

WHEAT (*Triticum aestivum* 'multiple cultivars') D.J.L. Mangel, M. A. Bruce, M.A. Davis, A.K.
Fusarium head blight; *Fusarium graminearum* Fritz, G. Zhang, and J.L. Rupp
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Reaction of Kansas Interstate Nursery winter wheat accessions to Fusarium head blight, 2019.

An experiment was established at the Kansas State University, Rocky Ford Research Station in Manhattan, KS. Soil was a Chase silty clay loam (pH = 6.5). The experiment was planted in a randomized complete block design with four replications of 36 entries. Single row plots were seeded at a rate of 67.25 kg/ha into 2.3-m long with 0.51-m row spacing on 30 Oct 2018. Corn kernel inoculum was grown with two aggressive *Fusarium graminearum* isolates and air-dried. Inoculum was spread onto the plots at a rate of 53 g/m² on 16 Apr, 26 Apr, and 10 May 2019. During anthesis, the nursery was mist irrigated to improve *F. graminearum* conditions for 5 minutes every 4 hours throughout the night for a total of 20 minutes per night. Heading dates were recorded when plots reached 50% headed tillers. FHB index was rated on 28 May, 31 May, 03 Jun, and 05 Jun by determining the percent of symptomatic spikelets. Plots were harvested on 2 Jul 2019. Fusarium damaged kernels (FDK) was recorded after cleaning. Due to small sample size and infection severity, grain samples were not evaluated for deoxynivalenol (DON) concentration. Area under the disease progress curve and stairs (AUDPC, AUDPS) were calculated using the R package 'Agricolae' version 1.3-1. Data were analyzed with Proc GLM in SAS (SAS Institute Inc.) followed by mean separation using Fisher's protected least significant difference (LSD) at P = 0.05.

Due to ideal environmental conditions for the pathogen during anthesis, Fusarium head blight disease pressure was severe. The early susceptible check 'Overley' had the second highest AUDPS of 598. Only one entry, 'KS13DH0035-66', had a higher AUDPS, but the difference was not significant. The moderately resistant check 'Everest' had an AUDPS of 329. There were four lines with a lower disease progress rating, but none that were significantly lower. All FDK scores were 100%. There was a significant correlation between heading date and AUDPS ($n = 144$, $r = 0.3471$, $P < 0.0001$) therefore, direct comparisons should not be made between cultivars with widely differing heading dates.

Variety	Heading Date ^z	Plot Damage Severity (%)				Mean Severity	AUDPS ^y	AUDPC ^x
		28-May	31-May	03-Jun	05-Jun			
1863	139.75	4.5	11.75	82.5	91.25	47.5	396.25	339.5
Everest	135	5.75	9.75	60	81.25	39.1875	329	269.125
KanMark	138.75	10.25	7	95	80	48.0625	401.75	353.875
Karl92	135.25	10	25	87.5	87.5	52.5	455	396.25
KS061278M-4	140	3	8.75	76.25	91.25	44.8125	370.25	312.625
KS080093K-18	138.75	5.75	12.5	82.5	91.25	48	402.25	343.625
KS090387K-20	135.75	9.75	35	86.25	91.25	55.5625	489.25	426.5
KS090387K-9	137.25	7.25	17.5	90	92.5	51.8125	439.25	380.875
KS090413K-4	136	17.75	21.25	93.75	98.75	57.875	502	423.5
KS090438K-9	135	15.25	23.75	92.5	95	56.625	492	420.375
KS090616K-1	142.5	3	1.25	76.25	93.75	43.5625	352.75	292.625
KS090725K-4	140.5	1.75	1.75	61.25	67.5	33.0625	268	228.5
KS100509K-2	134.5	29.25	42.5	97.5	78.75	62	567.75	493.875
KS12DH0023-118	142.75	2	3.25	57.5	81.25	36	293.25	237.75
KS12DH0156-88	138.5	6	23	91.25	93.75	53.5	457	399.875
KS13DH0030-21	138.25	10.25	18.75	95	96.25	55.0625	469.5	405.375
KS13DH0035-66	136	51.75	29.25	100	97.5	69.625	638	512.875
KS13DH0041-35	139.25	1.75	7.75	77.5	92.5	44.875	368.5	312.125
KS14DH0007-51	136.5	8	26.5	91.25	98.75	56.125	483.5	418.375
KS14HD255	148.5	1.75	3.25	61.25	95	40.3125	327.5	260.5
KS14HD286	147	1.75	1.5	82.5	95	45.1875	364.75	308.375
KS14HW106-6-6	137.25	5.5	13	95	96.25	52.4375	438	381
KS15H116-6-1	141.25	4.5	3.25	75	82.5	41.3125	338.25	286.5
KS15H161-1-4	143.5	0.5	3.5	82.5	91.25	44.4375	359.5	308.75
KS17H153-3	136.5	9.5	16.25	96.25	95	54.25	459.75	398.625
KS17H17	140.25	10	1.75	91.25	93.75	49.1875	405.25	342.125
KS17H37	140.75	4.5	7	82.5	92.5	46.625	384.5	326.5
KS17H91-1	143	4.75	3.5	81.25	95	46.125	377.25	315.75
KS17H96-1	143	1.75	8.25	82.5	93.75	46.5625	382.5	327.375
Larry	135.25	8.5	25	82.5	96.25	53.0625	458	390.25
NUSAKA15-3	139	4.75	6	93.75	100	51.125	419.75	359.5
NUSAKA4-14	141	2.75	1.5	61.25	78.75	36.0625	292.75	240.5
Overley	135	13.5	57.5	95	97.5	65.875	598	527.75
Tam105	140.75	1.75	6.75	85	92.5	46.5	380.5	327.875
Zenda	139	6.75	12.5	77.5	91.25	47	395.25	332.625
P value	<0.0001	<0.0001	<0.0001	<0.0001	0.5121	<0.0001	<0.0001	<0.0001
CV	2.79	114.46	90.14	13.86	7.74	16.12	19.63	20.43
LSD ^w (P=0.05)	2.4381	6.8116	15.98	18.245	--	9.4198	86.312	78.459

^zDays from January 1

^yArea Under the Disease Progress Stairs

^xArea Under the Disease Progress Curve

^wData were analyzed with Proc GLM in SAS (SAS Institute Inc.) followed by mean separation using Fisher's protected least significant difference (LSD) at P = 0.05

WHEAT (*Triticum aestivum*, ‘multiple cultivars’)
Fusarium head blight; *Fusarium graminearum*

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Reaction of Kansas and Nebraska winter wheat accessions to Fusarium head blight (FHB), 2019.

The experiment was conducted at Kansas State University Rocky Ford Research Station near Manhattan, KS. The soil type at the site was Chase silty clay loam (pH = 6.5). The experimental design was a randomized complete block with four replications. The Fusarium head blight (FHB) Nursery was composed of 36 entries from the Kansas and Nebraska breeding programs. Experiment plots were single rows 2.3-m long spaced 0.51-m apart. Plots were seeded on 30 Oct 2018 with the seeding rate of 67.25kg/ha. Corn kernels were inoculated with two aggressive isolates of *Fusarium graminearum* conidia. Air-dried kernels were spread throughout the test area at the rate 53g/m² three times on 16 Apr, 26 Apr, and 10 May 2019. Overhead, impulse sprinklers were used during anthesis to keep wheat heads wet. Water was applied for 5 min every four hours, overnight. Heading date (50 % headed) per plot was recorded and visual estimations of the percent symptomatic spikelets (FHB index) was also determined on 28 May, 31 May, 03 Jun, and 05 Jun. Plots were harvested by using a Wintersteiger plot combine on 08 Jul and the yield of each plot was recorded. Grain sub-samples per plot were visually rated for the percent *Fusarium* damaged kernels (FDK). Due to the severe infection (100 % FDK), deoxynivalenol (DON) concentrations were not recorded. FHB index of four different observation days were used to calculate the Area Under Disease Progressive Curve (AUDPC) by using “agricolae” package in R (R-Development Core Team). AUDPC values were analyzed by GLM procedure (SAS Institute Inc.) and Fisher’s protected least significant difference (LSD; $P = 0.05$) was used for mean comparisons. Correlation among AUDPC, heading date, yield, and FDK were also analyzed.

All breeding lines developed severe head blight due to weather conditions during the growing season. Mean AUDPC values varied with cultivars ($F = 15.29$, $P < 0.001$). ‘Overley’, the susceptible check had the highest mean AUDPC (583.1) which was significantly different than other entries ($P < 0.001$) except NE_12_561 ($P = 0.9$). Everest, the moderately resistant check (mean AUDPC = 216.3) was two times less than Overley, while NE_17_620 (mean AUDPC = 106.3) was significantly lower than ‘Everest’ ($P < 0.05$). There was a significant negative correlation between mean AUDPC and heading date (Julian) ($n = 142$, $r = -0.070$, $P < 0.001$). Mean FDK was significantly correlated with AUDPC ($n = 143$, $r = 0.027$, $P < 0.001$). Mean yield had significant negative correlation with AUDPC ($n = 143$, $r = 0.30$, $P < 0.001$). Due to the favorable season for FHB, rating index and FDK values were high at harvesting time.

Fusarium head blight index (% killed spikelets)

NAME	Heading date (Julian) ^z	Fusarium head blight index (% killed spikelets)				Yield (g/plot)	FDK (%) ^y	Average (FHB) ^x	AUDPC ^w
		FHB1 28-May	FHB2 31-May	FHB3 3-Jun	FHB4 5-Jun				
1863	140.8	1.3	19.3	46.3	100	12.8	98.8	41.7	275.3
Everest	134.8	3.3	12.8	31.8	93.75	39.3	93.8	35.4	216.3
Karl_92	135.8	2.5	30.0	55.8	100	27.3	93.0	47.1	333.1
KS080093K-18	139.0	5.5	20.8	27.5	100	8.5	99.5	38.4	239.3
KS090387K-20	134.8	4.3	27.5	70.0	100	10.3	99.3	50.4	363.9

Fusarium head blight index (% killed spikelets)									
NAME	Heading date (Julian) ^z	FHB1 28-May	FHB2 31-May	FHB3 3-Jun	FHB4 5-Jun	Yield (g/plot)	FDK (%) ^y	Average (FHB) ^x	AUDPC ^w
KS090413K-4	135.3	7.5	71.3	61.3	100	7.0	99.3	60.0	478.1
KS090438K-9	135.3	11.8	37.5	79.3	100	7.5	100.0	57.1	428.3
KS090616K-1	141.8	1.5	16.8	54.3	100	3.1	99.3	43.1	288.1
KS090725K-4	142.5	1.0	2.5	22.0	100	51.3	90.0	31.4	164.0
KS100028K-10	142.3	1.3	10.3	45.0	100	18.3	99.3	39.1	245.1
KS100028K-11	141.3	1.3	16.3	37.5	100	18.5	92.8	38.8	244.4
KS100196K-2	139.8	1.3	16.3	47.0	100	19.5	98.3	41.1	268.1
KS120252M~14	134.3	12.5	50.0	56.8	100	24.5	93.5	54.8	410.6
KS120552M~12	137.0	4.3	50.0	75.0	100	15.3	100.0	57.3	443.9
KS12DH0090-172	135.3	5.5	31.3	51.8	100	19.5	96.5	47.1	331.4
KS13DH0041-35	138.3	1.5	11.5	21.3	100	35.3	98.3	33.6	189.9
KS14DH0007-51	137.0	4.3	35.8	66.3	100	10.5	99.5	51.6	379.3
KS14DH0012-12	136.8	2.3	26.3	61.3	100	11.5	99.8	47.4	335.3
NE_10_478-1	138.3	3.3	22.3	37.0	100	17.3	97.0	40.6	264.1
NE_12_561	136.5	10.0	75.0	82.5	100	12.3	96.8	66.9	546.3
NE_13_493	144.3	0.8	4.8	24.3	100	28.8	87.8	32.4	176.0
NE_13_515	144.0	0.8	3.0	15.3	100	32.0	98.0	29.8	148.3
NE_14_494	144.8	1.0	8.8	13.5	100	19.0	90.5	30.8	161.5
NE_14_696	145.0	1.0	2.8	10.0	100	34.3	93.0	28.4	134.8
NE_15_624	145.3	1.0	4.5	18.8	100	14.8	98.3	31.1	161.9
NE_16_424	135.3	16.3	61.3	75.0	100	15.8	99.5	63.1	495.6
NE_16_468	141.5	1.3	8.0	30.0	100	7.3	98.0	34.8	200.9
NE_17_452	146.5	0.8	2.8	28.0	100	9.5	99.5	32.9	179.4
NE_17_524	143.3	1.3	13.8	42.5	100	11.0	96.8	39.4	249.4
NE_17_620	146.3	0.3	0.0	2.3	100	5.3	96.0	25.7	106.3
NE_17_627	146.7	1.0	2.5	12.3	100	6.8	95.8	28.9	139.6
NE_17_662	144.5	0.8	6.0	28.0	100	27.5	87.5	33.7	189.1
NH_14_4913-3	137.5	5.8	21.3	48.8	100	5.0	99.3	43.9	294.3
Overley	134.5	22.5	67.5	98.8	100	1.5	99.8	72.2	583.1
Tam_105	143.0	1.0	10.0	46.3	100	9.5	99.5	39.3	247.1
Zenda	138.5	1.5	13.8	48.8	100	28.5	95.0	41.0	265.4
Average	140.0	4.0	22.6	43.7	99.8	17.4	96.6	42.5	282.7
P-value									<0.001
LSD ($P = 0.05$)	2.2	4.4	15.5	22.8	2.9	21.9	9.4	8.1	85.1

^z Days from January 1

^y *Fusarium* damaged kernels

^x Average rating from FHB1-FHB4

^w Area Under Disease Progress Curve