

# Accelerated Breeding for Resistance to Fusarium Head Blight

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## Research Questions

Complete resistance to Fusarium Head Blight (FHB) is unavailable, yet genetic variability for resistance is well documented. Steady progress toward increasing resistance levels has been demonstrated by breeding programs through the implementation of largely repeatable FHB screening procedures. Breeding programs must sustain efforts to simultaneously select resistant materials with desirable agronomic characteristics. The objective of this program is to use traditional plant breeding and selection techniques to develop hard spring wheat germplasm and cultivars that possess agronomic characteristics worthy of release in addition to acceptable levels of FHB resistance.

## Results

Entries retained in the advanced yield trial (AYT) are thought to be at least moderately resistant to FHB. Those that do not perform adequately are generally discarded after the first year of AYT observation. 2016 AYT results are presented in the appendix. Thirty-five experimental breeding lines were tested along with thirteen check cultivars during the 2016 growing season. Of the thirty-five experimental lines, twenty nine had FHB disease index (DIS) values that were less than the test average. Twenty five of the twenty nine entries also had Fusarium damaged kernel (FDK) values that were below average. Among these twenty five, eighteen produced more grain than average, and both test weight and protein content of seven were also better than average. One of these seven, SD4579, is presently being increased for the second year and may be considered for release as a new cultivar in fall 2017. Although slightly low on the scales of test weight and protein concentration, the experimental line SD4465 is also being increased for the second year and may also be considered for release in fall 2017. SD4546 and SD4625 are presently being increased for the first year and may be considered for cultivar release in fall 2018.

## Application and Use

With the progression of time, increases in FHB resistance levels should help to prevent devastating losses to growers caused by severe FHB outbreaks.

## Materials and Methods

Focused efforts to increase resistance began within this program after the 1993 FHB epidemic in the spring wheat production region. Both mist-irrigated greenhouse and field screening nurseries were established and disease evaluation methods were developed. Breeding materials are evaluated for FHB resistance using three generations per year: two in the greenhouse and one in the field. We have the capacity to screen as many as 4,500 individual hills in

the greenhouse. We also have 4 acres in the field under mist-irrigation. Both the field and greenhouse nurseries are inoculated with grain spawn (corn that is infested with the causal fungus) and spore suspensions. Mist-irrigation is used to provide a favorable environment for infection. Approximately 25 percent of the experimental populations possess *Fhb1* as a source of resistance. Most of what remains are crosses with various "field resistant" advanced breeding lines. Experimental materials are advanced through the program in the following fashion;

Year 1	Field	Space planted F <sub>2</sub> populations
Year 1	Fall greenhouse	F <sub>2,3</sub> hills
Year 1	Spring greenhouse	F <sub>3,4</sub> hills
Year 2	Field	F <sub>4,5</sub> progeny rows
Year 2	Off-season Nursery	F <sub>5,6</sub> progeny rows
Year 3	Field	F <sub>5,7</sub> Yield Trials (1 replication, 2 locations)
Year 4	Field	F <sub>5,8</sub> Yield Trials (2 replications, 5 locations)
Year 5	Field	Advanced Yield Trials (3 reps, 8 locations)

F<sub>2</sub> populations are planted in the field and individual plants are selected. These are advanced to the fall greenhouse where seed from each plant is sown as individual F<sub>2,3</sub> hills and evaluated for FHB resistance. Four plants from each of the top 25% of the hills are advanced to the spring greenhouse. They are sown as individual F<sub>3,4</sub> hills and evaluated for FHB resistance. Those with FHB resistance nearly equal to or better than 'Brick' are advanced to the mist-irrigated field nursery as F<sub>4,5</sub> progeny rows. They are evaluated again for resistance and general agronomic performance. Plants are selected within the superior rows and sent to New Zealand as F<sub>5,6</sub> progeny rows for seed increase. A portion of seed from each selected plant is also grown in the fall greenhouse to confirm its resistance. If the FHB resistance of an F<sub>5,6</sub> line is confirmed, then the respective progeny row is harvested in New Zealand. In the following South Dakota field season, the selected lines are tested in a two replication, multi-location yield trial. Those that have agronomic performance and yield similar to current cultivars are included in more advanced, multi-location, replicated yield trials the following year. In year 5, lines advanced through this portion of the program are included in the AYT along with entries from the traditional portion of the program. Performance data with respect to DIS and FDK, along with agronomic potential from the 2016 AYT are presented in Table 1 of the appendix.

## Economic Benefit to a Typical 500 Acre Wheat Enterprise

The presence of FHB inoculum within fields and favorable weather conditions are just two factors that heavily influence whether this disease becomes problematic. Immediate economic benefits are therefore difficult to assess. When conditions become favorable for disease presence, however, cultivars with elevated FHB resistance levels can help to reduce potentially serious grower losses.

**Table 1.** South Dakota State University advanced yield trial spring wheat entries ranked according to FHB disease index values (lowest to highest – collected at Brookings) presented along with agronomic data obtained from three replication trials conducted at eight test environments in 2016.

Entry	FHB DIS Index	Tombstone (%)	Grain Yield (bu/ac)	Test Weight (lb/bu)	Grain Protein (%)	Head Date (D>6/1)	Plant Height (Inches)
SD4582	11.50	11.17	47.87	62.36	15.21	15.47	37.60
BRICK	12.02	12.83	52.32	62.20	14.71	11.60	34.19
FOREFRONT	12.05	11.67	54.44	61.41	14.88	13.60	35.92
FOCUS	12.09	11.17	52.94	62.24	15.31	11.40	35.76
SD4465	12.20	18.33	54.17	61.36	14.49	15.07	34.11
SD4546	12.76	15.00	53.18	62.15	15.01	11.93	34.01
SD4539	13.11	19.17	54.02	61.07	14.71	17.33	36.05
SD4660	13.32	19.17	46.35	62.30	15.89	16.20	35.11
SD4631	13.39	17.50	51.99	62.33	14.80	16.00	35.82
SELECT	13.40	18.33	52.71	62.12	14.63	11.73	34.03
SD4623	13.58	15.83	46.20	61.79	15.38	16.60	40.22
SURPASS	13.70	16.67	55.55	60.55	14.60	12.60	31.96
SD4595	14.27	17.50	52.81	62.27	14.94	14.93	35.42
PREVAIL	14.29	17.50	58.92	60.92	14.08	13.73	32.30
SD4659	14.30	15.00	47.31	61.78	15.70	16.00	35.63
BOOST	14.36	17.50	52.96	60.27	15.21	18.73	33.77
SD4393	14.60	15.83	52.34	61.44	15.22	15.53	31.83
SD4625	14.98	16.67	55.50	61.83	14.52	17.40	33.12
SD4587	15.17	14.17	51.20	61.91	15.34	15.20	36.71
SD4607	15.40	14.17	50.80	62.54	15.08	15.60	36.37
ADVANCE	15.50	19.17	52.82	61.20	14.03	17.07	30.47
SD4579	15.60	16.67	52.61	61.49	15.11	16.33	34.40
SD4650	16.02	25.83	53.90	60.61	14.64	16.87	35.06
SD4628	16.06	16.67	52.56	61.93	15.35	16.87	35.47
SD4557	16.09	22.50	51.98	60.87	13.83	14.00	32.51
SD4671	16.27	21.67	52.30	60.97	14.56	16.33	33.72
SD4492	16.45	18.33	51.82	61.91	14.58	13.00	34.61
SD4597	16.57	14.17	52.72	62.16	14.15	14.80	36.03
SD4529	16.68	20.00	55.06	61.93	15.30	16.33	36.42
TRAVERSE	17.02	30.00	54.31	58.38	13.97	16.00	35.47
SD4681	17.15	18.33	52.74	62.40	14.92	14.53	35.50
BRIGGS	17.28	22.50	51.80	60.94	15.15	12.93	33.43
SD4472	17.52	25.00	49.75	60.47	15.18	14.60	31.26
SD4493	17.92	20.83	52.41	62.06	14.67	14.87	32.15
SD4684	18.01	19.17	51.85	62.50	15.19	13.60	35.13
SD4624	18.16	19.17	55.10	61.78	14.84	16.47	30.89
STEELE-ND	18.50	21.67	50.99	60.85	15.07	16.73	34.66
SD4416	18.58	20.83	53.61	61.16	15.15	15.33	33.25
SD4673	18.73	20.00	51.01	61.73	14.65	11.87	32.93
SD4514	19.10	23.33	53.39	61.75	15.07	17.33	37.73
SD4403	19.25	17.50	53.28	60.84	15.00	17.07	34.66
SD4543	20.27	17.50	51.11	62.18	15.31	15.20	37.13
FALLER	20.88	27.50	49.65	58.95	13.85	18.47	33.96
SD4676	20.92	23.33	51.79	61.43	14.97	17.93	31.96
SD4575	21.27	24.17	52.95	60.80	14.57	17.93	36.65
SD4649	21.31	20.83	54.04	61.50	14.73	15.60	36.60
OXEN	31.08	32.50	52.61	59.43	14.73	15.73	32.15
SD4678	33.00	37.50	51.58	61.17	14.73	19.87	31.26
MEAN	16.70	19.41	52.36	61.42	14.85	15.42	34.49
LSD (0.05)	4.31	5.67	1.90	0.34	0.26	0.82	0.87
cv	25.06	26.89	4.39	1.45	3.05	12.87	5.93