Project Title:	Evaluation of Spring Wheat Genotypes for Resistance to the Orange Wheat Blossom Midge
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Project Personnel:	Qasim Khan and Qingwu Xue
Project Cooperators:	Bill Berzonsky, Luther Talbert, and David Weaver
Objective:	Identify spring wheat genotypes that are resistant to the orange wheat blossom midge

Results:

The nursery was established at the Northwestern Agricultural Research Center located near Kalispell, MT in a field with a previous history of low to moderate midge densities. The soil type was a Creston silt loam and the field was fertilized with 100-30-60-24 lb/A of N, P, K and S, respectively.

Thirty spring wheat entries were evaluated for resistance to the orange wheat blossom midge (OWBM). The 30 genotypes consisted of 10 experimental lines from Dr. Berzonsky's spring wheat breeding program at NDSU, plus twenty commercially available varieties from Dr. Talbert's uniform off-station spring wheat nursery.

The spring wheat entries were planted as three non-replicated trials, with each trial consisting of a different planting date. Since wheat is most vulnerable to midge damage from heading through pollination, the three planting dates were use in order to assure that each entry would be exposed to adequate midge pressures, regardless of individual maturity differences.

The planting dates were May 1, May 9, and May 15, with corresponding growing degree day units (GDD base 40^{o} F) of 247, 338, and 432, respectively. Entries were randomized within each planting date and were seeded at a rate of 78 lb/A to a depth of 1.5 inches. Each plot was 10 foot long and consisted of 7 rows, spaced 6 inches apart.

Heading and pollination were recorded when 50 percent of the plants in a plot had reached the corresponding growth stage. Exposure duration (ED) was calculated as the time period between these two events. Five, randomly selected heads were collected on August 24. Each head was dissected and the number of larvae, damaged kernels and healthy kernels were determined. Plots were swathed and the grain initially separated with a stationary thresher. Grain yield test weight and thousand kernel weight were determined.

There was good synchronization between adult midge emergence and spring wheat heading. Midge adults were first observed in emergence traps on June 20. The adult flight continued throughout July, with ninety percent adult emergence occurring on July 25, based on pheromone trap captures. Concurrently, spring wheat heading occurred from June 25 through July 21 (Julian 176 through 200) depending on the genotype and planting date (Table 1).

The susceptible exposure period for midge damage to occur (ED) ranged from1 to 7 days depending on the cultivar/line and planting date. The ED decreased as planting was delayed and averaged 6, 5, and 4 days for the first, second, and third planting dates, respectively. While the third planting date was associated with the shortest ED, larvae numbers per spike were greatest.

Averaged over all other factors, the first, second, and third planting dates corresponded to midge densities of 35, 61, and 75 larvae per spike, respectively (Table 2). In short, the later planted genotypes were exposed to higher midge populations, which more than offset the shorter ED.

When averaged over planting dates, larvae numbers per spike ranged from a low of 4 to a high of 152 (Table 2). Hank, WB 926, McNeal and Norpro each had 100 or more larvae per spike. In contrast, the entries with the lowest larvae numbers consisted of CAP 19, NDSW0501, SW 3, and Largo. CAP 19 and NDSW0501 are both known to carry the SM1 gene for resistance. Explorer, Ernest, Fortuna, Reeder, Knudson, MT0414, and MT0415 also showed low to moderate larvae numbers.

There was good agreement between larvae numbers per spike and percent damaged kernels (Table 3, Figure 1). CAP 19, NDSW0501, SW 3, and Largo had the lowest percent damaged kernels (<25%), while Hank, Norpro, WB 926, Choteau, and McNeal had the highest damage ratings (>78%). Explorer, Reeder, MT0414, and MT0415 demonstrated low to moderate kernel damage. The highest yields were observed with CAP 19, NDSW0608, NDSW0501, MT 0414, MT 0415, and Reeder (Table 4).

Summary:

Midge larvae numbers were substantial and ranged as high as 213 larvae per spike for Hank when planted on May 9, 2007. Larvae infestation tended to increase as planting was delayed. As larvae numbers increased so too did percent damaged kernels. Midge infestation levels and yield results indicate that CAP 19, NDSW0608, NDSW0501, MT 0414, MT 0415, and Reeder may have some level of resistance.

Table 1: Days to heading, days to pollination and exposure duration (ED) in 30 spring wheat cultivars and lines planted at three dates in 2007 at Kalispell MT.

	Planting date								
	5/1/2007			5/9/2007			5/15/2007		
Cultivar / Line	Heading	Pollination	ED	Heading	Pollination	ED	Heading	Pollination	ED
	Julian days		days	Julian days		days	Julian days		days
EXPLORER	176	183	7	182	187	5	185	190	5
AGAWAM	176	182	6	182	188	6	186	189	3
WB 926	177	183	6	182	187	5	186	190	4
HANK	177	184	7	184	188	4	186	190	4
CHOTEAU	178	185	7	182	187	5	186	191	5
CORBIN	178	184	6	182	189	7	187	190	3
CONAN	179	184	5	184	189	5	188	191	3
FREYR	179	185	6	183	188	5	188	192	4
MT 0414	179	184	5	183	187	4	187	191	4
REEDER	179	186	7	183	188	5	187	191	4
CAP20*	180	186	6	183	188	5	188	191	3
FORTUNA	180	186	6	183	188	5	187	190	3
MT 0415	180	185	5	183	188	5	188	191	3
MT 0515	180	187	7	185	189	4	188	192	4
NDSW0449*	180	186	6	184	189	5	188	192	4
NDSW0501*	180	185	5	183	188	5	187	191	4
NDSW0608*	180	186	6	182	187	5	188	189	1
NORPRO	180	187	7	184	188	4	187	191	4
VIDA	180	185	5	183	188	5	187	191	4
ERNEST	181	186	5	183	188	5	187	191	4
KNUDSON	181	186	5	183	188	5	188	192	4
MCNEAL	181	186	5	185	190	5	188	192	4
OUTLOOK	181	187	6	185	188	3	189	192	3
SCHOLAR	181	186	5	183	188	5	188	191	3
CAP19*	182	187	5	185	188	3	189	192	3
NDSW0601*	182	186	4	186	190	4	190	193	3
SW 7*	187	191	4	191	195	4	195	198	3
SW 8*	187	191	4	193	195	2	198	201	3
SW 3*	188	192	4	193	195	2	198	201	3
LARGO*	189	193	4	194	197	3	200	203	3
Mean	**181**	**186**	**6**	**185**	**189**	**5**	**189**	**192**	**4**
GDD 40**	**1222**	**1371**		**1326**	**1471**		**1462**	**1567**	

* Indicates North Dakota cultivar/line.

** Cumulative growing degree days from January 1 using base temperature of 40 ^{0}F.

Table 2: Mean number of OWBM larvae per spike in 30 spring wheat cultivars and lines planted at three dates in 2007 at Kalispell MT.

	Larvae per spike** (Aug. 24, 2007)							
	Overall		***Planting 1		Planting 2		Planting 3	
Cultivar / Line	Mean	Rank	Mean	S.E	Mean	S.E	Mean	S.E
EXPLORER	38	17	22	3	53	7	39	8
AGAWAM	95	6	31	3	125	12	130	28
WB 926	121	2	54	12	105	16	204	29
HANK	152	1	67	12	213	17	175	20
CHOTEAU	84	9	57	6	76	22	118	22
CORBIN	96	5	33	5	118	9	137	11
CONAN	94	7	60	7	81	7	142	23
FREYR	69	11	23	3	80	9	105	22
MT 0414	27	19	16	3	24	5	42	12
REEDER	26	20	13	4	43	18	22	5
CAP20*	26	20	23	9	25	4	31	8
FORTUNA	34	18	35	4	33	6	34	7
MT 0415	24	21	17	5	31	6	24	4
MT 0515	64	12	31	3	43	12	117	14
NDSW0449*	58	13	17	2	85	13	71	13
NDSW0501*	10	26	9	4	5	5	17	7
NDSW0608*	23	22	13	2	22	8	34	11
NORPRO	100	4	62	7	76	10	163	23
VIDA	50	15	33	5	82	16	36	7
ERNEST	51	14	24	5	59	14	69	10
KNUDSON	42	16	28	4	56	8	43	5
MCNEAL	103	3	52	4	107	12	149	11
OUTLOOK	88	8	62	8	95	18	106	17
SCHOLAR	83	10	108	17	54	11	87	19
CAP19*	4	27	1	1	2	1	11	4
NDSW0601*	84	9	73	12	62	13	117	21
SW 7*	16	23	12	7	21	5	14	1
SW 8*	27	19	37	7	36	13	8	6
SW 3*	11	25	20	10	13	7	1	1
LARGO*	13	24	31	7	3	2	4	2
Mean	**57**		**35**	**6**	**61**	**10**	**75**	**12**

* Indicates North Dakota cultivar/line.
** Average of 5 spikes per plot.
*** Planting 1 = May 1, 2007; Planting 2 = May 9, 2007; and Planting 3 = May 15, 2007.

Table 3: Percent kernel damage by OWBM larvae in 30 spring wheat cultivars and lines planted at three dates in 2007 at Kalispell MT.

	Percent damaged kernels** (Aug. 24, 2007)							
	Overall		***Planting 1		Planting 2		Planting 3	
Cultivar / Line	Mean	Rank	Mean	S.E	Mean	S.E	Mean	S.E
EXPLORER	45	17	39	6	62	4	35	4
AGAWAM	61	10	42	3	72	5	69	6
WB 926	80	2	73	9	75	7	92	2
HANK	83	1	70	8	93	2	85	5
CHOTEAU	79	3	75	7	82	5	80	8
CORBIN	71	7	41	7	89	5	84	5
CONAN	73	6	66	5	73	3	79	1
FREYR	68	8	41	4	82	3	82	8
MT 0414	38	19	26	3	36	9	51	7
REEDER	32	22	21	6	50	14	26	3
CAP20*	50	15	55	14	41	7	54	7
FORTUNA	57	12	58	5	56	4	56	4
MT 0415	39	18	33	6	41	4	45	5
MT 0515	60	11	51	3	50	8	78	3
NDSW0449*	60	11	40	3	77	2	64	6
NDSW0501*	16	26	14	3	8	8	25	8
NDSW0608*	29	23	27	5	23	9	38	12
NORPRO	83	1	80	5	78	5	91	4
VIDA	56	13	58	5	72	8	37	8
ERNEST	54	14	43	9	61	11	57	5
KNUDSON	49	16	52	3	58	7	37	9
MCNEAL	78	4	67	7	81	3	87	1
OUTLOOK	76	5	77	7	82	6	70	7
SCHOLAR	73	6	81	2	63	12	74	7
CAP19*	7	27	2	1	2	1	18	9
NDSW0601*	66	9	77	5	49	7	73	6
SW 7*	35	21	22	11	53	9	31	4
SW 8*	37	20	50	8	43	12	17	8
SW 3*	20	25	27	12	30	18	3	2
LARGO*	24	24	51	10	11	6	11	7
Mean	**53**		**49**	**6**	**56**	**7**	**55**	**6**

* Indicates North Dakota cultivar/line.
** Average of 5 spikes per plot.
*** Planting 1 = May 1, 2007; Planting 2 = May 9, 2007; and Planting 3 = May 15, 2007.

Table 4: Grain yield, and test weight in 30 spring wheat cultivars and lines planted at three dates in 2007 at Kalispell MT.

	Grain yield (bu/ac)					Test weight (lb/bu)				
	Overall		**Planting date			Overall		Planting date		
Cultivar / Line	Mean	Rank	1	2	3	Mean	Rank	1	2	3
EXPLORER	26	7	25	21	32	57	2	57	57	57
AGAWAM	20	10	28	18	14	55	4	58	53	53
WB 926	11	16	14	9	9	52	7	54	53	48
HANK	11	16	15	6	14	51	8	52	51	50
CHOTEAU	10	17	11	7	12	55	4	57	53	54
CORBIN	11	16	19	3	11	54	5	57	-	52
CONAN	15	14	18	16	13	56	3	55	56	56
FREYR	14	15	18	9	16	54	5	55	56	50
MT 0414	36	4	38	41	28	56	3	58	57	55
REEDER	28	6	29	25	32	58	1	58	57	58
CAP20*	18	12	4	26	24	54	5	54	55	53
FORTUNA	20	10	21	17	22	56	3	54	54	61
MT 0415	33	5	36	33	30	57	2	57	57	56
MT 0515	18	12	18	20	15	56	3	56	56	55
NDSW0449*	26	7	30	19	29	56	3	57	55	55
NDSW0501*	37	3	35	41	35	58	1	58	59	57
NDSW0608*	38	2	45	42	27	57	2	57	58	57
NORPRO	16	13	22	16	10	53	6	50	55	54
VIDA	22	8	28	15	24	55	4	55	55	54
ERNEST	21	9	25	22	17	56	3	57	56	56
KNUDSON	19	11	22	19	16	55	4	56	52	56
MCNEAL	22	8	20	24	22	53	6	53	53	52
OUTLOOK	14	15	13	16	14	51	8	53	50	50
SCHOLAR	16	13	16	16	15	56	3	56	57	56
CAP19*	41	1	49	40	35	57	2	57	57	56
NDSW0601*	14	15	14	18	11	52	7	53	52	50
SW 7*	9	18	10	8	7	50	9	48	51	49
SW 8*	5	19	6	6	3	51	8	52	52	48
SW 3*	5	19	8	3	4	48	10	53	43	47
LARGO*	9	18	12	5	10	50	9	53	49	47
Mean	**20**		**22**	**19**	**18**	**54**	**5**	**55**	**54**	**53**

* Indicates North Dakota cultivar/line.

** Planting 1 = May 1, 2007; Planting 2 = May 9, 2007; and Planting 3 = May 15, 2007.

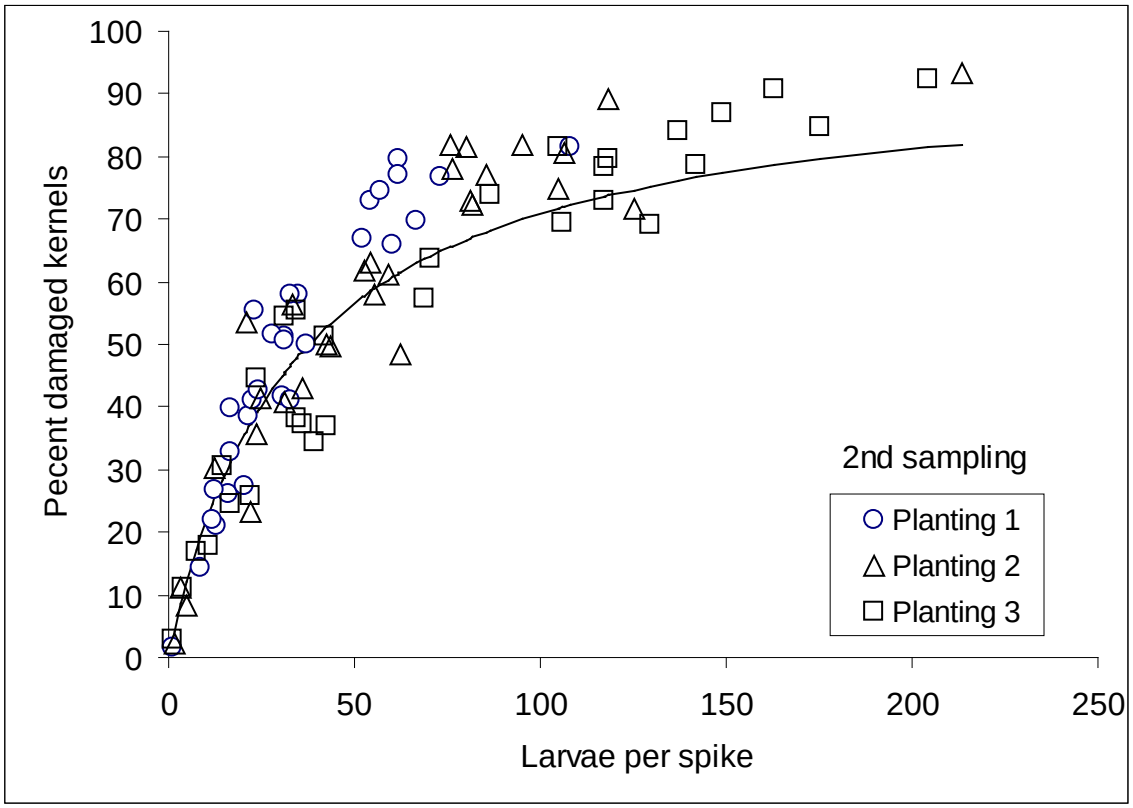

Figure 1. Relationship between midge infestation and kernel damage to 30 spring wheat entries planted at three dates in 2007 at Kalispell, MT.