

Seeding Rate for Dryland Wheat

A. Schlegel, J. Holman, and L. Haag

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, 2016, and 2017 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. In 2018, yield increased with increased seeding rate. 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. In 2018, Winterhawk was the lowest yielding variety. Variety selection and growing season appears to have more effect on wheat yields than seeding rate. A seeding rate of 30 or 45 lb/a, and often 60 lb/a, resulted in lower yields than the 75 or 90 lb/a rate. Yield response to seeding rate, and optimal seeding rate for any site-year was similar across varieties.

Introduction

The purpose of this project is to determine appropriate seeding rates for dryland winter wheat in western Kansas, and to determine if the optimal seeding rate is dependent on variety. A preliminary study conducted in 2014 found no yield benefit from increasing seeding rates from 30 to 75 lb of 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 or TAM114, and Winterhawk
- Five seeding rates—30, 45, 60, 75, and 90 lb/a
- 2015 seed size (seed/lb) was Byrd (15,839), T158 (15,479), TAM 111 (17,627), and Winterhawk (12,921)

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. at 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 in 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 3). 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. De Wolf, 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 4). 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 5). 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.

Wheat yields increased by increasing seeding rates at all locations in 2018 (Table 6). Wheat yields were lowest at Garden City and highest at Colby. Yields by variety were generally mixed with the exception of Winterhawk being the lowest yielding variety at all three locations. As seeding rate increased from 30 to 90 lb/a, yields increased by 7, 7, and 16 bu/a at Garden City, Tribune, and Colby, respectively.

Averaged across years (2015–2018), T158 was the highest yielding variety at Garden City and Colby (Table 6). 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 by 8 bu/a from 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 \times seeding rate interaction as all varieties responded positively to increased seeding rate.

In 14 site-years of this study, a variety \times seeding rate interaction has only been observed in 2 site-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 reduction of productive leaf area due to stripe rust. In general, the data collected in this study would not support the need for variety-specific seeding rate recommendations.

Brand names appearing in this publication are for product identification purposes only. No endorsement is intended, nor is criticism implied of similar products not mentioned. Persons using such products assume responsibility for their use in accordance with current label directions of the manufacturer.

Table 1. Site conditions and factors at three locations of winter wheat seeding rate trials, 2015–2018

Site	Year	Planting date	Harvest date	Growing season precipitation ¹ in.	Fertilizer		
					Starter (N- P-K) lb/a	Pre-plant ----- lb N/a -----	Topdress
Colby	2015	10/20/2014	7/04/2015	14.03	---	---	90
	2016	10/14/2015	7/10/2016	12.36	---	90	---
	2017	10/10/2016	7/01/2017	16.05	---	60	---
	2018	10/11/2017	7/03/2018	12.54	---	---	90
Garden City	2015	10/09/2014	6/29/2015	12.18	5.5-26-0	---	30
	2016	10/09/2015	6/22/2016	11.31	5.5-26-0	---	100
	2017	10/14/2016	7/06/2017	11.14	5.5-26-0	---	80
	2018	10/12/2017	7/02/2018	7.96	5.5-26-0	---	40
Tribune	2015	9/26/2014	6/30/2015	12.83	6-20-0	---	60
	2016	10/13/2015	7/04/2016	14.32	5-16-0	---	80
	2017	10/05/2016	6/28/2017	14.96	7-23-0	---	80
	2018	10/12/2017	7/01/2018	7.99	7-24-0	---	100

¹October – June.

N = nitrogen. P = phosphorus. K = potassium.

Table 2. Herbicide application at three locations of winter wheat seeding rate trials, 2015–2018

Site	Year	Herbicides
Colby	2015	Ally Extra (0.5 oz/a)
	2016	Huskie (15 oz/a) + dicamba (2 oz/a) + Zidua (2 oz/a)
	2017	Rave (4 oz/a)
	2018	Rave (4 oz/a)
Garden City	2015	Starane Ultra (0.4 pt/a) + MCPA (0.75 pt/a) + Ally (0.1 oz/a) + NIS (0.25% v/v)
	2016	Starane Ultra (0.4 pt/a) + MCPA (0.75 pt/a) + Ally (0.1 oz/a) + NIS (0.25% v/v)
	2017	Starane Ultra (0.4 pt/a) + MCPA (0.75 pt/a) + Ally (0.1 oz/a) + NIS (0.25% v/v)
	2018	Starane Ultra (0.4 pt/a) + MCPA (0.75 pt/a) + Ally (0.1 oz/a) + NIS (0.25% v/v)
Tribune	2015	Dicamba (4 oz/a) + Ally (0.1 oz/a) + NIS (0.25% v/v)
	2016	Dicamba (4 oz/a) + Ally (0.1 oz/a) + NIS (0.25% v/v)
	2017	Dicamba (4 oz/a) + Ally (0.1 oz/a) + NIS (0.25% v/v)
	2018	Dicamba (4 oz/a) + Ally (0.1 oz/a) + NIS (0.25% v/v)

Table 3. Dryland wheat response to variety and seeding rate at three locations in 2015

Variety	Seeding rate	Grain yield			Average
		Tribune	Garden City	Colby	
	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 3. Dryland wheat response to variety and seeding rate at three locations in 2015

Variety	Seeding rate lb/a	Grain yield			
		Tribune	Garden City	Colby	Average
		----- 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
MEANS¹					
Variety					
Byrd		54 b	47 b	26 b	43 c
T158		64 a	72 a	53 a	63 a
TAM 111		42 c	44 bc	28 b	38 d
Winterhawk		65 a	43 c	29 b	46 b
LSD _{0.05}		2	3	3	2
Seeding rate (lb/a)					
30		51 c	44 c	27 c	41 c
45		55 b	49 b	32 b	45 b
60		59 a	54 a	35 ab	49 a
75		58 a	56 a	37 a	50 a
90		60 a	55 a	38 a	51 a
LSD _{0.05}		3	4	4	2

¹Means 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 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 4. Dryland wheat response to variety and seeding rate at three locations in 2016

Variety	Seeding rate lb/a	Grain yield			Average
		Tribune	Garden City	Colby	
		----- 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
MEANS¹					
Variety					
Byrd		81 a	78 d	102 b	90 c
T158		68 c	111 a	110 a	96 a
TAM 111		71 b	92 c	102 b	88 c
Winterhawk		68 c	101 b	106 ab	91 b
LSD _{0.05}		2	5	6	3
Seeding rate (lb/a)					
30		63 d	92	95 c	84 d
45		68 c	95	102 b	88 c
60		72 b	94	107 ab	91 b
75		76 a	98	112 a	95 a
90		78 a	98	111 a	96 a
LSD _{0.05}		2	6	6	3

¹Means within a column with the same letter are not statistically different at $P = 0.05$.

ANOVA = analysis of variance.

LSD = least significant difference.

Table 5. Dryland wheat response to variety and seeding rate at three locations in 2017

Variety	Seeding rate	Grain yield			Average
		Tribune	Garden City	Colby	
	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 5. Dryland wheat response to variety and seeding rate at three locations in 2017

Variety	Seeding rate lb/a	Grain yield			Average
		Tribune	Garden City	Colby	
		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
MEANS¹					
Variety					
Byrd		32 ab	34 b	51 c	39 d
T158		30 bc	40 a	72 a	47 b
TAM 114		33 a	42 a	74 a	50 a
Winterhawk		29 c	34 b	68 b	44 c
LSD _{0.05}		3	4	3	2
Seeding rate (lb/a)					
30		26 c	30 c	61 c	39 c
45		29 bc	35 b	65 b	43 b
60		31 b	39 ab	66 b	45 b
75		35 a	43 a	67 b	48 a
90		36 a	42 a	72 a	50 a
LSD _{0.05}		3	4	4	2

¹Means within a column with the same letter are not statistically different at $P = 0.05$.

ANOVA = analysis of variance.

LSD = least significant difference.

Table 6. Dryland wheat response to variety and seeding rate at three locations in 2018

Variety	Seeding rate	Grain yield			
		Tribune	Garden City	Colby	Average
	lb/a	bu/a			
Byrd	30	49	34	67	50
	45	55	31	71	52
	60	58	36	76	56
	75	57	40	76	58
	90	56	36	79	57
T158	30	47	28	63	46
	45	47	28	76	50
	60	51	35	78	54
	75	54	39	81	58
	90	54	40	85	60
TAM 114	30	47	33	70	50
	45	48	35	71	52
	60	50	42	79	57
	75	52	37	76	55
	90	56	40	87	61
Winterhawk	30	43	27	55	41
	45	45	29	58	44
	60	48	30	61	47
	75	45	33	67	48
	90	47	33	70	50

continued

Table 6. Dryland wheat response to variety and seeding rate at three locations in 2018

Variety	Seeding rate lb/a	Grain yield			
		Tribune	Garden City	Colby	Average
		----- bu/a -----			
ANOVA (P>F)					
Variety		0.001	0.001	0.001	0.001
Seeding rate		0.005	0.001	0.001	0.001
Variety × seeding rate		0.907	0.119	0.075	0.125
Location					0.001
Location × variety					0.001
Location × seeding rate					0.002
Location × variety × seeding rate					0.642
MEANS¹					
Variety					
Byrd		55 a	35 ab	74 b	55 a
T158		51 b	34 b	76 a	54 a
TAM 114		51 b	38 a	76 a	55 a
Winterhawk		46 c	30 c	62 c	46 b
LSD _{0.05}		3	2	3	2
Seeding rate (lb/a)					
30		46 c	30 b	64 d	47 d
45		49 bc	31 b	69 c	50 c
60		52 ab	36 a	73 b	54 b
75		52 ab	37 a	75 b	55 b
90		53 a	37 a	80 a	57 a
LSD _{0.05}		4	3	3	2

¹Means within a column with the same letter are not statistically different at $P = 0.05$.

ANOVA = analysis of variance.

LSD = least significant difference.

Table 7. Average dryland wheat response to variety and seeding rate at three locations from 2015–2018

Variety	Seeding rate	Grain yield			Average
		Tribune	Garden City	Colby	
	lb/a	bu/a			
Byrd	30	48	44	56	49
	45	54	46	61	54
	60	57	49	65	57
	75	58	52	68	60
	90	61	51	67	59
T158	30	47	60	69	59
	45	51	62	79	64
	60	53	65	77	65
	75	58	67	80	68
	90	58	67	84	69
TAM 111/114	30	5	44	48	52
	45	44	46	52	54
	60	50	50	55	59
	75	52	52	57	60
	90	54	54	58	63
Winterhawk	30	7	48	45	50
	45	48	50	49	54
	60	54	54	53	58
	75	53	53	57	60
	90	56	56	57	62

continued

Table 7. Average dryland wheat response to variety and seeding rate at three locations from 2015–2018

Variety	Seeding rate lb/a	Grain yield			Average
		Tribune	Garden City	Colby	
		----- 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		0.270	0.916	0.064	0.468
Year		0.001	0.001	0.001	0.001
Year × variety		0.001	0.001	0.001	0.001
Year × seeding rate		0.020	0.223	0.091	0.476
Year × variety × seeding rate		0.855	0.044	0.313	0.160
Location					0.001
Location × variety					0.001
Location × seeding rate					0.187
Location × variety × seeding rate					0.209
Year × location					0.001
Year × location × variety					0.001
Year × location × seeding rate					0.007
Year × location × variety × seeding rate					0.192
MEANS¹					
Variety					
Byrd		55 a	48 d	63 d	56 c
T158		53 b	64 a	78 a	65 a
TAM 111/114		49 d	54 b	70 b	58 b
Winterhawk		52 c	52 c	66 c	57 c
LSD _{0.05}		1	2	2	1
Seeding rate (lb/a)					
30		47 e	49 d	62 e	52 e
45		50 d	52 c	67 d	56 d
60		53 c	56 b	70 c	60 c
75		55 b	58 a	73 b	62 b
90		57 a	58 a	75 a	63 a
LSD _{0.05}		2	2	2	1

¹Means within a column with the same letter are not statistically different at $P = 0.05$.

ANOVA = analysis of variance.

LSD = least significant difference.