WHEAT (*Triticum aestivum* 'multiple cultivars')
Fusarium head blight; *Fusarium graminearum*

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Reaction of Northern winter wheat accessions to Fusarium head blight, 2020.

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 50 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 01 Oct 2019. Corn kernel inoculum was grown with two aggressive *Fusarium graminearum* isolates (GZ-3639, Pt-1-04) and air-dried. Inoculum was spread onto the plots at a rate of 53 g/m^2 on 12 Apr, 27 Apr, and 12 May 2020. During anthesis, the nursery was mist irrigated to improve *F. graminearum* conditions for 12 minutes every 4 hours throughout the night for a total of 48 minutes per night. Heading dates were recorded when plots reached 50% headed tillers. FHB index was rated on 23 May, 27 May, 31 May, 04 Jun, and 06 Jun by determining the percent of symptomatic spikelets. Plots were harvested on 24 Jun 2020. Fusarium damaged kernels (FDK) was recorded after cleaning. Grain samples were evaluated for deoxynivalenol (DON) concentration. Area under the disease progress stairs (AUDPS) and the least significant difference (LSD) (α=0.05) were calculated using the R package 'Agricolae' version 1.3-3 (Mendiburu, 2020). Data were analyzed with the 'aov' function (R Core Team, 2019).

High pathogen pressure allowed easy differentiation between cultivars. AUDPS ratings ranged from 85 to 898.5, the most severe of which was the moderately susceptible check 'Overly'. There was a wide range of AUDPS ratings in this data but due to the nature of infection and differing environmental conditions during infection, cultivars of different heading dates should not be directly compared. DON ratings ranged from 5.91 to 36.67, and were roughly correlated with AUDPS. However, two lines, 'Flourish' and SD17246, accumulated more DON than the moderately susceptible check while maintaining a lower AUDPS rating. The mean percent of FDK was a relatively low 9.07% and there were no significant differences between varieties.

Variety	Heading Date[z]	Plot Damage Severity (%)					AUDPS[y]	Mean FDK (%)	Mean DON (ppm)
		23-May	27-May	31-May	04-Jun	06-Jun			
19NORD-116	137	0.0	1.8	6.3	42.5	67.5	252	10.25	13.62
19NORD-118	133.5	0.0	1.3	11.5	12.5	66.3	208.5	3.25	9.75
19NORD-119	130.5	0.0	3.0	16.3	28.8	65.0	264.5	8.75	15.36
19NORD-120	130.75	0.0	1.3	16.3	28.8	53.8	235	2.5	13.95
19NORD-121	135.75	0.0	0.8	4.0	10.0	42.5	124	2.25	6.33
19NORD-122	135.5	0.0	0.8	4.0	20.0	63.8	186.5	2.5	10.03
19NORD-124	136.5	0.0	1.3	15.0	37.5	58.8	257.5	8.25	20.33
19NORD-125	134.25	0.0	1.3	8.0	10.0	46.3	149.5	3.25	13.73
19NORD-126	135	0.0	1.0	9.3	26.3	53.8	201	4.75	6.34
19NORD-128	133.5	0.3	1.5	7.5	26.3	63.8	217	5	18.95
19NORD-129	127.25	0.0	7.8	22.5	27.5	45.0	266	4	7.16
19NORD-130	128.5	0.0	1.0	3.0	15.0	58.8	163.5	1.5	9.35
19NORD-131	135.75	0.0	0.8	3.3	10.0	46.3	128.5	1.25	7.03
19NORD-132	122.75	0.8	32.5	38.8	80.0	88.8	625.5	3.25	10.34
19NORD-133	135.5	0.0	2.3	8.5	31.3	58.8	223	10.75	25.00
Decade	135.25	0.3	2.3	16.3	37.5	70.0	290	12.75	20.53
Emerson	136	0.0	0.3	3.5	16.3	35.0	117.5	2.5	15.16
Flourish	131.5	0.0	2.0	26.3	88.8	76.3	443	15	34.53
Karl 92	124.5	0.8	11.5	21.3	62.5	73.8	406.5	4	8.14
LCS Chrome	130	0.0	1.3	10.0	33.8	55.0	222.5	5	13.33
MT1793	135	0.0	1.3	9.3	20.0	63.8	209.5	4.75	9.58
MT19106	134.25	0.0	5.8	16.3	51.3	66.3	323	8.25	10.16
MT19116	128.25	0.0	3.8	13.8	26.3	55.0	232.5	4	10.62
MT19117	136	0.0	0.8	15.0	38.8	67.5	275.5	5.75	16.97
MT19122	135	0.0	0.8	4.3	7.5	25.0	85	1.5	11.77
MT19128	134.25	0.0	2.3	11.3	31.3	65.0	246.5	9.25	23.95
MT19132	134.75	0.0	1.8	13.8	32.5	65.0	257	10	14.79
MT19133	136.5	0.0	0.5	4.3	31.3	57.5	196.5	60	16.43
MT19135	137	0.0	1.3	11.3	53.8	73.8	305	16.25	18.80
MT19142	137	0.0	2.0	26.3	56.3	67.5	360.5	10	22.70
MT1915	138	0.0	0.8	28.8	66.3	72.5	395.5	9	18.65
MT1916	137.5	0.0	1.3	26.3	61.3	77.5	387.5	15.75	16.37
MT19183	136.75	0.0	0.8	13.8	31.3	58.8	238	17	25.48
MTS18149	135.25	0.0	0.5	11.8	46.3	76.3	294	16.75	16.24
Overley	123.5	2.8	57.5	67.5	93.8	100.0	898.5	32.5	29.28
SD15007-11	135	0.0	1.8	21.3	35.0	72.5	307	10.25	22.36
SD15007-5	135.5	0.3	2.0	15.0	33.8	57.5	251.5	17.75	24.40
SD15007-8	132.75	0.0	1.3	3.3	12.5	48.8	140.5	1.5	6.19
SD15025-1	132.75	0.0	1.0	13.8	18.8	48.8	194	3.25	13.32
SD15164-1	136.25	0.0	3.5	31.3	66.3	70.0	411.5	6.25	22.12
SD16008-7	124.5	0.3	5.5	17.5	41.3	65.0	305.5	6.25	8.52
SD17032	135.5	0.0	1.5	22.5	22.5	60.0	261	12	20.94
SD17141	127	0.3	13.8	42.5	68.8	73.8	511	11.25	15.32
SD17181	135.5	0.3	0.8	20.0	31.3	58.8	264	13.25	16.26
SD17246	134.5	0.0	2.5	30.0	63.8	66.3	390	20	36.67
SD17371	129.5	0.0	1.0	6.3	10.0	31.3	111.5	2.5	5.91
SD18009-4	134.25	0.0	0.5	8.8	8.8	53.8	162	3.5	9.38
SD18025-8	129.25	0.0	2.3	17.5	28.8	65.0	266.5	5	23.05
SD18036-1	126.5	0.5	10.5	32.5	61.3	67.5	431.5	3.5	13.24
SD18272-3	125	0.0	9.3	23.8	57.5	77.5	402	5.5	9.65
p-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.1466	<0.0001
cv	1.36	181.60	103.33	62.33	46.20	16.48	35.42	188.18	48.93
LSD[x] ($P = 0.05$)	2.53	0.32	6.15	14.46	23.92	14.26	127.10	--	10.78

[z]Days from January 1

[y]Area Under the Disease Progress Stairs

[x]Data were analyzed with R Core Team (2019). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/. Least significant difference (LSD) at P = 0.05 were calculated using the Agricolae package.

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

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Reaction of Kansas, Colorado and Nebraska winter wheat accessions to Fusarium head blight (FHB), 2020.

This experiment was conducted at Rocky Ford Research Station, Kansas State University, Manhattan, Kansas. The soil type at the field was Chase silty clay loam. The experimental design of Fusarium head blight (FHB) Nursery was a randomized complete block with four blocks where 50 entries from the Kansas, Colorado, and Nebraska breeding programs were randomly assigned within block. Experiment plots were single rows 2.3-m long spaced 0.51-m apart. Plots were seeded on 1 Oct 2019 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 plots at the rate 57g/m^2 three times on 10 Apr, 24 Apr, and 09 May 2019. Overhead, impulse sprinklers were used apply the water at the rate of 12 min every four hours overnight during anthesis. Visual estimations of the percent symptomatic spikelets (FHB index) was determined on 23 May, 27 May, 31 May, 02 Jun, 04 Jun, and 06 Jun and heading date (50% headed) per plot was also recorded. Plots were harvested on 01 Jul and the yield of each plot was recorded. Grain sub-samples per plot were visually rated for the percent *Fusarium* damaged kernels (FDK) and were sent to the North Dakota State University Toxicology lab for determination of deoxynivalenol (DON) concentration. FHB index of six 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, DON, yield, and FDK were also analyzed.

Good head blight symptoms were observed in all breeding lines. Mean AUDPC values varied with cultivars ($F = 11.41$, $P < 0.001$). 'Overley', the susceptible check had significantly high AUDPC values than other entries ($P < 0.001$) except BrawCLPlus, KS100028K^11, KS110409M-1, KS110489M-6, and KS120849K-9. Mean DON concentrations varied with cultivars ($F = 4.3$, $P < 0.001$). Breck had the highest DON levels (42.0 ppm) and it was statistically similar to Overley, KS110832M-2, and KS120742M-1. All other entries had statistically lower DON levels than Overley ($P < 0.001$). There was a significant negative correlation between mean AUDPC and heading date (Julian) ($n = 200$, $r = -0.24$, $P < 0.001$). Mean AUDPC was significantly correlated with mean FDK ($n = 200$, $r = 0.37$, $P < 0.001$) and mean DON ($n = 200$, $r = 0.26$, $P = 0.0002$). Mean yield had significant negative correlation with AUDPC ($n = 200$, $r = -0.53$, $P < 0.001$).

Fusarium head blight Index (% killed spikelets)												
NAME	Heading date(Julian)[z]	FHB1	FHB2	FHB3	FHB4	FHB5	FHB6	FDK (%)[y]	Average (FHB)[x]	Yield (g/plot)	DON (ppm)	AUDPC[w]
Antero	125.5	0.8	13.0	50.0	61.3	62.5	73.8	6.3	43.5	144.3	18.3	517.9
Avery	125.7	0.8	11.3	27.5	46.3	62.5	66.3	18.3	35.8	165.3	14.9	406.8
BrawlCLPlus	124.5	0.8	37.5	61.3	63.8	67.5	81.3	31.3	52.0	151.3	25.9	659.9
Breck	126.5	0.3	15.5	28.8	67.5	76.3	87.5	29.5	46.0	78.0	42.0	515.9
Canvas	126.5	0.5	4.8	17.5	35.0	37.5	62.5	3.3	26.3	277.8	9.3	277.4
CO13D0346	128.0	0.3	8.8	17.5	46.3	46.3	67.5	15.0	31.1	283.0	15.5	336.0
CO15D098R	126.7	0.3	13.0	37.5	57.5	61.3	76.3	10.0	41.0	169.5	20.4	472.1
Denali	128.2	0.3	4.3	20.0	32.5	45.0	76.3	13.8	29.7	154.0	19.5	306.5
Everest	132.0	1.0	2.5	21.3	31.3	43.8	73.8	5.8	28.9	269.3	11.3	297.8
FortifySF	125.2	0.3	10.5	20.0	40.0	37.5	60.0	11.5	28.0	177.3	8.6	312.1
Guardian	128.5	0.3	9.8	23.8	53.8	53.8	78.8	8.8	36.7	165.5	13.8	399.5
Hatcher	124.7	1.0	27.5	46.3	65.0	70.0	76.3	16.3	47.7	145.3	19.0	582.8
Karl92	124.5	0.8	20.0	33.8	46.3	48.8	77.5	6.5	37.8	159.0	13.3	439.9
KS100028K^11	125.2	1.5	47.5	61.3	77.5	77.5	82.5	41.3	58.0	95.0	25.5	744.8
KS100028K^12	126.5	0.5	9.3	27.5	46.3	53.8	77.5	25.0	35.8	108.0	16.0	393.1
KS110069K-3	125.5	0.3	7.8	31.3	51.3	66.3	73.8	35.0	38.4	86.8	15.6	430.0
KS110409M-1	125.2	1.3	33.8	66.3	73.8	78.8	88.8	24.5	57.1	86.0	21.9	712.5
KS110489M-6	125.2	1.0	45.0	67.5	81.3	81.3	88.8	16.3	60.8	107.8	13.2	775.3
KS110832M-2	129.2	0.0	8.0	33.8	55.0	63.8	77.5	50.0	39.7	138.0	40.6	444.3
KS120081K-1	125.2	1.0	11.3	31.3	53.8	65.0	73.8	28.3	39.3	194.5	14.1	445.9
KS120081K-7	128.5	0.0	3.3	12.5	41.3	35.0	62.5	12.5	25.8	175.3	21.6	263.9
KS120267K-5	132.0	1.0	21.3	38.8	63.8	61.3	72.5	12.0	43.1	267.5	12.9	514.6
KS120267M-3	128.2	0.8	18.8	42.5	61.3	63.8	75.0	22.5	43.7	214.3	11.3	519.3
KS120310M-3	126.5	0.8	27.5	37.5	56.3	40.0	73.8	22.0	39.3	87.5	16.2	476.1
KS120742M-1	124.2	1.0	10.3	40.0	63.8	65.0	78.8	38.8	43.1	130.3	31.1	493.6
KS120766M-6	129.2	0.0	11.8	31.3	46.3	48.8	65.0	24.0	33.8	123.5	15.0	389.9
KS120849K-9	128.7	0.5	30.0	52.5	76.3	78.8	93.8	28.8	55.3	53.5	20.6	667.0
KS15DH0055-11	126.0	0.5	4.5	20.0	45.0	42.5	62.5	5.8	29.2	226.8	16.5	314.0
Langin	127.5	1.3	12.8	32.5	55.0	60.0	76.3	20.0	39.6	169.8	8.8	450.3
Monarch	131.25	0.0	6.0	37.5	47.5	55.0	77.5	12.5	37.3	140.5	20.1	416.0
NE-13-515	129.5	0.0	8.0	17.5	36.3	38.8	62.5	14.0	27.2	163.3	20.9	293.0
NE-14-434	128.0	0.0	2.5	11.8	32.5	32.5	72.5	23.3	25.3	207.8	18.9	246.5
NE-14-494	129.2	0.0	2.5	12.5	30.0	28.8	58.8	9.0	22.1	172.5	12.5	222.5
NE-14-696	128.2	0.0	5.5	18.8	43.8	48.8	70.0	25.0	31.1	163.5	23.7	330.5
NE-15-624	129.7	0.0	4.8	13.8	50.0	53.8	71.3	25.0	32.3	178.0	15.7	336.6
NE-17-433	125.7	0.3	2.8	17.5	36.3	37.5	65.0	3.5	26.5	183.8	14.8	275.0
NE-17-441	125.2	0.3	6.8	21.3	40.0	40.0	58.8	1.8	27.8	294.3	7.5	306.5
NE-17-589	128.5	0.0	2.8	10.0	36.3	35.0	71.3	8.5	25.9	214.3	13.4	253.4
NE-17-629	130.2	0.3	3.5	15.0	31.3	47.5	56.3	2.5	25.6	171.3	13.9	271.4
NE-18-517	126.7	0.3	3.0	14.3	31.3	42.5	68.8	12.0	26.7	240.8	14.9	269.9
NE-18-640	131.5	0.5	1.8	6.3	23.8	33.8	62.5	9.0	21.4	151.8	17.3	203.1
NHH-17-447	125.5	0.8	13.5	35.0	52.5	50.0	65.0	15.0	36.1	193.3	23.2	423.4
NHH-17-450	125.7	0.8	16.3	23.8	37.5	40.0	65.0	5.8	30.5	251.5	11.9	349.3
NHH-17-612	128.0	0.3	6.5	11.3	41.3	42.5	58.8	8.0	26.8	217.3	21.3	283.1
NW-13-493	130.2	0.3	3.0	27.5	37.5	51.3	70.0	7.0	31.6	154.5	11.8	340.9
Overley	128.0	1.8	41.3	62.5	76.3	87.5	100.0	26.3	61.5	102.5	38.6	762.0
Snowmass2.0	129.0	0.0	12.3	27.5	41.3	45.0	52.5	12.5	29.8	224.0	22.8	350.4
WB4699	127.2	0.3	8.3	26.3	36.3	45.0	51.3	5.0	27.9	220.3	14.9	321.8
Whistler	133.0	0.0	6.5	31.3	42.5	46.3	75.0	18.8	33.6	93.8	18.8	369.0
Zenda	126.0	0.5	3.8	12.5	31.3	46.3	71.3	8.3	27.6	221.8	13.7	277.6
Average	127.5	0.5	12.8	29.7	48.6	52.8	71.7	16.7	36.0	171.3	18.1	409.2
LSD	2.18	0.7	14.4	17.0	15.9	14.5	13.2	8.0	16.6	73.9	10.3	119.7

[z]Days from January 1

[y] Fusarium damaged kernels

[x] Average rating from FHB1-FHB6

[w]Area Under Disease Progress Curve

WHEAT (*Triticum aestivum* 'multiple cultivars')
Fusarium head blight; *Fusarium graminearum*

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Reaction of Southern winter wheat accessions to Fusarium head blight, 2020.

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 35 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 01 Oct 2019. Corn kernel inoculum was grown with two aggressive *Fusarium graminearum* isolates (GZ-3639, Pt-1-04) and air-dried. Inoculum was spread onto the plots at a rate of 53 g/m^2 on 12 Apr, 27 Apr, and 12 May 2020. During anthesis, the nursery was mist irrigated to improve *F. graminearum* conditions for 12 minutes every 4 hours throughout the night for a total of 48 minutes per night. Heading dates were recorded when plots reached 50% headed tillers. FHB index was rated on 23 May, 27 May, 29 May, 31 May, 02 Jun, 04 Jun, and 06 Jun by determining the percent of symptomatic spikelets. Plots were harvested on 24 Jun 2020. Area under the disease progress stairs (AUDPS) and the least significant difference (LSD) (α=0.05) were calculated using the R package 'Agricolae' version 1.3-3 (Mendiburu, 2020). Data were analyzed with the 'aov' function (R Core Team, 2019).

The overall mean AUDPS severity rating was a high 618.4 units. This indicates that disease pressure was high in the nursery. The moderately susceptible check 'Overley' had an AUDPS rating of 904.5 and several lines were statistically no better. The best performing line by AUDPS rating was 'OK16103083' which had an AUDPS rating of only 193. The second best performing cultivar was 'Everest' with a AUDPS rating of 406.5 units. This nursery had a seven day range of heading dates and there was a slight negative correlation between heading date and AUDPS rating. Caution should be taken when comparing cultivars with widely differing heading dates.

Variety	Heading Date[z]	Plot Damage Severity (%)							AUDPS[y]
		23-May	27-May	29-May	31-May	02-Jun	04-Jun	06-Jun	
Baker's Ann	122.3	1.0	35.0	55.0	52.5	78.8	97.0	97.5	835.5
Everest	121.8	0.5	6.8	9.3	27.5	37.5	47.5	73.8	406.5
Green Hammer	123.3	1.3	35.0	65.0	55.0	80.0	97.0	92.5	854.0
Karl92	122.3	0.3	12.5	10.0	23.8	46.3	81.3	76.3	501.0
Langin	121.5	0.3	12.5	16.3	38.8	38.8	72.5	77.5	513.5
OCW04S717T-6W	127.0	0.3	33.8	15.5	26.3	43.8	72.5	57.5	499.5
OK09915C-1	124.3	1.0	50.0	68.8	81.3	75.0	97.0	97.5	943.0
OK12206-127206-2	124.3	0.3	9.3	11.0	25.0	48.8	72.5	76.3	486.5
OK16103083	128.3	0.0	5.5	6.8	10.5	23.8	18.8	31.3	193.0
OK16107125-17HR-5	125.3	0.3	13.8	17.5	23.8	38.8	58.8	58.8	423.5
OK16107131	124.8	1.5	27.5	35.0	40.0	53.8	72.5	66.3	596.0
OK16107155	124.8	1.0	21.3	35.0	56.3	58.8	82.5	76.3	664.0
OK16107157	125.8	0.8	30.0	38.8	43.8	63.8	83.8	76.3	675.5
OK16D101089	122.8	1.0	9.3	20.0	36.3	58.8	86.3	81.3	587.5
OK16D103071	121.5	0.5	20.0	10.0	27.5	43.8	88.8	86.3	554.5
OK188608	121.8	0.8	31.3	37.5	30.0	56.3	85.0	80.0	643.0
Overley	122.0	0.8	47.5	63.8	65.0	78.8	97.0	98.8	904.5
Showdown	126.0	0.8	12.5	17.5	31.3	51.3	72.5	73.8	520.5
Smith's Gold	124.3	0.3	25.0	27.5	36.3	61.3	80.0	78.8	618.5
Tam112	121.3	1.0	33.8	37.5	67.5	78.8	93.5	90.0	806.0
TAM114	123.3	0.5	18.8	17.5	42.5	55.5	86.3	82.5	608.0
TAM115	124.8	0.3	43.8	61.3	42.5	63.8	89.8	85.0	773.0
TAM204	124.8	0.3	12.5	21.3	27.5	45.0	78.8	63.8	498.5
TAM205	123.0	0.8	21.3	20.0	37.5	40.0	80.0	72.5	545.5
TX09A001194	122.3	1.0	25.0	43.8	46.3	57.5	87.3	86.3	696.0
TX14A001035	123.0	0.5	18.8	46.3	47.5	68.8	97.0	82.5	723.5
TX14M7061	124.0	0.3	22.5	27.5	42.5	66.3	91.3	80.0	661.0
TX15M8024	125.3	0.5	38.8	55.0	56.3	63.8	81.3	83.8	759.5
TX16M9216	123.8	0.8	36.3	50.0	55.0	72.5	97.0	85.0	794.5
TX16M9315	123.3	0.3	30.0	23.8	31.3	53.8	68.8	75.0	566.0
TX17M1296	124.0	0.8	17.5	31.3	30.0	63.8	85.0	72.5	603.0
TX17M1309	123.8	0.3	16.3	25.0	41.3	50.0	80.0	85.0	596.0
TX17M1652	122.3	0.8	21.3	18.8	30.0	60.0	88.8	91.3	623.0
WB4699	124.8	0.3	10.5	13.8	18.8	41.3	55.0	73.8	427.0
Zenda	123.5	0.0	15.5	15.5	31.3	45.0	85.0	80.0	544.5
p-value	<0.0001	<0.001	<0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
cv	0.80	82.15	66.07	43.28	39.96	20.78	12.15	11.72	17.76
LSD[x] (*P* = 0.05)	1.39	0.67	21.72	18.52	22.07	16.34	13.67	12.89	140.03

[z]Days from January 1

[y]Area Under the Disease Progress Stairs

[x]Data were analyzed with R Core Team (2019). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/. Least significant difference (LSD) at P = 0.05 were calculated using the Agricolae package.