

EFFECT OF WARMING ON AGRONOMIC AND DISEASE TRAITS IN WHEAT, 2015-2017

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For the past several years we have been evaluating the effect of soil warming on wheat breeding lines and varieties. With climate variability on the rise, it is important to identify possible sources of genes that we can use to breed more robust and stable varieties.

In order to increase soil temperature in the root zone, heating cables were buried at a depth of 1 inch between plant rows. The cables were attached to a data-logger so that when the temperature sensors indicated that the difference between control and warmed was less than 3°C, the heating cable would be turned on. In the control treatment there were no cables buried; thus soil temperature was not affected.

We were interested to know how different varieties and breeding lines would respond to warming in terms of agronomic performance and disease resistance. Table 1 shows the effect of warming on maturity, height and yield in a set of KY breeding lines that were part of a much larger group of lines we studied in 2017. With 240 lines, we had to grow them in small hill plots to fit all of them in the footprint of the warming setup. With very small micro plots like these the yield estimates are not accurate, but it is interesting to see the trend: warming

resulted in a yield reduction of ~ 4.5 bu/a or roughly 10 percent. Plant height was reduced by ½ inch and heading date was about 4 days earlier in the warmed treatment than in the control.

Table 2 shows the effect of warming on disease traits in this same set of breeding lines. In every disease studied, a higher level of disease was observed in the warm vs control treatments. All of the diseases are expressed on a 0-9 or a percentage basis; in both cases the lower the number, the less disease.

In Table 3 are the yield data from a 2-year study that was grown in single rows instead of hill plots. In this instance we are looking at the ratio of: yield in warmed treatment to yield in the control treatment. The ratio is then multiplied by 100 to provide a percentage of control yield estimate. The entries highlighted in yellow are those that had a reduced yield in response to warming both years of the study; entries in blue had a positive response to warming both years. For example, Agripro Branson had a yield in the warmed treatment that was 103% of the control yield in 2015 and 116% of the control yield in 2016. Lines like Branson may be good parents when breeding wheat that can tolerate warmer temperatures.

**Table 1. Heading Date, Plant Height and Yield of Wheat Breeding Lines
Under Control and Warmed Conditions, 2017.**

Line Name	Control	Warmed	Control	Warmed	Control	Warmed
	Heading Date (Jan. 1 = 1)		Plant Height (in)		Yield (bu/a)	
KY93C-1238-17-1	113.8	110.8	38.3	35.0	47.0	30.8
KY02C-1122-06	115.8	112.8	37.3	34.0	25.5	29.3
KY03C-1192-37	115.3	111.8	37.3	35.5	26.7	28.0
KY03C-1221-22	115.8	110.0	34.0	33.3	32.3	29.5
KY03C-2399-02	113.3	109.0	37.3	32.5	26.8	32.5
KY03C-1237-01	111.8	110.0	34.5	32.8	33.0	17.3
KY02C-1076-07	116.0	111.0	37.7	35.5	32.3	33.8
KY03C-1195-10-1-5	113.5	110.3	34.3	32.0	25.8	25.3
KY04C-2006-41-1-1	113.3	108.5	32.7	30.8	19.3	21.0
KY06C-1003-139-8-3	114.8	111.5	34.8	31.5	29.5	21.3
KY05C-1007-2-12-5	114.3	112.3	34.8	36.3	26.5	30.8
KY05C-1617-17-17-3	115.3	111.3	37.0	33.8	35.3	36.5
KY05C-1105-42-20-1	113.0	110.3	28.8	27.3	23.7	16.7
KY04C-1128-38-1-5	115.3	109.3	34.8	32.0	33.0	28.7
KY04C-3006-33-14-3	118.0	112.8	35.3	33.5	41.0	26.8
KY03C-2049-02	115.0	110.8	35.0	33.0	35.7	24.0
KY03C-1237-32	114.5	110.3	36.3	35.0	34.0	33.5
KY03C-1002-02	111.0	109.3	37.0	35.3	30.8	27.3
KY02C-2215-02	115.0	110.8	36.3	35.5	36.0	33.0
KY02C-1121-75	114.8	110.5	39.3	35.0	29.8	30.3
KY02C-1058-03	117.3	114.5	36.0	34.5	27.0	24.5
KY03C-2047-06	113.5	110.7	34.3	32.7	36.7	32.3
KY03C-2047-02	113.5	111.0	30.5	29.3	22.5	22.0
KY03C-1221-01	114.3	109.0	36.3	30.0	34.3	20.5
KY03C-1221-06	114.5	112.3	38.5	35.3	33.5	33.0
KY04C-2151-40	115.5	110.0	35.3	32.8	36.3	34.8
KY04C-2151-41	115.3	113.3	38.0	30.3	39.8	28.3
KY03C-2314-08	116.3	111.0	29.0	34.3	35.3	28.8
KY05C-1381-77-7-5	113.7	111.0	37.7	36.5	45.7	39.3
Average	114.6	110.9	35.4	33.3	32.2	28.3
Difference Control - Warmed	3.7		2.2		4.0	

Table 2. Effect of Warming on Disease Traits in Wheat Breeding Lines, Lexington, KY, 2017.

Line Name	Control	Warmed	Control	Warmed	Control	Warmed	Control	Warmed	Control	Warmed
	Scab Rating (0-9)		FDK (%)		Leaf Blotch Rating (0-9)		Mildew Rating (0-9)		Leaf Rust Rating (0-9)	
KY93C-1238-17-1	1.75	2.5	13.75	28.75	4.5	4.5	1.5	1.5	5	2.25
KY02C-1122-06	2	3.25	6.25	22.5	3.5	4	2	1	5.5	5
KY03C-1192-37	1.25	2.75	8.75	21.25	3.25	3.5	1.75	1.5	1.75	2
KY03C-1221-22	1.75	2.25	10	32.5	4	3.5	3	5	3.5	4
KY03C-2399-02	1.25	2	28.75	30	3.5	4	1	2	1	1.5
KY03C-1237-01	2	2.25	20	35	3	5	3.5	5.5	2.5	1.5
KY02C-1076-07	1.25	2	7.5	22.5	2.75	4.5	0.75	2	1.25	2.75
KY03C-1195-10-1-5	1.5	2	7.5	28.75	3.5	3.5	1	2.5	1.5	1.25
KY04C-2006-41-1-1	1.25	2.25	3.75	17.5	2.25	4.5	1.25	2.5	2.25	3.5
KY06C-1003-139-8-3	2	3	7.5	25	3	3	1.5	3	4.5	3
KY05C-1007-2-12-5	1.75	2.5	13.75	43.75	3	3.5	1	2	3	2
KY05C-1617-17-17-3	1.75	2.75	11.25	35	3	4.5	1	3	3	2.5
KY05C-1105-42-20-1	2.25	2.25	16.25	27.5	3	2.75	1	1.5	1	1.25
KY04C-1128-38-1-5	1	2	8.75	35	2.5	3.75	2.5	1.75	1	0.75
KY04C-3006-33-14-3	0.75	1.5	7.5	13.75	1.25	3.5	0.75	1	1.75	3.5
KY03C-2049-02	0.75	2	5	12.5	2.25	3	0.75	1	2.25	2.75
KY03C-1237-32	1.25	1.75	5	6.25	3	4	4.5	5	1	3
KY03C-1002-02	1.25	1.75	6.25	13.75	4	5	2	3.5	2	1.25
KY02C-2215-02	1.75	1.75	7.5	15	3.5	3	2.5	3	1.5	1.25
KY02C-1121-75	1.25	1.5	5	7.5	2.75	3	4	4.5	1	1
KY02C-1058-03	1.25	2.25	6.25	10	3	4	1	1.5	2	3
KY03C-2047-06	1.5	2	10	23.75	3	2.75	1.5	1.25	1	2
KY03C-2047-02	1.75	2.25	13.75	12.5	3	4.5	2	1.5	3.5	1.5
KY03C-1221-01	1	1.25	7.5	10	1.75	2.5	0.75	1	0.75	1
KY03C-1221-06	1.25	2.25	5	10	3	3	3.5	4	1	1.5
KY04C-2151-40	1.25	1.75	6.25	20	3	4	2	1.5	2	3.5
KY04C-2151-41	2.5	3.25	15	40	3	2.5	1.5	1.5	1.5	2.25
KY03C-2314-08	1.5	2	5	17.5	3	4	1.5	2.5	2.5	4
KY05C-1381-77-7-5	1	1.75	5	18.75	2.75	3.5	0.75	1	1.75	2.25
Average	1.47	2.16	9.44	21.94	3.00	3.68	1.78	2.36	2.15	2.31
Difference Control - Warmed	-0.69		-12.50		-0.68		-0.58		-0.16	

**Table 3. Comparison of Wheat Yield in Control and Warmed Environments,
Lexington, KY 2015 and 2016.**

YEAR	Entry	Yield Warm/Yield Control (%)	YEAR	Entry	Yield Warm/Yield Control (%)
2015	26R61	73.6	2016	26R61	87.3
2015	AR00255-16-1	87.7	2016	AR00255-16-1	61.4
2015	JAMESTOWN	90.9	2016	JAMESTOWN	84.3
2015	KWS013	69.3	2016	KWS013	67.3
2015	KY05C-1105-43-6-1	93.5	2016	KY05C-1105-43-6-1	96.8
2015	LA05130D-P5	79.2	2016	LA05130D-P5	52.7
2015	MD07W272-11-5	91.8	2016	MD07W272-11-5	73.5
2015	MDC07026-12-10	63.2	2016	MDC07026-12-10	62.9
2015	NC08-233324	71.2	2016	NC08-233324	60.9
2015	TRUMAN	90.4	2016	TRUMAN	68.5
2015	USG3555	79.5	2016	USG3555	57.4
2015	VA11W-301	95.3	2016	VA11W-301	89.1
2015	BRANSON	103.5	2016	BRANSON	116.6
2015	DANW1003	124.6	2016	DANW1003	127.6
2015	KWS011	115.6	2016	KWS011	113.6
2015	KY05C-1381-77-17-1	101.7	2016	KY05C-1381-77-17-1	109.8
2015	OH07-264-35	110.1	2016	OH07-264-35	139.0
2015	PEM16	117.4	2016	PEM16	109.7
2015	SHIRLEY	147.8	2016	SHIRLEY	147.8
2015	25R32	83.7	2016	25R32	104.9
2015	AGS200	90.5	2016	AGS200	115.7
2015	BESS	117.5	2016	BESS	43.9
2015	DANW1006	126.0	2016	DANW1006	91.7
2015	DANW1008	136.0	2016	DANW1008	84.0
2015	DINAH	105.7	2016	DINAH	65.6
2015	GA04121-11E26	90.8	2016	GA04121-11E26	121.1
2015	GA041293-11E54	110.2	2016	GA041293-11E54	80.4
2015	GA04434-11E44	198.6	2016	GA04434-11E44	69.4
2015	KY05C-1121-131-3-3	120.0	2016	KY05C-1121-131-3-3	74.6
2015	KY05C-1140-8-4-1	97.6	2016	KY05C-1140-8-4-1	137.8
2015	KY93C-1238-17-1	133.1	2016	KY93C-1238-17-1	84.4
2015	LA05038D-105	154.7	2016	LA05038D-105	86.2
2015	LCS10516	77.5	2016	LCS10516	122.9
2015	LCS19228	86.6	2016	LCS19228	104.4
2015	LCS19229	98.7	2016	LCS19229	116.8
2015	PEM08	58.6	2016	PEM08	115.9
2015	PEM14	59.4	2016	PEM14	132.7
2015	SS8700	122.5	2016	SS8700	87.2
2015	SSMPV57	75.1	2016	SSMPV57	180.6
2015	VA09W-73	97.7	2016	VA09W-73	110.8

