SEEDING RATE EFFECT ON WINTER TRITICALE AND SOFT WHITE WINTER WHEAT: YEAR II

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Abstract

Response of 'Celia' winter triticale and 'Stephens' soft white winter wheat to seeding rates was tested at the Central Oregon Agricultural Research Center (COARC), at Madras, Oregon, in the crop year 1998/1999. 'Stephens' had significantly higher yield, protein, test weight, and lodging, later heading date, more heads/ft^2, more fertile spikelets per spike, greater grain N uptake, grain protein yield, and grain N use efficiency than did 'Celia'. Yield was increased from 1-8 seeds/ft^2 seeding rate, but was not statistically different with the higher seeding rates. The lowest seeding rates produced the highest protein content; as seeding rates increased up to 4 seeds/ft^2, there was a significant decrease in protein content, then there was no statistical difference with higher seeding rates. Test weight increased up to 8 seeds/ft^2. Lodging increased as seeding rates increased beyond 16 seeds/ft^2. Increasing seeding rates, significantly increased heads per ft^2. Heads per seed planted decreased up to 16 seeds/ft^2, then there were no significant differences with higher seeding rates. Grain nitrogen uptake, protein yield, and grain N use efficiency was statistically highest at the seeding rate of 8 seeds/ft^2. Spikelets per spike were the same from 1-8 seeds/ft^2, then decreased significantly, as seeding rates increased. Seeding rates had a significant effect on seeds per pound and future seeding rates. The trial is the second year results of a 2-year study.

Introduction

Most cereal acreage is devoted to soft white winter wheat in central Oregon. Winter triticale is a "new" cereal crop with high yield potential. Interest in triticale is growing for both grain and forage purposes. The grain is excellent for livestock feed, especially in swine and poultry rations. Triticale is also being used for human food. 'Celia' winter triticale has the ability to outyield barley and is less prone to lodging and disease. 'Celia' also has superior test weight in comparison to other triticale varieties. There is less cultural information available for triticale. A seeding rate trial was initiated in October 1997 to compare yield, quality, and other agronomic responses of 'Celia' winter triticale and 'Stephens' soft white winter wheat. It also generates useful information in comparing yields from a reduced plant population from simulated winter-kill, even though winter-killed plants are not usually evenly spaced. Information generated will allow better production practice decision-making.

Materials and Methods

'Celia' winter triticale and 'Stephens' soft white winter wheat were planted on October 16, 1998, at the rate of 1, 2, 4, 8, 16, 20, 30, and 40 seeds/ft^2 with a six-row, 8-inch row spacing, Oyjard small-plot cone-type planter. The pounds per acre seeding rates are presented in Table 1. The design was randomized complete block, two factor, factorial

design, with four replications. Plot size was 4.5 by 20 ft, with approximately 4.5 by 15 ft harvested.

The field was sampled with a soil probe to bedrock (2 ft deep) on February 20, 1999. Soil analyses were performed by Agri-Check Laboratory, Umatilla, OR, and soil test results are listed in Table 2. The previous crop was "fallow", preceded by Kentucky bluegrass for multiple years. It was assumed that approximately 20 lb/acre nitrogen was taken up by the plants at the time of sampling. The trial was fertilized with 144 lb/acre N, 72.6 lb/acre P_2O_5, and 74.8 lb/acre S (290 lb/acre of 30-0-0-7 and 363 lb/acre of 16-20-0-15) on April 6, 1999. The trial was irrigated as needed with 30 by 40 ft spacing, solid-set sprinkler lines with 9/64-inch Rainbird® nozzles.

Heading dates were recorded and just prior to harvest, plant height was measured and lodging was estimated. The trial was harvested on August , 1999 with a Hege small plot combine. The grain samples were shipped to Corvallis and processed. Protein was predicted by NIRS whole grain analyzer and 1,000-kernel weight and test weight determined. Yield and protein was presented on a 10 and 12 percent moisture basis. Seeds per pound, heads per ft^2, and heads per seed planted were calculated. Ten heads were counted for fertile spikelets per spike. Grain N uptake was calculated by dividing percent protein by a factor of 5.7 and converted to percent N and then multiplied by yield (lb/acre) at zero percent moisture. Grain protein yield was calculated by multiplying percent protein times yield (lb/acre) at zero percent moisture. Grain N use efficiency was calculated by dividing grain N uptake by "total" nitrogen available in the soil and the repective fertilizer N applied. Future seeding rates were calculated by multiplying seeds per ft^2 times 43,560 ft^2 (1 acre) and dividing by seeds per pound.

MSTAT-C computer software was used for statistical analyses.

Table 1. Seeding rate in pounds per acre based on seeds per square foot for the 'Celia' winter triticale and 'Stephens' soft white winter wheat seeding rate trial planted on October 16, 1998 at the COARC, Madras, OR,.

	1 Seed/ft^2	2 Seeds/ft^2	4 Seeds/ft^2	8 Seeds/ft^2	16 Seeds/ft^2	20 Seeds/ft^2	30 Seeds/ft^2	40 Seeds/ft^2
Variety	lb/acre	lb/acre	lb/arec	lb/acre	lb/acre	lb/acre	lb/acre	lb/acre
Celia	3.8	7.7	15.4	31.7	63.4	78.7	118.1	157.4
Stephens	4.8	10.6	22.9	41.3	82.6	103.7	155.5	207.4

Table 2. Soil test results from the soil sample taken on February 20, 1999, at the COARC, Madras, OR.

Soil Depth (inches)	pH	P (ppm)	K (ppm)	NO_3 (lb/acre)	NH_4 (lb/acre)
0-12	7.3	17	366	28	11
12-24	8.2	8	180	56	9
Total				84	20

Results and Discussion

The results for grain yield, protein content, test weight, height, lodging, and heading date are presented in Table 3. The results for 1,000-kernel weight, seeds per pound, heads per square ft, heads per seed planted, and fertile florets per spike are presented in Table 4. Results for grain N uptake, protein yield, grain N use efficiency for first ft NO_3 + applied N, grain N use efficiency for first and second ft NO_3 + applied N, and grain N use efficiency for first and second ft NO_3 + NH_4 + applied N are presented in table 5. The results for future seeding rate in pounds per acre for 1, 2, 4, 8, 16, 20, 30, and 40 seeds per square foot are presented in Table 6.

'Stephens' soft white winter wheat was significantly higher yielding (165.7 bu/acre vs. 144.5 bu/acre) than 'Celia' winter triticale (Table 3). There was a significant increase in yield, as seeding rates increased from 1-8 seeds/ft^2. Maximum statistical yield was reached with the 8 seeds/ft^2 seeding rate. The highest numerical yield (see Table 3) was produced with 30 and 40 seeds/ft^2, but was not statistically different from 8 and 30 seeds/ft^2, but was statistically higher yielding than 16 and 20 seeds/ft^2 seeding rate.

'Stephens' produced a significantly higher protein content (9.7 vs. 8.8 percent) than did 'Celia'. The low seeding rate (1 and 2 $^{seeds}/ft^2$) produced the highest protein content (10.1 and 9.9 percent), which was significantly higher than 4 and 8 seeds/ft^2 seeding rate. There were no statistical differences in protein contents from 16-40 seeds/ft^2. There was no difference from 16-30 seeds/ft^2, but 40 seeds/ft^2 had higher protein content than did 16 seeds/ft^2.

'Stephens' had significantly higher test weight (59.1 lb/bu vs. 56.3 lb/bu) than did 'Celia'. Test weights from the of seeding rates of 1 and 2 seeds/ft^2 were significantly less than all other seeding rates. Test weight of 4 seeds/ft^2 was significantly less than 8 and 16 seeds/ft^2. Twenty seeds/ft^2 had lighter test weight than 8 and 16 and 30 and 40 seeds/ft^2. Test weight of the 30 seeds/ft^2 was the highest, though it was not significantly different from 8, 16, and 40 seeds/ft^2. Planting 8-40 seeds/ft^2 would achieve desired test weight.

'Celia' seeding rate treatments of 30 and 40 seeds/ft^2 were significantly taller than 2 seeds/ft^2, but were not different from the rest of the seeding rates for 'Celia'. Plants at 1 seed/ft^2 rate were significantly shorter than all of the other seeding rates for 'Stephens'. 'Celia's' seeding rate of 1 seed/ft^2 produced plants significantly taller than 'Stephens', then height was comparatively the same up to 16 seeds/ft^2. From 20 to 40 seeds/ft^2, Celia was significantly taller.

‘Stephens’ is significantly more prone to lodging than ‘Celia’. Seeding rate increased lodging as seeding rates went beyond 16 seeds/ft^2. There was a definite trend for Stephens to lodge more at the higher seeding rates.

‘Stephens’ headed out one day earlier than did ‘Celia’. There were no heading date differences between seeding rates.

Thousand-kernel weight was the same at 1 seeds/ft^2 for both ‘Stephens’ and ‘Celia’. ‘Stephens’ had greater 1,000-kernel weight from 2 to 40 seed / ft^2 compared to ‘Celia’. Thousand-kernel weight for ‘Celia’ seeding rate of 8 seeds/ft^2 was higher than 16 and 20 seeds/ft^2, but equaled the kernel weight of all other seeding rates. Highest numerical 1,000-kernel weight was 42.4 g for ‘Celia’ at 8 seeds/ft^2 and 46.4 g for ‘Stephens’ at 8 and 16 seeds/ft^2.

Seeds per pound were the inverse of 1000-kernel weight.

Heads/ft^2 were significantly higher for ‘Stephens’ than ‘Celia’ (78.7 vs. 52.2 heads/ft^2). As the seeding rate increased, there was a definite trend for increasing heads/ft^2 (from 38.7 to 92.2), with the exception of a decrease from 4 to 8 seeds/ft^2. Significant increases occurred from 1 to 2 seeds/ft^2, but not from 2 to 4 seeds, and then a decrease from 4 to 8 seeds (though not significant), and then a significant increase from 8 to 16 seeds/ft^2. From 16-40 seeds/ft^2, there was a very strong trend for increasing number of heads/ft^2, though not always a significant difference between each higher seeding rate.

For heads per seed planted, Stephens had significantly greater ability to produce more heads per seed planted from 1-4 seeds/ft^2 (Table 4). As seeding rates increased beyond 4 seeds/ft^2, there were no differences between ‘Celia’ and ‘Stephens’ ability to produce heads. ‘Stephens’ ability to tiller, and produce more heads/ft^2 than ‘Celia’, was at the rate of 155, 127, 144, 166, 156, 141, 155, and 156 percent greater at the respective seeding rates of 1-40 seeds/ft^2.

Though ‘Celia’ has less ability to tiller than ‘Stephens’, ‘Celia’ made up for this difference, with its ability to significantly produce a larger number of fertile spikelets per spike (Table 4). The average was 245 percent greater fertile spikelets per spike, over all seeding rates. The two varieties responded the same from 1-8 seeds/ft^2, but then there was a significant decrease in fertile spikelets per spike at 16 and 20 seeds/ft^2, compared to the lower seeding rates. Fertile spikelets per spike significantly decreased with the next higher seeding rates of 30 and 40 seeds/ft^2. As seeding rates increase, fertile spikelets per spike decrease.

‘Stephens’ had greater nitrogen uptake and more protein yield than did ‘Celia’ (Table 5). Highest numerical nitrogen uptake and protein yield occurred with 8, 30, and 40 seeds/ft^2 seeding rate. Eight seeds/ft^2 were significantly greater than 1-2 seeds/ft^2. There was a strong trend for 8 seeds/ft^2 to be greater than 4 seeds/ft^2, but was not significantly different. From 8 to 40 seeds/ft^2, there was no difference statistically.

Three different grain N use efficiency versions are presented in table 5 for comparison. The numbers change, but the statistics do not change. If one only takes into account the top foot of soil NO_3 + fertilizer N, it does not take into account, deeper soil N as evidenced by the greater than 100 percent efficiency for nitrogen recovery in one of the treatments. This discussion will focus on the efficiency of the grain N recovery, looking at first and second foot NO_3 + fertilizer N applied, which is the more generally accepted practice. 'Stephens' was about 15 percent more efficient than 'Celia' in grain N recovery. The grain N use efficiency would mirror the discussion in the grain N uptake. For seeding rates, grain N use efficiency was significantly higher, increasing seeding rates from 1 to 2 seeds/ft^2, but not from 2-4 seeds/ft^2, nor from 4 to 8 seeds/ft^2. Eight seeds/ft^2 had greater grain N use effiency though than did 2 seeds/ft^2. Beyond 8 seeds/ft^2 there were no differences in grain N recovery efficiency.

The calculated future seeding rate in pounds per acre (Table 6) for 'Stephens' from the seed produced in this trial was significantly higher than 'Celia' at all seeding rates. There was a variety by seeding rate interaction. The seeding rates (pounds per acre) used for planting the trial were almost identical for the future seeding rate produced by 'Celia', but were heavier than 'Stephens' future seeding rate produced. 'Stephens' produced lower future seeding rates (lb/acre), compared to the seed planted. The table is provided as an example reference for seeding rates, based on seeds/ft^2.

Summary

Grain yield, protein and nearly all agronomic pararmeters were influenced by species and by seeding rate. Speices and seeding rates did not interact for the most part to influence agronomic characteristics. Seeding rates of less than 8 seeds/ft^2 resulted in reduced yields, increased grain protein, and lower grain use efficiency, even though the species showed great capacity to compensate for low population. At seeding rates above 8 seeds/ft^2, differences among seeding rates were generally not statistically significant. Seeding rates of 20 seeds/ft^2 or more resulted in more lodging for 'Stephens' soft white winter wheat, but not for 'Celia' winter tiricale.

The 1999 results were similar for the 1998 trial, though there were more species by seeding rate interactions with the 1998 trial. Yield and lodging responses were similar, with the exception that lodging was greater in 1998; the 30 and 40 seeds/ft^2 seeding rates had higher lodging and thus yield was significantly depressed at those higher seeding rates for 'Stephens' in comparison. Highest yield for both species was achieved with 16 seeds/ft^2 in 1998 vs. 8 seeds/ft^2 in 1999. These seeding rates are ¼ to ½ of the normal practice of planting around 30 seeds/ft^2. Lodging depressed grain N uptake and protein yield in 1998 for 'Stephens' at the two highest seeding rates. In general, the rest of the agronomic parameters responses were similar.

Reducing seeding rates would appear to have some merit with varieties that are high yielding, but are more prone to lodging. Research would need to be conducted on each variety to determine the optimum seeding rate, in order to reduce lodging, but still

maintain maximum yield. It also has some economic merit to the producer for reducing seed purchases.

This was the second year of a 2-year trial comparing ‘Celia’ winter triticale to ‘Stephens’ soft white winter wheat. The purpose of the trial was to generate more cultural production information for winter triticale. In the process, other valuable information on ‘Stephens’ has been generated. It would be better to have a third year of data, but we doubt this trial will ever be continued for budget and resource reasons and ‘Celia’ is a variety that is no longer in demand.

Acknowledgements

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Table 3. The effect of seeding rates on the yield, protein, test weight, height, lodging, and heading date of 'Celia' winter triticale and 'Stephens' soft white winter wheat planted on October 18, 1998 at the COARC, Madras, OR.

Treatments	Yield (bu/acre)	Protein (%)	Test wt. (lb/bu)	Height (in.)	Lodging (%)	Heading date (day of year)
Variety						
Celia	144.5	8.8	56.3	38.9	1.4	162.4
Stephens	165.7	9.7	59.1	37.1	13.8	163.3
Seed rate (Seeds/ft^2)						
1	103.1	10.1	56.7	36.8	0.6	163.4
2	136.0	9.9	56.9	37.7	3.3	162.8
4	151.3	9.3	57.6	37.9	2.4	163.3
8	169.5	9.2	58.1	38.8	1.8	162.8
16	162.5	8.6	58.2	37.4	1.0	162.4
20	163.3	8.8	57.8	38.4	13.3	162.9
30	177.4	9.1	58.3	38.9	18.9	162.8
40	177.9	9.1	58.1	38.4	19.5	162.8
Variety x Seed rate (seeds/ft^2)						
Celia						
1	92.9	10.0	55.4	38.4	0.0	162.5
2	126.3	9.9	55.4	37.5	0.8	162.3
4	139.4	8.9	56.2	38.8	2.3	163.0
8	151.5	8.6	56.5	38.5	1.3	162.8
16	144.9	7.9	57.0	37.8	0.5	161.5
20	150.7	8.1	56.5	39.5	1.0	162.3
30	174.3	8.6	56.7	40.9	2.8	163.0
40	176.2	8.8	56.8	39.9	2.8	162.3
Stephens						
1	113.3	10.2	58.0	35.1	1.3	164.3
2	145.6	10.0	58.3	37.9	2.8	163.3
4	163.1	9.7	59.0	37.0	2.5	163.5
8	187.5	9.8	59.8	39.0	2.3	162.8
16	180.0	9.4	59.4	37.0	1.5	163.3
20	176.0	9.6	59.1	37.3	25.5	163.5
30	180.5	9.6	60.0	36.9	36.0	162.5
40	179.5	9.5	59.4	37.0	36.3	163.3
Mean	155.1	9.3	57.7	38.0	7.6	162.9
Variety						
PLSD 0.10	S	S	S	S	S	S
PLSD 0.05	S	S	S	S	S	S
Seed Rate						
PLSD 0.10	13.1	0.6	0.4	NS	13.9	NS
PLSD 0.05	15.7	0.7	0.5	NS	NS	NS
Variety x Seed rate						
PLSD 0.10	NS	NS	NS	2.0	NS	NS
PLSD 0.05	NS	NS	NS	NS	NS	NS
CV%	10.0	7.6	0.9	4.4	219.1	0.6
P > F Variety	0.0000	0.0000	0.0000	0.0001	0.0047	0.0015
P > F Seed rate	0.0000	0.0014	0.0000	0.1779	0.0817	------[2]
P > F Variety x Seed rate	0.3425	0.3129	-----[2]	0.0749	0.1516	0.2812

[1] Heading date = days from January 1.

[2] ------ = off of the scale, no number presented by MSTAT software

Table 4. The effect of seeding rates (seeds/ft^2) on 'Celia' winter triticale and 'Stephens' soft white winter wheat 1,000-kernel weight, seeds per pound, heads per ft^2, heads per seed planted, and spikelets per spike, planted on October 16, 1998 at the COARC, Madras, OR.

Treatments	1,000-kernel wt. (g)	Seeds per lb	Heads per ft^2	Heads per seed planted	Fertile spikelets per spike
Variety					
Celia	40.9	11,091	52.2	10.1	32.2
Stephens	44.9	10,140	78.7	14.6	14.4
Seed rate (Seeds/ft^2)					
1	41.8	10,878	38.7	38.7	24.6
2	43.0	10,573	51.7	25.8	24.5
4	43.7	10,435	58.0	14.5	24.5
8	44.4	10,246	52.9	6.6	24.2
16	43.0	10,623	69.6	4.3	22.6
20	42.4	10,773	77.1	3.8	23.2
30	43.0	10,595	83.7	2.8	21.8
40	42.1	10,800	92.2	2.3	21.1
Variety x Seed rate (seeds/ft^2)					
Celia					
1	41.5	10,943	30.4	30.4	32.7
2	41.7	10,892	45.6	22.8	32.9
4	41.7	10,889	47.7	11.9	33.4
8	42.4	10,706	40.0	5.0	32.9
16	39.6	11,456	54.2	3.4	31.9
20	39.3	11,529	63.9	3.2	32.3
30	40.8	11,129	65.1	2.2	31.1
40	40.6	11,184	71.0	1.8	30.2
Stephens					
1	42.1	10,812	47.0	47.0	16.4
2	44.2	10,255	57.7	28.9	16.2
4	45.6	9,982	68.3	17.1	15.6
8	46.4	9,787	65.8	8.3	15.5
16	46.4	9,791	84.9	5.3	13.4
20	45.4	10,017	90.2	4.5	14.0
30	45.2	10,061	102.3	3.4	12.6
40	43.6	10,418	113.5	2.8	11.9
Mean	42.9	10,616	65.5	12.4	23.3
Variety					
PLSD 0.10	S	S	S	S	S
PLSD 0.05	S	S	S	S	S
Seed rate					
PLSD 0.10	1.5	356	9.8	3.8	0.9
PLSD 0.05	NS	NS	11.7	4.6	1.0
Variety x Seed rate					
PLSD 0.10	2.1	504	NS	5.4	NS
PLSD 0.05	2.5	604	NS	6.5	NS
CV%	4.1	4.0	17.8	37.0	4.4
P > F Variety	0.0000	0.0000	0.0000	0.0002	0.0000
P > F Seed rate	0.0961	0.0924	0.0000	0.0000	0.0000
P > F Variety x Seed rate	0.0317	0.0236	0.1793	0.0248	0.2632

Table 5. The effect of seeding rates (seeds/ft^2) on Celia winter triticale and 'Stephens' soft white winter wheat grain N uptake, grain protein yield, and grain N use effiency planted on October 16, 1998 at the COARC, Madras, OR.

Treatments	Grain N uptake (lb/acre)	Grain protein yield (lb/acre)	Grain N use eff. 1st ft NO_3 + applied N (%)	Grain N use eff. 1st & 2nd ft NO_3 + applied N (%)	Grain N use eff. 1st & 2nd ft. NO_3 + NH_4 + applied N (%)
Variety					
Celia	136.6	778.5	70.8	54.9	50.8
Stephens	172.9	985.6	89.6	69.4	64.3
Seed rate (seeds/ft^2)					
1	112.7	642.6	58.4	45.3	41.9
2	145.5	829.3	75.4	58.4	54.1
4	152.6	870.0	79.1	61.3	56.8
8	169.7	967.5	88.0	68.2	63.1
16	152.0	866.4	78.8	61.0	56.5
20	156.2	890.1	80.9	62.7	58.1
30	174.1	992.5	90.2	69.9	64.7
40	175.1	998.3	90.8	70.3	65.1
Variety x Seed rate (seeds/ft^2)					
Celia					
1	100.9	575.3	52.3	40.5	37.5
2	134.6	767.3	69.7	54.0	50.0
4	133.9	763.3	69.4	53.8	49.8
8	140.7	802.3	72.9	56.5	52.3
16	122.5	698.0	63.4	49.2	45.5
20	131.2	747.5	68.0	52.7	48.8
30	161.2	919.0	83.5	64.8	59.9
40	167.7	955.7	86.9	67.4	62.4
Stephens					
1	124.5	710.0	64.5	50.0	46.3
2	156.4	891.3	81.0	62.8	58.1
4	171.4	976.8	88.8	68.8	63.7
8	198.8	1,132.8	103.0	79.8	73.9
16	181.6	1,034.8	94.1	72.9	67.5
20	181.2	1,032.8	93.9	72.8	67.4
30	187.0	1,066.0	96.9	75.1	69.5
40	182.6	1,040.8	94.6	73.3	67.9
Mean	154.7	882.1	80.2	62.1	57.5
Variety					
PLSD 0.10	S	S	S	S	S
PLSD 0.05	S	S	S	S	S
Seed rate					
PLSD 0.10	20.4	116.2	10.6	8.2	7.6
PLSD 0.05	24.5	139.3	12.7	9.8	9.1
Variety x Seed rate					
PLSD 0.10	NS	NS	NS	NS	NS
PLSD 0.05	NS	NS	NS	NS	NS
CV%	15.7	15.7	15.7	15.7	15.7
P > F Variety	0.0000	0.0000	0.0000	0.0000	0.0000
P > F Seed rate	0.0000	0.0001	0.0000	0.0000	0.0000
P > F Variety x Seed rate	0.4236	0.4251	0.4254	0.4244	0.4215

Table 6. The effect of seeding rates on 'Celia' winter triticale and 'Stephens' soft white winter wheat trial seed produced for future seeding rates of 1, 2, 4, 8, 16, 20, 30, and 40 seeds per ft^2, in pounds per acre, planted on October 16, 1998 at the COARC, Madras, OR.

Treatments	Future seed rate 1/ ft^2 (lb/acre)	Future seed rate 2/ft^2 (lb/acre)	Future seed rate 4/ft^2 (lb/acre)	Future seed rate 8/ft^2 (lb/acre)	Future seed rate 16/ft^2 (lb/acre)	Future seed rate 20/ft^2 (lb/acre)	Future seed rate 30/ft^2 (lb/acre)	Future seed rate 40/ft^2 (lb/acre)
Variety								
Celia	3.9	7.9	15.7	31.5	62.9	78.7	118.0	157.3
Stephens	4.3	8.6	17.2	34.5	68.9	86.2	129.2	172.3
Seed rate (seeds/ft^2)								
1	4.0	8.0	16.1	32.1	64.2	80.3	120.4	160.6
2	4.1	8.3	16.5	33.0	66.0	82.5	123.8	165.1
4	4.2	8.4	16.8	33.5	67.0	83.8	125.7	167.6
8	4.3	8.5	17.1	34.1	68.2	85.3	127.9	170.6
16	4.1	8.3	16.5	33.0	66.1	82.6	123.9	165.2
20	4.1	8.1	16.3	32.5	65.1	81.4	122.0	162.7
30	4.1	8.2	16.5	33.0	66.0	82.6	123.8	165.1
40	4.0	8.1	16.2	32.3	64.7	80.8	121.3	161.7
Variety x Seed rate (seeds/ft^2)								
Celia								
1	4.0	8.0	15.9	31.9	63.8	79.7	119.5	159.3
2	4.0	8.0	16.0	32.1	64.7	80.1	120.1	160.2
4	4.0	8.0	16.0	32.0	64.1	80.1	120.1	160.2
8	4.0	8.1	16.3	32.6	65.2	81.4	122.1	162.8
16	3.8	7.6	15.3	30.4	60.9	76.1	114.1	152.2
20	3.8	7.6	15.1	30.2	60.5	75.6	113.4	151.2
30	3.9	7.9	15.7	31.4	62.7	78.4	117.6	156.8
40	3.9	7.8	15.6	31.2	62.3	77.9	116.9	155.8
Stephens								
1	4.0	8.1	16.2	32.4	64.7	80.9	121.4	161.9
2	4.3	8.5	17.0	34.0	68.0	85.0	127.5	170.0
4	4.4	8.8	17.5	35.0	70.0	87.6	131.3	175.0
8	4.4	8.9	17.9	35.7	71.3	89.2	133.8	178.4
16	4.5	8.9	17.8	35.7	71.3	89.1	133.6	178.2
20	4.4	8.7	17.4	34.9	69.7	87.2	130.7	174.3
30	4.4	8.7	17.4	34.7	69.4	86.7	130.1	173.4
40	4.2	8.4	16.8	33.5	67.0	83.8	125.7	167.6
Mean	4.1	8.2	16.5	33.0	65.9	82.4	123.6	164.8
Variety								
PLSD 0.10	S	S	S	S	S	S	S	S
PLSD 0.05	S	S	S	S	S	S	S	S
Seed rate								
PLSD 0.10	NS	NS	0.56	1.13	2.3	2.8	4.2	5.6
PLSD 0.05	NS	NS	NS	NS	NS	NS	NS	NS
Variety x Seed rate								
PLSD 0.10	0.19	0.40	0.79	1.6	3.2	4.0	6.0	8.0
PLSD 0.05	0.24	0.48	0.95	1.9	3.8	4.8	7.2	9.6
CV%	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
P > F Variety	0.0000	0.0000	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
P > F Seed rate	0.1029	0.1069	0.0866	0.0928	0.0982	0.0969	0.0994	0.0986
P > F Variety x Seed rate	0.0313	0.0283	0.0378	0.0303	0.0332	0.0335	0.0337	0.0341