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Seeding Rate for Dryland Wheat

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Seeding Rate for Dryland Wheat

Abstract
Four winter wheat varieties (PlainsGold Byrd, Limagrain T158, Syngenta TAM 111, and WestBred Winterhawk) were planted at five seeding rates (30, 45, 60, 75, and 90 lb/a) in the fall of 2014, 2015, and 2016 at Colby, Garden City, and Tribune, KS. The objective of the study is to identify appropriate seeding rates for dryland winter wheat in western Kansas. Averaged across varieties, a seeding rate of 60 lb/a seemed to be adequate at all locations in 2015. However, with higher yields in 2016, a higher seeding rate (75 lb/a) was beneficial. Although yields were less in 2017 than 2016, a seeding rate of 75 lb/a generally produced the highest yields. The wheat variety T158 was the highest yielding (or in the highest group) at all locations in 2015. Other varieties may have been affected by differential response to stripe rust and winter injury resulting in lower yields. In 2016, the highest yielding variety varied by location. TAM 114 was in the highest yielding variety at each location in 2017. Variety selection and growing season appears to have more effect on wheat yields than seeding rate.

Keywords
seeding rates, dryland wheat, western Kansas wheat

Seeding Rate for Dryland Wheat

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Summary

Four winter wheat varieties (PlainsGold Byrd, Limagrain T158, Syngenta TAM 111, and WestBred Winterhawk) were planted at five seeding rates (30, 45, 60, 75, and 90 lb/a) in the fall of 2014, 2015, and 2016 at Colby, Garden City, and Tribune, KS. The objective of the study is to identify appropriate seeding rates for dryland winter wheat in western Kansas. Averaged across varieties, a seeding rate of 60 lb/a seemed to be adequate at all locations in 2015. However, with higher yields in 2016, a higher seeding rate (75 lb/a) was beneficial. Although yields were less in 2017 than 2016, a seeding rate of 75 lb/a generally produced the highest yields. The wheat variety T158 was the highest yielding (or in the highest group) at all locations in 2015. Other varieties may have been affected by differential response to stripe rust and winter injury resulting in lower yields. In 2016, the highest yielding variety varied by location. TAM 114 was in the highest yielding variety at each location in 2017. Variety selection and growing season appears to have more effect on wheat yields than seeding rate.

Introduction

The purpose of this project is to determine appropriate seeding rates for dryland winter wheat in western Kansas. In recent years, there appears to be an increase in seeding rate without corresponding increase in grain yields. A preliminary study conducted in 2014 found no yield benefit from increasing seeding rates from 30 to 75 lb seed/a for 4 wheat varieties at Tribune, while a similar study at Garden City suffered severe hail damage causing yields to be less than 10 bu/a. The objective is to evaluate seeding rates on grain yield of several popular wheat varieties representing a range of genetic backgrounds and tillering ability under dryland conditions at three sites in western Kansas.

Experimental Procedures

Four winter wheat varieties (Byrd, T158, TAM111, and Winterhawk) were planted at five seeding rates (30, 45, 60, 75, and 90 lb/a) in the fall of 2014 to 2016 at Colby, Garden City, and Tribune, KS. The date of seeding was October 20, 2014, October 14, 2015, and October 10, 2016 at Colby; October 9, 2014, October 9, 2015, and October 14, 2016 at Garden City; and September 26, 2014, October 13, 2015, and October 5, 2016 at Tribune. Seed size in 2015 was 15,839, 15,479, 17,627, and 12,921 seed/lb for Byrd, T158, TAM 111, and Winterhawk, respectively. All plots were planted on no-till fallow land. Harvest was done on July 4, 2015, July 10, 2016, and July 1, 2017 at Colby, June 29, 2015, June 22, 2016, and July 6, 2017 at Garden City, and June 30, 2015, July 4, 2016, and June 28, 2017 at Tribune. Growing season precipitation (October through June) for 2015 wheat was 14.03 in. at Colby, 12.18 in. at Garden City, and 12.83 in.

at Tribune. For 2016, growing season precipitation was 12.36 in. at Colby, 11.31 in. at Garden City, and 14.32 in. at Tribune. For 2017, growing season precipitation was 16.05 in. at Colby, 11.14 in. at Garden City, and 14.89 in. at Tribune. Starter fertilizer was applied (5.5-26-0 (nitrogen, N; phosphorus, P; and potassium, K)) at Garden City and (6-20-0) at Tribune each year. The wheat was topdressed with 90 lb N/a at Colby, 30 lb N/a at Garden City, and 60 lb N/a at Tribune in 2015. In 2016, wheat was fertilized pre-plant with 90 lb N/a at Colby, and topdressed with 100 lb N/a at Garden City, and 80 lb N/a at Tribune. In 2017, wheat was fertilized pre-plant with 60 lb N/a at Colby, and topdressed with 80 lb N/a at Garden City, and 80 lb N/a at Tribune. Herbicides were applied in the spring for weed control: Ally Extra (0.5 oz/a) at Colby in 2015, Huskie (15 oz/a) + Dicamba (2 oz/a) + Zidua (2 oz/a) in 2016, and Rave (4 oz/a) in 2017; Starane Ultra (0.4 pt/a) + MCPA (0.75 pt/a) + Ally (0.1 oz/a) at Garden City in 2015 to 2017; and dicamba (4 oz/a) + Ally (0.1 oz/a) at Tribune in 2015 to 2017. Plot size was 7.5 × 30 ft at Garden City, and 5 or 6 × 40 ft at Colby and Tribune. Fungicide was applied for control of stripe rust at flag leaf emergence at Colby and Tribune in 2016 and Colby in 2017. All treatments were replicated four times. Grain yields were determined by harvesting with a plot combine with moisture corrected to 13%.

Results and Discussion

Growing season precipitation was below normal for Garden City all years, but normal to above normal for Tribune and Colby. In addition, precipitation was infrequent and variable across the growing seasons. In 2015, precipitation was high in May (6.38 in. in Garden City, 6.16 in. at Tribune, and 6.42 in. at Colby) making up for a dry winter and early spring. For 2016, rainfall was above normal for Tribune, slightly below normal for Garden City, and below normal at Colby. April was wet with 5.16 in. at Tribune, 4.59 in. at Garden City, and 5.64 in. at Colby. In 2017, precipitation was above average at Tribune for April (4.67 in.) and May (5.00 in.), however, wheat streak mosaic virus reduced grain yield. At Garden City conditions were very dry in the fall of 2016 (0.3 in. between October and January), and the majority of the precipitation (6.58 in.) occurred in March and April. At Colby, conditions were extremely dry at seeding time followed by above normal precipitation in the late spring. A blizzard event on April 30 to May 1, 2017 resulted in the wheat being completely laid flat at the boot stage at Tribune and Colby with 14-20 inches of snow on top.

In 2015, averaged across seeding rates at Tribune, T158 and Winterhawk produced the greatest yields with TAM 111 producing the lowest yields (Table 1). At Colby and Garden City in 2015, T158 produced significantly higher yields than all other varieties. Stripe rust was prevalent in the 2015 growing season. Resistance ratings from the Kansas State University Department of Plant Pathology (publication MF991, Wheat Variety Disease and Insect Ratings 2016, E.D. Dewolf, R. Lollato, and R.J. Whitworth.), with a scale of 1 being resistant to 10 being susceptible, were 8, 2, 8, and 6 for Byrd, T158, TAM111, and Winterhawk, respectively. Stripe rust infestation and associated yield reductions at Colby (and other locations) were consistent with these ratings.

At all sites averaged across varieties in 2015, there was a positive yield response to increased seeding rates with greatest response when increasing from 30–60 lb/a with minimal response above 60 lb/a.

Wheat yields were very good at all locations in 2016 (Table 2). The response to variety and seeding rate varied greatly across locations. Averaged across seeding rates, Byrd produced the greatest yields at Tribune while it produced the lowest yields at Garden City. Winterhawk and T158 were the lowest yielding at Tribune while they were the highest yielding at Garden City and Colby. There was a significant positive yield response to increased seeding rate at Tribune and Colby but no significant response to seeding rate at Garden City.

Wheat yields were increased by increased seeding rates at all locations in 2017 (Table 3). Wheat yields were the lowest at Tribune (significant wheat streak mosaic virus damage) and greatest at Colby. TAM 114 was in the highest yielding group at all locations. The ranking of the other varieties depended upon location. The dry fall conditions in 2016 at Garden City likely reduced tiller development, resulting in reduced wheat yields at seeding rates less than 60 lb/a. Relative differences in growth stage among varieties at the time of the late spring blizzard may have affected their yield potential, however this was very difficult to assess.

Averaged across years (2015–2017), T158 was the highest yielding variety at Garden City and Colby (Table 4). Byrd was the highest yielding variety at Tribune, but the lowest yielding at the other two locations. At all locations, grain yields were increased by increased seeding rate. When averaged across all locations and years, yields were increased 8 bu/a by increasing seeding rate from 30 to 60 lb/a and an additional 3 bu/a when seeding rate was increased to 90 lb/a. There was not a significant variety × seeding rate interaction as all varieties responded positively to increased seeding rate. These results support a previous Kansas State University recommendation that the economic optimum seeding rate for rainfed winter wheat production in western Kansas is 60 lb/a, while the highest yield can be obtained with a 75 lb/a seeding rate.

In 11 site-years of this study, the variety × seeding rate interaction has only been significant in 2 of 11 years. At those two site years (Garden City and Tribune, 2015), increasing seeding rates resulted in increased yield for stripe rust-susceptible varieties. We hypothesize that higher seeding rates in the stripe rust-susceptible varieties partially compensated for lower per plant grain yield due to stripe-rust reducing productive leaf area. In general, the data collected in this study would not support the need for variety-specific seeding rate recommendations.

Table 1. Dryland wheat response to variety and seeding rate at three locations in 2015

Variety	Seeding rate	Grain yield			
		Tribune	Garden City	Colby	Average
	lb/a	bu/a			
Byrd	30	47	38	23	36
	45	52	42	25	40
	60	60	50	27	46
	75	53	51	29	45
	90	58	53	28	46
T158	30	58	72	45	59
	45	60	71	53	61
	60	64	79	56	67
	75	69	71	53	65
	90	71	65	55	64
TAM 111	30	39	34	20	31
	45	40	40	25	35
	60	43	44	28	39
	75	46	50	32	43
	90	44	52	34	43
Winterhawk	30	60	31	21	37
	45	66	41	25	44
	60	68	42	29	47
	75	64	51	34	50
	90	67	50	35	51

continued

Table 1. Dryland wheat response to variety and seeding rate at three locations in 2015

Variety	Seeding rate	Grain yield			
		Tribune	Garden City	Colby	Average
	lb/a	bu/a			
ANOVA (P>F)					
Variety		0.001	0.001	0.001	0.001
Seeding rate		0.001	0.001	0.001	0.001
Variety × seeding rate		0.046	0.001	0.731	0.124
Location					0.001
Location × variety					0.001
Location × seeding rate					0.743
Location × variety × seeding rate					0.001
Means[1]					
Variety					
Byrd		54b	47b	26b	43c
T158		64a	72a	53a	63a
TAM 111		42c	44bc	28b	38d
Winterhawk		65a	43c	29b	46b
$LSD_{0.05}$		2	3	3	2
Seeding rate (lb/a)					
30		51c	44c	27c	41c
45		55b	49b	32b	45b
60		59a	54a	35ab	49a
75		58a	56a	37a	50a
90		60a	55a	38a	51a
$LSD_{0.05}$		3	4	4	2

[1] Means within a column with the same letter are not statistically different at $P = 0.05$.
ANOVA = analysis of variance.
LSD = least significant difference.

Table 2. Dryland wheat response to variety and seeding rate at three locations in 2016

Variety	Seeding rate	Grain yield			
		Tribune	Garden City	Colby	Average
	lb/a	bu/a			
Byrd	30	70	78	89	79
	45	76	79	100	85
	60	81	76	103	87
	75	86	79	116	94
	90	90	78	103	90
T158	30	60	107	102	90
	45	67	109	115	97
	60	69	110	107	95
	75	74	114	111	99
	90	73	115	115	101
TAM 111	30	63	89	95	82
	45	65	91	91	82
	60	72	90	106	89
	75	75	95	108	93
	90	77	96	110	94
Winterhawk	30	61	95	94	83
	45	65	99	100	88
	60	67	101	112	94
	75	70	105	111	95
	90	74	103	114	97

continued

Table 2. Dryland wheat response to variety and seeding rate at three locations in 2016

Variety	Seeding rate	Grain yield			
		Tribune	Garden City	Colby	Average
	lb/a	bu/a			
ANOVA (P>F)					
Variety		0.001	0.001	0.029	0.001
Seeding rate		0.001	0.205	0.001	0.001
Variety × seeding rate		0.361	0.999	0.190	0.584
Location					0.015
Location × variety					0.001
Location × seeding rate					0.058
Location × variety × seeding rate					0.594
Means[1]					
Variety					
Byrd		81a	78d	102b	90c
T158		68c	111a	110a	96a
TAM 111		71b	92c	102b	88c
Winterhawk		68c	101b	106ab	91b
$LSD_{0.05}$		2	5	6	3
Seeding rate (lb/a)					
30		63d	92	95c	84d
45		68c	95	102b	88c
60		72b	94	107ab	91b
75		76a	98	112a	95a
90		78a	98	111a	96a
$LSD_{0.05}$		2	6	6	3

[1] Means within a column with the same letter are not statistically different at $P = 0.05$.
ANOVA = analysis of variance.
LSD = least significant difference.

Table 3. Dryland wheat response to variety and seeding rate at three locations in 2017

Variety	Seeding rate	Grain yield			
		Tribune	Garden City	Colby	Average
	lb/a	bu/a			
Byrd	30	26	25	47	33
	45	32	33	49	38
	60	29	36	53	40
	75	36	39	52	42
	90	38	35	56	43
T158	30	24	33	67	41
	45	29	40	71	47
	60	29	36	67	44
	75	34	43	75	51
	90	33	48	79	53
TAM 114	30	30	35	70	45
	45	30	41	72	48
	60	33	45	77	52
	75	37	47	72	52
	90	37	44	78	53
Winterhawk	30	24	26	62	37
	45	25	27	69	40
	60	31	38	65	45
	75	32	41	71	48
	90	34	41	74	50

continued

Table 3. Dryland wheat response to variety and seeding rate at three locations in 2017

Variety	Seeding rate	Grain yield			
		Tribune	Garden City	Colby	Average
	lb/a	bu/a			
ANOVA (P>F)					
Variety		0.014	0.001	0.001	0.001
Seeding rate		0.001	0.001	0.001	0.001
Variety × seeding rate		0.910	0.376	0.400	0.259
Location					0.001
Location × variety					0.001
Location × seeding rate					0.249
Location × variety × seeding rate					0.763
Means[1]					
Variety					
Byrd		32ab	34b	51c	39d
T158		30bc	40a	72a	47b
TAM 111		33a	42a	74a	50a
Winterhawk		29c	34b	68b	44c
$LSD_{0.05}$		3	4	3	2
Seeding rate (lb/a)					
30		26c	30c	61c	39c
45		29bc	35b	65b	43b
60		31b	39ab	66b	45b
75		35a	42a	67b	48a
90		36a	43a	72a	50a
$LSD_{0.05}$		3	4	4	2

[1] Means within a column with the same letter are not statistically different at $P = 0.05$.
ANOVA = analysis of variance.
LSD = least significant difference.

Table 4. Dryland wheat response to variety and seeding rate at three locations from 2015–2017

Variety	Seeding rate	Grain yield			
		Tribune	Garden City	Colby	Average
	lb/a	bu/a			
Byrd	30	47	47	53	49
	45	54	51	58	54
	60	57	54	61	57
	75	58	57	66	60
	90	62	55	62	60
T158	30	47	71	71	63
	45	52	73	80	68
	60	54	75	76	69
	75	59	76	79	72
	90	59	76	83	73
TAM 111/114	30	44	53	62	53
	45	45	58	63	55
	60	49	60	70	60
	75	53	64	71	62
	90	53	64	74	64
Winterhawk	30	48	51	59	52
	45	52	56	64	57
	60	55	60	69	62
	75	55	65	72	64
	90	59	65	75	66

continued

Table 4. Dryland wheat response to variety and seeding rate at three locations from 2015–2017

Variety	Seeding rate	Grain yield			
		Tribune	Garden City	Colby	Average
	lb/a	bu/a			
ANOVA (P>F)					
Variety		0.001	0.001	0.001	0.001
Seeding rate		0.001	0.001	0.001	0.001
Variety × seeding rate		0.305	0.680	0.178	0.306
Year		0.001	0.001	0.001	0.001
Year × variety		0.001	0.001	0.001	0.001
Year × seeding rate		0.013	0.247	0.125	0.521
Year × variety × seeding rate		0.391	0.103	0.327	0.356
Location					0.001
Location × variety					0.001
Location × seeding rate					0.890
Location × variety × seeding rate					0.381
Year × location					0.001
Year × location × variety					0.001
Year × location × seeding rate					0.013
Year × location × variety × seeding rate					0.085
Means[1]					
Variety					
Byrd		56a	53c	60c	56d
T158		54b	74a	78a	69a
TAM 111/114		49c	60b	68b	59c
Winterhawk		54b	59b	68b	60b
$LSD_{0.05}$		1	2	2	1
Seeding rate (lb/a)					
30		47e	55d	61d	54d
45		51d	59c	66c	59c
60		54c	62b	69b	62b
75		56b	65a	72a	65a
90		58a	65ab	73a	66a
$LSD_{0.05}$		2	3	3	1

[1] Means within a column with the same letter are not statistically different at $P = 0.05$.
ANOVA = analysis of variance.
LSD = least significant difference.