to the development and release of new variety with improved tolerance to bacterial leaf streak. As the new winter wheat breeder, Dr. Sehgal took charge of the project from October 2014.

Introduction:

With 1.42 million acres planted and a production of 43 million bushels in 2015, winter wheat continues to be a crop of economic importance for South Dakota. To increase the profitability of South Dakota wheat producers, and to maintain South Dakota wheat production to its current level, it is essential to develop and release stable high-yielding varieties adapted to South Dakota's environment, resistant to prevalent diseases and pests, and with excellent end-use quality. The objective of the breeding program at South Dakota State University (SDSU) is to rapidly develop winter wheat varieties adapted to South Dakota that exhibit:

- high and stable yield,
- resistance to the prevalent bacterial, fungal, and viral disease pathogens,
- and excellent quality for bread, wheat flour tortillas, and other emerging end-use markets.

Description of Accomplishments:

During this reporting period, 790 unique wheat hybridizations (F_1 's) were created, an almost two fold increase from that in 2013. Nearly 290 F_1 populations developed in Fall 2014 were selfed and resulted in the same number of segregating F_2 populations for 2016 and another 500 F_1 populations were sent to Arizona winter nursery for developing 500 segregating F_2 populations for 2017. The breeding operation is cyclic, nearly 241 F_2 populations from crosses made in 2013 and 2014 were evaluated at single location in Brookings, SD. In this period 180 F_3 populations were evaluated at three locations; Brookings, Dakota Lakes and Castroville (TX). Nearly 50-100 individual ears were selected from each population. More than 15,000 headrows (F_4) from 150 populations and 23 DH populations were evaluated at Brookings and selections were moved to early yield trials or reselections nursery.

The yield trials performed in 2014-15

- **Early Yield Trial (EYT):** 1016 entries evaluated at 1 South Dakota location.
- **Preliminary Yield Trial (PYT):** 90 entries evaluated at 5 South Dakota locations.
- **Advanced Yield Trial (AYT):** 30 entries evaluated at 5 South Dakota locations.
- **Crop Performance Trial (CPT):** 37 entries including 11 SDSU advanced breeding lines were planted at 14 South Dakota locations.

Breeding lines from the PYT and AYT nurseries are tested for grain yield potential, test weight, protein content and end-use quality characteristics. The entries are screened for Fusarium head blight and other diseases like leaf rust and bacterial leaf streak. Comparisons over years and locations are made with respect to the check cultivars and top entries are moved to CPT and regional nurseries where they are evaluated for agronomic performance for 2-3 years at 15 locations across South Dakota. The entries are evaluated for several diseases including Fusarium head blight resistance in a mist-irrigated field nursery at Volga, SD. Lines with superior performance for 2-3 years are considered for potential release after seed increase through SD Foundation Seed Stocks Division. As of Fall 2015, three experimental breeding lines are in various stages of seed increase.

In addition, 10 entries were evaluated at 15 locations in Kansas, Nebraska, South Dakota, North Dakota, Montana, Minnesota in USA and Alberta, Canada. SDSU winter wheat advanced line SD10257-2 was the highest yielding among 40 entries in the Northern Regional Performance Nursery (NRPN) in 2014 (Table 1). Four of the top 10 entries in NRPN trial were from SDSU winter wheat breeding program.

Projections:

The development of new winter wheat varieties adapted to South Dakota is expected to maximize South Dakota winter wheat producers' profit. Seed increase with intent to release has been initiated for SD10257-2 and will be proposed for release as a new cultivar to Certified seed growers for the 2016 growing season. The experimental line SD10257-2 has been submitted to Wheat Quality Council (WQC) for evaluating the milling and baking quality.

Publications:

- Cainong JC, Bockus WW, Feng Y, Chen P, Qi L, Sehgal SK, Danilova TV, Koo D, Friebe B, Gill BS (2015) Chromosome engineering, mapping, and transfer of native grass resistance to Fusarium Head Blight disease into wheat. *Theor Appl Genet* **128**:1019-1027
- Chhuneja P, Yadav B, Stirnweis D, Hurni S, Kaur S, Elkot AF, Keller B, Wicker T, Sehgal SK, Gill BS, Singh KS (2015) Fine mapping of a new powdery mildew resistance gene PmTb7A and a new allele of Pm1Tb in *Triticum boeoticum* and identification of STS markers suited for MAS using the survey sequence data of chromosome 7AL. *Theor Appl Genet* **128**:2099-2111.
- Chapman JA, Mascher M, Buluç AN, Barry K, Georganas E, Session A, Strnadova V, Jenkins J, Sehgal S, Olikier L, Schmutz J, Yelick KA, Scholz U, Waugh R, Poland JA, Muehlbauer GJ, Stein N, Rokhsar DS (2015) A whole-genome shotgun approach for assembling and anchoring the hexaploid bread wheat genome. *Genome Biol.* **16**(1):26

Table 1. Northern Regional Performance Nursery results for 2014

Entry	Line/selection	Grain Yield mean (kg/ha)	Rank	Grain Volume Weight (kg/hl)
1	Kharkof	3160	40	74.3
2	Overland	4372	16	76.0
3	Wesley	4188	28	74.2
4	Jagalene	4235	23	75.1
5	Jerry	4275	22	74.6
6	NX04Y2107W	4123	32	72.9
7	NX11MD2337	4403	15	71.3
8	N11MD2129W	4290	20	74.7
9	N11MD2157W	4415	14	74.8
10	N11MD2166W	4276	21	72.8
11	N11MD2172	4011	37	71.7
12	LCH11-147	4086	36	75.0
13	LCH10-187	4161	30	75.6
14	LCH11-1064	4089	35	75.1
15	LCH09-06	4520	8	74.6
16	LCH13NEDH-14-53	4679	3	75.2
17	NE10507	4478	11	74.5
18	NE10589	4713	2	76.6
19	NHH11569	4506	10	76.5
20	NI09710H	4194	27	70.8
21	NW09627	4321	18	74.7
22	NI10718W	4428	13	74.9
23	NE10683	4516	9	71.8
24	W434 = Flourish	4352	17	73.4
25	W454 = Emerson	4305	19	75.9
26	NH11490	3983	38	76.3
27	HV9W06-505	4147	31	78.0
28	FA9W10-6012R	4106	34	76.7
29	MT1078	4539	6	70.1
30	MT1090	4184	29	69.9
31	SD08080	4442	12	76.2
32	SD08200	4645	4	75.0
33	SD09113	4120	33	71.8
34	SD09118	4228	24	73.5
35	SD09138	3977	39	74.6
36	SD09192	4640	5	76.1
37	SD09227	4224	25	74.2
38	SD10257-2	4744	1	76.2
39	SD10W153	4527	7	75.7
40	SD110060-9	4208	26	74.6
	Mean	4295		74.4
	CV (%)	11.4		
	n	47		
	l.S.D.	383		