

The Effect of Seeding Rate on Spring Wheat Yields in Western North Dakota- An Update

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Introduction:

Experiments to determine optimum seeding rates for wheat and other cereals have been conducted by nearly all experiment stations in North Dakota. As a result of these experiments and farmer experience, seeding rates are fairly well standardized in most localities. Farmers in North Dakota tend to plant from 60 to 120 lbs/acre of spring wheat, depending on wheat types, earliness of planting season, their experience, and perhaps germination and purity. Recommended seeding rates in North Dakota for hard red spring wheat range from 55 to 75 lbs/acre, and 60 to 90 lbs/acre for durum. These recommendations are based on pure live seed; that is, germination per cent times purity equals percentage of pure live seed. The range of the recommendations within the wheat types are made to try to compensate for kernel size variations of varieties. Theoretically, the largerkerneled varieties need to be seeded at heavier rates in order to plant the same number of kernels per acre as varieties having small kernels, although Waldron (5,6,7) has shown that yields of largerkerneled varieties can exceed yields of smallerkerneled varieties despite the difference in seeding rates as influenced by kernel size.

This report summarizes a study in western North Dakota undertaken to determine the effect of seeding rates on agronomic performance of semi-dwarf and standard hard red spring wheats and durum, each differing in kernel size and weight.

Procedure:

The trial was initiated in 1969 and was conducted by the Williston, Dickinson, and North Central (Minot) Experiment Stations in western North Dakota. Waldron, Fortuna, and Chris were chosen to represent the standard height spring wheat varieties. Chris was planted only at Minot. Fortuna was planted at Dickinson and Williston. Wisconsin 271 and Leeds were chosen at all locations as the varieties

to represent the semi-dwarf hard wheats and durum, respectively. All locations used high quality planting seed from the same seed source. Seed size of planting seed as indicated by 1,000 kernel weights as reported in Table 1. In order to plant equivalent numbers of seeds per acre of each variety, seeding rates were expressed in numbers of plants per acre. Planting rates in millions of plants per acre and the equivalent seeding rate in pounds per acre are also shown in Table 1. All seeding rates were adjusted for purity and germination. Seeding rates of 1/2, 2/3, 1, and 1 1/3 million plants per acre were used by all locations in 1969 and 1970. In 1971-73, seeding rates were changed to 1/2, 3/4, 1, 1 1/4, and 1 1/2 million plants per acre at Williston and Minot, and to 1/2, 3/4, 1, 1 1/2, and 2 million plants per acre at Dickinson. A seven foot Kirschman drill with six inch row spacing was carefully calibrated to seed these plots. Each treatment was replicated at least three times. Statistical design was a randomized split plot with varieties as whole plots and seeding rates in millions of plants per acre as sub-plots.

Herbicides were applied to control broadleaf weeds. Fertilizer was applied to eliminate nutrient variables. Data collected include stand counts, yields, test weights, 1,000 kernel weights, per cent grain protein and number of fertile heads per unit area.

Results and Discussion:

Data from Minot in 1970 and 1972 is not reported because of stand establishment problems and green foxtail infestation. Data from Williston in 1971 is not reported because of severe hail damage.

Yields:

Although all yield data by location and years are not reported, statistical analysis of 1971-1973 yield data by location as shown in Figure 1 implies that varieties responded to seeding rates similarly with only slight and non-significant variations. Results as shown in Table 2 indicates that 1) Yields averaged over the years are maximized at approximately one million plants per acre at all locations. 2) There was a positive yield response to increas-

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Table 1. Equivalent Seeding Rate by Weight for Five Varieties of Wheat Seeded at Nine Populations

Planting Rate Million Plants/A	Seeding Rate in lb/Acre					Average seeding rate for each gram of 1,000 Kernel Weight lbs/acre
	Chris	Wisc 271	Waldron	Fortuna	Leeds	
.33	17	27	28	25	30	0.73
.50	26	40	42	37	46	1.10
.67	34	54	56	50	60	1.46
.75	38	61	63	56	69	1.65
1.00	51	81	84	75	92	2.20
1.25	64	101	105	94	114	2.75
1.33	68	108	112	99	122	2.92
1.50	77	121	126	112	137	3.30
2.00	102	162	168	150	186	4.40

1,000 KWT of Planting Seed in Grams					
	23.3	37.0	38.0	34.0	41.6

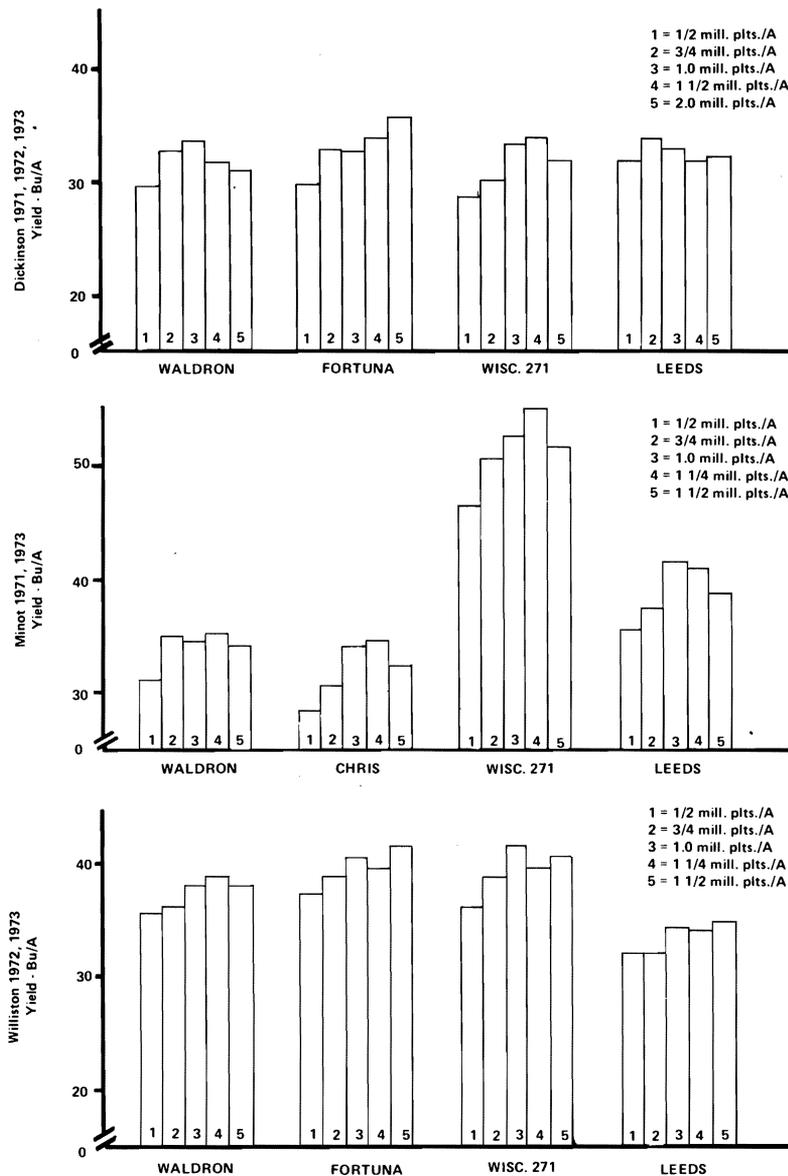


Figure 1. The Effect of Five Seeding Rates on Yield of Four Varieties at Dickinson, Minot and Williston in 1971-1973.

ing seeding rates up to one million plants per acre in 9 of the 12 station years in which this trial was conducted. Figure 2 shows the yields at the four seeding rates averaged over those 9 years, locations and varieties, and the per cent increase in yield attributable to seeding rate. There is a 19 and 7.5 per cent yield increase when the varieties were planted at one million plants per acre compared to planting those same varieties at 1/3 - 1/2 and 2/3 - 3/4 million plants per acre, respectively. 3) There are 2 years (1970 and 1973) at Dickinson and 1 year (1973) at Williston in which there are no significant increases attributable to seeding rate. Yields are maximized only 25 per cent of the time (3 of 12 station years) by seeding 1/3 - 1/2 million plants per acre, and there is virtually no evidence to suggest that this seeding rate will maximize yields in dry, low yield potential years. These results disagree with Pelton (4) who

indicates that seeding rates of 20 to 40 lbs/acre for HRS wheat is sufficient to maximize yields in semiarid southwestern Saskatchewan. 4) Planting 2/3 to 3/4 million plants per acre will maximize yields 50 per cent of the time (6 of 12 station years). However, when yield potential is less than 30 bushels per acre, yields are maximized 80 per cent of the time (4 of 5 station years). 5) Planting one million plants per acre will maximize yields 100 per cent of the time (12 of 12 station years), regardless of yield potential, without any adverse effect on yield in years when yield potential is relatively low. Only seeding rates of one million plants per acre or greater maximize yields when the yield potential is greater than 35 bushels per acre. 6) Planting at rates greater than one million plants per acre generally did not result in any significant yield increases above that obtained at the one million plants per acre seeding rate.

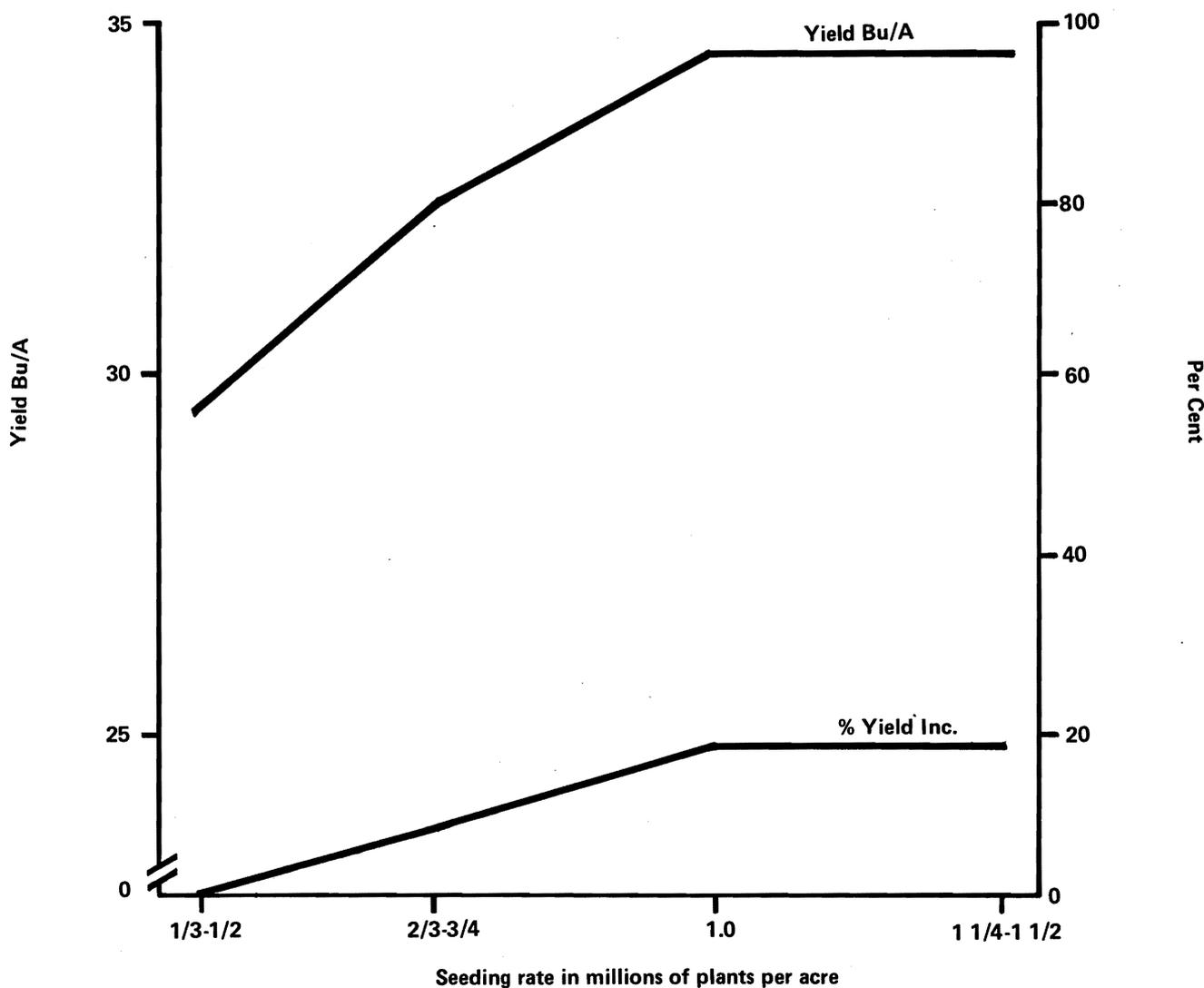


Figure 2. The Influence of Seeding Rates on Average Yield of Four Varieties Grown at Three Locations (9 Station Years of Data).

Table 2. The Effect of Five Population Planting Rates on Yields Averaged over Varieties at Minot, Dickinson, and Williston.

Planting Rate Million Plants/A	Yield in Bu/A - Minot					Average 1969-73	Average 1971-73
	1969	1971	1973				
.33 - .50	43.0	26.8	43.7			37.8	35.3
.67 - .75	49.2	31.5	44.7			41.8	38.1
1.00	51.5	32.2	48.7			44.1	40.5
1.25 - 1.33	50.9	32.7	49.9			44.5	41.3
1.50		32.2	46.1				39.2
LSD 05	1.8	2.9	1.6				

Planting Rate Million Plants/A	Yield in Bu/A - Dickinson					Average 1969-73	Average 1971-73
	1969	1970	1971	1972	1973		
.33 - .50	35.0	18.0	15.3	28.8	30.4	25.5	24.8
.67 - .75	40.0	19.4	16.6	31.7	32.2	28.0	26.8
1.00	42.8	20.6	17.2	35.2	31.4	29.4	27.9
1.33 - 1.50	44.3	20.6	17.9	33.0	31.5	29.5	27.5
2.00			17.1	35.0	27.7		26.0
LSD 05	2.5	N.S.	1.7	3.4	N.S.		

Planting Rate Million Plants/A	Yield in Bu/A - Williston				Average 1969-73	Average 1972-73
	1969	1970	1972	1973		
.33 - .50	22.5	16.5	32.4	28.8	25.0	30.6
.67 - .75	25.4	20.0	34.6	28.8	27.2	31.7
1.00	25.2	22.3	38.7	28.4	28.7	33.6
1.25 - 1.33	23.6	22.3	37.4	28.3	27.9	32.8
1.50			38.9	28.5		33.7
LSD 05	2.2	0.9	2.8	N.S.		

What do these results mean relative to present seeding rate recommendations? There was no differential response to seeding rates by wheat type. Durum, semi-dwarf HRS wheat and standard height HRS wheats responded similarly by location. Seeding one million plants per acre, regardless of variety, wheat type, or yield potential, maximized yields most consistently. Seed size definitely influences the planting rate by weight of the wheat, whether it is durum or hard red spring wheat. There is a direct relationship between 1,000 kernel weight of seed and seeding rate in lbs/acre at a given plant population, regardless of wheat type. From Table 1, the one million plants per acre planting rate converts to the following seeding rates based on 1,000 kernel weight of the planting seed: Chris - 51 lbs/acre; Wisconsin 271 - 81 lbs/acre; Waldron - 84 lbs/acre; Fortuna - 75 lbs/acre; and Leeds, the large kernalled durum, - 92 lbs/acre **pure live seed**. Assuming that one million plants per acre is the most desirable plant population, the seeding rate increases by 2.2 lbs/acre for each gram increase in 1,000 kernel weight (Figure 3). If planting seed has a 1,000 kernel weight of 25-35 grams, the present seeding recommendation for hard red spring wheat of 55 to 75 lbs/acre is correct. However, the seeding rate should be adjusted by 2.2 lbs/acre for each gram increase or decrease in 1,000 kernel weight of planting seed outside that range. Table 1 also shows the average seeding rate in pounds per

acre for each gram increase in 1,000 kernel weight of planting seed for each plant population.

These results do not completely agree with older studies conducted on seeding rates (1,3,7); however, no attempt was made in these studies to directly correlate 1,000 kernel weight of the planting seed with seeding rate.

Seed producers will be interested in these results since, with a limited amount of seed of a new variety, seeding 25 to 40 lbs/acre and planting that seed over more acres will produce more total bushels of that variety than trying to maximize yields on a smaller number of acres.

Other Agronomic Data:

Average stand counts indicate that only 75 to 85 per cent of the seeded kernels survived as plants at any given population seeding rate above 1/3 million plants per acre (Table 3). This data agrees with L. R. Waldron (5,6) who, in two studies with HRS wheat, showed only 70 to 75 per cent of the seeded kernels become established plants. Also Pelton (4) noted that the stand counts of Chinook HRS wheat were considerably short of the planted population, since only about 700,000 plants per acre were counted at a seeding rate of 90 lbs/acre. There were no appreciable differences in stand establishment that can be attributed to seed size, though the large kernalled durum

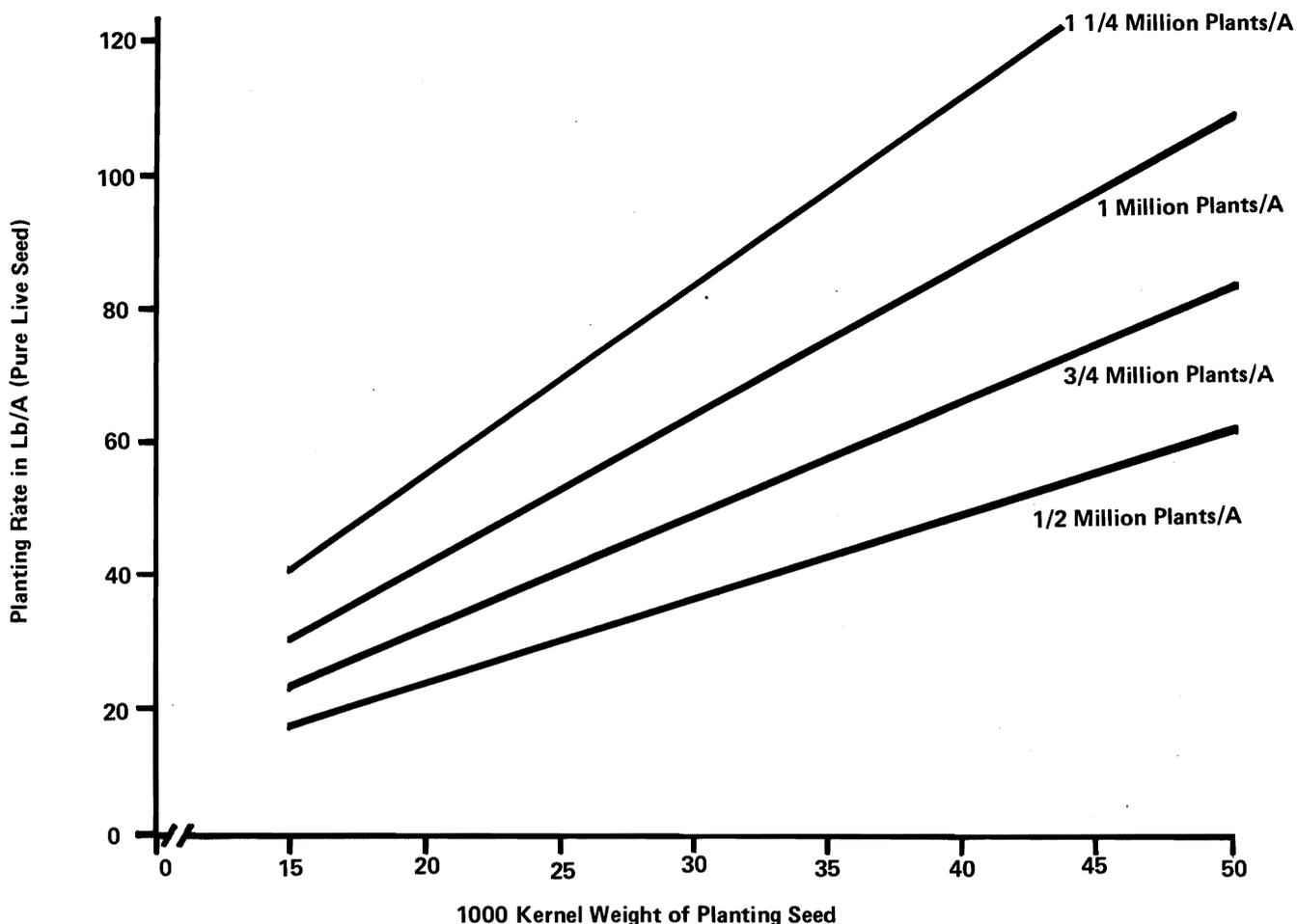


Figure 3. The Relationship of 1000 Kernel Weight of the Planting Seed to Seeding Rate by Weight.

averaged about 10 per cent less plants established than HRS wheat varieties. Geiszler and Hoag (2) found that plumpness of planting seed was more important than seed size, and Waldron (7) and Geiszler et al. (2) agree that stand establishment and yield decrease only if planting seed contains relatively large amounts of shrunken kernels (low test weight). Since the seed of all varieties used in

Table 3. Average Number of Established Plants Obtained at Nine Population Seeding Rates.

Seeding Rate Millions of Plants/A	Average Number of Established Plants - Millions of Plants/A	Per Cent
.33	.35	105
.50	.42	84
.67	.52	78
.75	.62	82
1.00	.81	81
1.25	.96	77
1.33	1.05	79
1.50	1.15	77

this study was of very good quality (plumpness) and purity, no appreciable differences in stand establishment was expected.

Varieties responded similarly to seeding rates when the agronomic characters of test weight, 1,000 kernel weight of produced seed and per cent grain protein were considered. The data averaged over varieties are shown in Table 4. Although individual data are not reported, there was a tendency for 1,000 kernel weight of Leeds to decrease as planting rate increased at both Williston and Minot. At Minot, there was a tendency for increased test weight as seeding rate increased. As seeding rate increased, a slight decline in grain protein percentage was noted at Minot.

The number of heads produced per acre, calculated from head counts made in each plot on a known area, increased as seeding rate increases (Table 5). Although Leeds durum tended to produce fewer heads per acre than HRS wheat, there was no significant differential response by varieties to seeding rates for this character. Also, the number of culms per plant (calculated from the ratio of stand counts to number of heads per acre produced) decreased with increased seeding rate.

Table 4. The Effect of Four Seeding Rates on Average Test Weight, 1,000 Kernel Weight and % Grain Protein at Williston (1969-1970, 72-73) and Minot (1969, 1971, 1973).

Seeding Rate Millions Plants/A	Test Weight lbs/Bu		1,000 Kernel Weight-grams		% Grain Protein ^{1/}	
	Will.	Minot	Will.	Minot	Will.	Minot
.33-50	59.8	60.1	35.2	35.6	15.2	14.0
.67-.75	60.0	60.6	34.6	35.6	15.1	13.7
1.0	60.0	61.0	34.9	35.2	15.3	13.7
1.25-1.33	60.0	61.0	34.7	34.7	15.4	13.4

^{1/} On a 14% Moisture Basis

Table 5. The Effects of Seeding on Number of Heads Produced and the Number of Culms per Plant by Variety for Williston (1969-1973) and Minot (1969-1971).

Planting Rate Millions Plants/A	Millions of Heads/Acre							
	Leeds		Waldron		Wisc 271		Fortuna	Chris
	Will.	Minot	Will.	Minot	Will.	Minot	Will.	Minot
.33-50	0.83	0.96	0.94	1.37	0.94	1.27	0.90	1.13
.67-.75	0.88	1.17	1.12	1.33	1.20	1.52	1.14	1.45
1.00	1.08	1.33	1.38	1.73	1.30	1.76	1.25	1.71
1.25-1.33	1.01	1.57	1.43	1.68	1.39	1.79	1.37	1.87
	Number of Culms/Plant							
.33-50	2.12	3.28	2.49	3.92	2.38	3.50	2.39	2.70
.67-.75	1.63	2.72	2.08	2.54	1.96	2.90	1.93	2.40
1.00	1.55	2.10	1.71	2.19	1.64	2.25	1.58	2.07
1.25-1.33	1.19	1.85	1.50	1.73	1.28	1.85	1.33	1.78

Summary:

Yields were maximized most consistently at one million plants per acre, regardless of variety or type of wheat. Since seed size influences the seeding rate expressed by weight, it is suggested that 1,000 kernel weight of the planting seed be used to determine the optimum seeding rate of wheat. Figure 3 shows a convenient way of accurately determining seeding rate in pounds per acre for four different plant populations. The producer would determine the 1,000 kernel weight of the seed, select the plant population he thinks is most desirable for his situation, and then determine from this graph (Figure 3) his planting rate in pounds per acre. The producer still needs to adjust for germination and purity.

The present general recommended seeding rates cover most situations, but this method offers a way to expand those recommendations to include seed size as the major consideration in determining seeding rate.

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