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Effect of Seeding Rates on Yield and Yield Components of Wheat Cultivar "Yecora Rojo" in Al-Qassim Region

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ABSTRACT. The present investigation was carried out during the four successive growing seasons (1987/88 - 1990/91) to study the response of wheat cultivar "Yecora Rojo" to five seeding rates; 120, 150, 180, 210 and 240 kg/ha at the Agricultural Experimental Station, College of Agriculture and Veterinary Medicine, King Saud University, Al-Qassim Branch. Experiments conducted during the first two seasons were used to study grain and biological yields and harvest index whereas those conducted in the third and fourth seasons were used to study yield and its components as well as plant height and heading date. A randomized complete block design with four replications was used in all experiments in each of the four seasons.

Results revealed that seeding rate had significant effects on grain yield and harvest index in three seasons and on biological yield in one season only. Increasing seeding rate beyond 150 kg/ha decreased grain yield and harvest index in 1987/88 and 1988/89 seasons, while, it non significantly increased both traits in 1990/91 season. Biological yield was increased by increasing seeding rate in 1989/90 season, however, this increase was not significant beyond 180 kg/ha.

Seeding rate had significant effects on number of spikes/m^2 and kernel weight in 1989/90 and on number of kernels/spike and number of days to heading in 1990/91 season. On the other hand, high seeding rate significantly increased plant height in both seasons.

The results indicated that the response of wheat cultivar "Yecora Rojo" to seeding rate varied with environment. However, it could be concluded that, the optimum seeding rate for Al-Qassim region lies between 150 and 180 kg/ha.

Introduction

Continued encouragement and subsidization offered by Saudi Arabian government to wheat growers resulted in increasing wheat cultivated area from 30100 ha in 1969/70 to 601,592 ha in 1987/88, with a total production of 2,651,921 tons at an average of 4.41 tons/ha (Saudi Arabia annual report 1988).

Optimum seeding rate is one of the most important limiting factors affecting wheat production. It could indirectly affect yield components by affecting number of tillers and consequently number of spikes per unit area. A close relationship is always occurring among seeding rate and soil fertility, especially nitrogen, and irrigation (Ghandorah 1986 and Pendelton and Dugan 1960). Most of wheat growers in Saudi Arabia grow their crop under very high seeding rates and only few ones stick to the recommended rates. In fact, seeding rates used in the Kingdom are not only different from one location to another, but they also differ from one farm to the other in the same location.

Several investigators in different countries studied the effect of seeding rates on grain yield and its components. Briggs (1974) and Briggs and Aytenfisu (1979) showed that increasing seeding rate beyond 100 kg/ha did not significantly increase grain yield. In Saudi Arabia, Ghandorah (1986) found that increasing seeding rate from 127 to 207 kg/ha had no effect on grain or biological yield of "Yecora Rojo" cultivar. However, seeding rate and plant distribution in a given area had marked effects on wheat yield components (Agarwal *et al.* 1972 and Puckridge and Donald 1967). In the United States, Freeze and Bacon (1990) found that the response of wheat cultivars grown in the mid-south to spacing and seeding rate varied with the environment. The highest yield was obtained when 26 seeds/sq ft were used. Similar results were found by Johnson *et al.* (1988) and Joseph *et al.* (1985) in other soft red winter wheat regions.

Three components of grain yield; spikes/m^2, kernel/spike and kernel weight have interdependent relationships and compensate for one another to stabilize yield as cultural and climatic conditions change (Frederick and Marshall 1985 and Joseph *et al.* 1985). High seeding rates generally increase number of spikes per unit area; however, fewer and smaller kernels per spike can occur, while results in little change in total grain yield (Darwinkel 1978 and Puckridge and Donald 1967).

The main objective of this research was to determine the optimum seeding rate for maximizing wheat production under the agricultural conditions prevailing in Al-Qassim region.

Material and Methods

The present investigation was conducted at the Agricultural Experimental Station, College of Agriculture and Veterinary Medicine, King Saud University, Al-Qassim, during the four seasons (1987/88 - 1990/91) to evaluate the performance of a high yielding wheat cultivar "Yecora Rojo" at five (120, 150, 180, 210 and 240 kg/ha) seeding rates. Experiments conducted in the first two growing seasons (1987/88 and 1988/89) were used as a pilot trials to study grain and biological yields; whereas those conducted in seasons 1989/90 and 1990/91 were used to study yield and its components together with some other agronomic traits.

The experiment was set up in a randomized complete block design with four replications. The experimental plot consisted of six rows; 3 m long and 20 cm apart. The experiment was sown in December 9 and November 30 for the first two growing seasons, while it was planted in December 1 and December 18 in the last two growing seasons, respectively. The soil type of Al-Qassim area is classified as sandy (Rabie *et al.* 1991). During land preparation, 180 kg P_2O_5/ha were applied each year. Also, 240 kg N/ha were splitted into four equal doses and applied during the critical wheat stages; seedling, tillering, booting and heading. Irrigation was applied by a pivot system during each of the four growing seasons.

Data taken in each of the four seasons included: grain yield, biological yield and harvest index. In addition data on number of spikes/m^2, number of kernels/spike, 1000-kernel weight, plant height and days to heading were collected in the third and fourth seasons.

Biological yield (tons/ha), the weight of above ground dry matter was determined from weight of the four central rows of each plot. Grain yield (tons/ha) was obtained from the weight of the clean seeds harvested from the four central rows of each plot. Harvest index was calculated by dividing the grain yield by the biological yield. Number of spikes/m^2 was determined from a random sample of 1 m^2 taken from each plot; whereas number of kernels/spike was recorded from a sample of 10 main spikes collected from 10 randomly selected plants in each plot. Kernel weight was obtained from the weight of a random sample of 1000 kernels taken from each plot. Plant height, expressed as the distance from the ground level to the top of spikes, excluding awns, was determined by the measurement of 5 randomly selected plants from each plot. Days to heading was obtained by counting number of days from planting to the date on which about 50% of the heads were completely out of their flag leaf sheaths.

Statistical analysis of variance and comparisons of means for all obtained data were carried out according to Steel and Torrie (1980). The combined analysis of variance for grain and biological yields for the four seasons, and for yield component traits for the last two seasons were also computed.

Results and Discussion

Combined analysis of variance over the four seasons showed that season had a significant effects on grain and biological yields as well as on harvest index (Table 1). The significant seeding rate × season interactions on grain yield and harvest index (Table 1) indicated that the effect of seeding rate on these two traits was not the same in different seasons. Therefore, it was deemed appropriate to discuss the results of the four seasons (1987/88 - 1990/91) separately.

The analyzed data indicated that seeding rate had significant effects on grain yield

TABLE 1. Combined analysis of variance for grain and biological yields and harvest index as affected by five seeding rates over the four growing seasons of 1987/88, 1988/89, 1989/90 and 1990/91.

S.O.V.	*df*	Mean - squares		
		Grain yield (t/ha)	Biological yield (t/ha)	Harvest index
Seasons	3	19.64**	66.56**	0.658**
Reps	3	0.71	0.28	0.015
Reps × seasons	9	0.68	2.18	0.016
Treatments	4	0.64	0.66	0.021*
Treat. × seasons	12	0.70**	1.22	0.021**
Error	48	0.27	1.51	0.008
Total	79	–	–	–

*, ** Significant at 0.05 and 0.01 levels of probability, respectively.

and harvest index in all seasons except 1989/90 (Table 2). However, seeding rate showed significant effects on biological yield in 1989/90 season only. It is evident from the results that increasing seeding rate beyond 150 kg/ha significantly decreased grain yield and harvest index in seasons 1987/88 and 1988/89; but not in seasons 1989/90 and 1990/91 (Table 2). Although, increasing seeding rate increased the biological yield in seasons 1989/90, this increase was not significant beyond the 180 kg/ha seeding rate level (Table 2).

These results are in agreement with those found by Briggs (1974), Briggs and Aytenfisu (1979), but not in agreement with those obtained by Chia (1983) and Ghandorah (1986) who reported insignificant increase in grain yield as a result of increasing seeding rate.

TABLE 2. Means of grain and biological yields and harvest index as affected by five seeding rates for the four growing seasons 1987/88, 1988/89, 1989/90 and 1990/91.

Seeding rates (kg/ha)	Grain yield (t/ha)				Biological yield (t/ha)					Harvest index		
	1987/88	1988/89	1989/90	1990/91	1987/88	1988/89	1989/90	1990/91	1987/88	1988/89	1989/90	1990/91
120	2.28 a	2.62 b	3.79	2.62 b	5.53	7.67	7.28 b	4.87	0.41 ab	0.34 b	0.52	0.54 b
150	2.53 a	3.25 a	4.13	3.59 a	6.07	8.12	7.92 b	4.55	0.43 a	0.41 a	0.54	0.80 a
180	1.44 b	2.97 ab	4.26	3.65 a	4.99	8.85	8.26 a	4.72	0.30 ab	0.34 b	0.54	0.77 a
210	1.58 b	2.55 b	4.39	3.82 a	5.34	8.01	8.55 a	4.72	0.31 ab	0.32 b	0.51	0.81 a
240	1.43 b	2.40 b	4.40	3.83 a	5.07	8.13	9.49 a	5.04	0.28 b	0.30 b	0.44	0.77 a
LSD	0.71	0.55	NS	0.59	NS	NS	1.35	NS	0.14	0.07	NS	0.08
C.V.	14.22	10.96	17.22	11.10	25.34	13.06	10.54	11.34	0.25	0.14	19.23	7.33

Means within a column followed by the same letter are not significantly different according to LSD at 0.05 level of probability.

The combined analysis of variance over the last two seasons showed that season had significant effects on all of the yield components studied (Table 3). Except for number of spikes/m^2 and 1000-kernel weight, effects of seeding rate on the evaluated traits were also significant (Table 3). Seeding rate × season interactions were significant for plant height, number of days to heading and harvest index, indicating that the performance of these traits in contrast to that of number of spikes/m^2, number of kernels/spike and 1000-kernel weight at a certain seed rate was not the same in each of the two seasons.

TABLE 3. Combined analysis of variance for yield component traits as affected by five seeding rates over the two growing seasons of 1989-90 and 1990-91.

S.O.V.	*df*	Mean squares					
		No. of spikes / m^2	No. of kernels / spike	1000 - kernel weight	Plant height	Days to heading	Harvest index
Seasons	1	28090.00**	252.50**	3591.78**	105.63**	1123.60**	0.515*
Reps	3	2830.47	8.84	10.68	47.03	0.30	0 .029
Rep × seasons	3	711.27	2.47	33.04	2.36	1.27	0.020
Treatments	4	8884.10	38.84*	7.49	62.06**	0.69*	0.027**
Treat × seasons	4	3077.88	9.40	3.24	28.94**	1.04**	0.029**
Error	24	3951.89	10.24	6.13	6.82	0.18	0.006
Total	39	–	–	–	–	–	–

*, ** Significant at 0.05 and 0.01 levels of probability, respectively.

This differential performance could be attributed to the unsteady weather conditions in different seasons and/or to the heterogenity of the soil in Al-Qassim region (Ghandorah 1986 and Rabie *et al.* 1991).

It is evident from Table 4 that increasing seeding rate beyond 120 kg/ha tended to increase number of spikes/m^2, but decreased number of kernels/spike in each of the last two seasons. However, highest number of spikes/m^2 was observed when 180 kg/ha seeding rate was used in 1989/90 season, whereas lowest number of kernels/spike was observed at the rate of 240 kg/ha in the 1990/91 season (Table 4). It seems that competition between number of plants/m^2 supressed the size of reproductive tillers (number of kernels/spike) in the dense population, while at lower densities relatively larger spikes developed (Quinseberry and Reitz 1967). Although, kernel weight showed no specific trend, heaviest kernel weight was observed when 240 kg/ha was used in each of the two seasons (Table 4). These results are generally in agreement with those reported by Darwinkel (1978) and Puckridge and Donald (1967). However, Darwinkel *et al.* (1977) concluded that high seeding rates are advantageous only when conditions such as delayed planting and low temperatures inhibit tillering.

Plant height was significantly affected by seeding rate and it generally increased with the increase on seeding rate in both seasons (Table 4). The tallest plants were measured when 240 kg seeds/ha were used in both seasons. This is expected, as plants

TABLE 4. Means of no. of spikes/m^2, no. of kernels/spike, 1000 kernel weight, plant height and days to heading as affected by five seeding rates for the two growing seasons 1989/90 and 1990/91.

Seeding rates (kg/ha)	No. of spikes/m^2		No. of kernels/spike		1000 kernel weight		Plant height		days to heading	
	1989/90	1990/91	1989/90	1990/91	1989/90	1990/91	1989/90	1990/91	1989/90	1990/91
120	361 b	345	41.55	36.80 a	50.13 b	33.24	56.3 ab	54.5 c	84	72 b
150	383 ab	347	38.55	35.47 a	50.61 b	31.16	57.5 ab	58.3 b	84	73 a
180	469 a	355	37.60	34.45 a	52.53 b	33.93	55.0 b	59.3 b	84	72 b
210	446 ab	415	37.90	34.05 a	51.76 b	31.97	56.3 ab	64.3 a	84	73 a
240	444 ab	377	37.25	28.95 b	55.99 a	33.97	60.0 a	65.0 a	84	73 a
L.S.D.	100.56	NS	NS	2.87	2.66	NS	4.26	3.74	NS	0.57
C.V.	15.56	16.36	10.57	5.50	3.36	9.32	4.87	4.04	0.56	0.52

Means within a column followed by the same letter are not significantly different, according to LSD at 0.05 level of probability.

under high population densities (high seeding rates) tended to be more competitive for light intensity and therefore, they would grow taller; whereas plants under low population densities (low seeding rates) tended to be shorter (Quinseberry and Reitz 1967).

The present results indicated that the cultivated crop "Yecora Rojo" headed at 84 days in 1989/90, while it headed eleven days earlier in 1990/91 (Table 4). This could be attributed to the late sowing or high temperature during the 1990/91 season. Similar results were reported by Kassem and Eissa (1989), who observed that "Yecora Rojo" headed at 73 and 79 days in 1986 and 1987 seasons, respectively, in Al-Qassim region.

In conclusion, our data indicated that the response of "Yecora Rojo" cultivar to various seeding rates in Al-Qassim region varied with environment. The best seeding rate to be recommended for Al-Qassim region lies between 150 and 180 kg/ha. Increasing seeding rates beyond this rate would have no economic benefit.

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أثــر معـــدلات التقاوي عـلى المحصول ومكوناتـه في صنف القمـح «يوكرا روجو» في منطقـــة القصـــيم

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المستخلص . أُجري هذا البحث لمدة أربعة مواسم (من ١٩٨٨/٨٧م إلى ١٩٩١/٩٠م) في محطة البحوث الزراعية بكلية الزراعة والطب البيطري جامعة الملك سعود فرع القصيم ، لدراسة استجابة الصنف «يوكرا روجو» لخمسة معدلات من التقاوي هي ١٢٠، ١٥٠، ١٨٠، ٢١٠ و ٢٤٠ كجم تقاوي/هكتار . استخدمت التجارب المقامة في الموسمين الأوليين لدراسة محصول الحبوب ، المحصول البيولوجي ودليل الحصاد في حين أن التجارب المقامة في الموسمين الثالث والرابع استخدمت لدراسة المحصول ومكوناته وطول النبات وتاريخ التزهير . وقد استخدم تصميم القطاعات الكاملة العشوائية في أربعة مكررات لكل تجربة في المواسم الأربعة .

أظهرت النتائج أن لمعدلات التقاوي تأثيرًا معنويًا على محصول الحبوب ودليل الحصاد في ثلاثة مواسم ، في حين أنه لم يكن لها تأثيرًا معنويًا على صفة المحصول البيولوجي إلا في موسم واحد فقط . أدت زيادة معدل التقاوي عن ١٥٠ كجم للهكتار إلى نقص كل من محصول الحبوب ودليل الحصاد في موسمي ١٩٨٨/٨٧م و ١٩٨٩/٨٨م ، في حين أنها أدت إلى زيادة غير معنوية في هاتين الصفتين في موسم ١٩٩١/٩٠م . كما أن زيادة معدل التقاوي أدت إلى زيادة المحصول البيولوجي في موسم ١٩٩٠/٨٩م ولكن هذه الزيادة كانت غير معنوية بعد المعدل ١٨٠ كجم/هكتار .

أوضحت النتائج أيضًا أن لمعدل التقاوي تأثيرًا معنويًا على صفتي عدد السنابل/م^{2} ووزن الحبوب في موسم ١٩٩٠/٨٩م ، وكذلك على صفتي عدد حبوب السنبلة وتاريخ التزهير في موسم ١٩٩١/٩٠م . ومن ناحية أخرى أدت زيادة معدلات التقاوي إلى زيادة ارتفاع النبات في كلا الموسمين . هذه النتائج تدل على أن استجابة صنف القمح «يوكرا روجو» لمعدلات التقاوي يختلف باختلاف الظروف البيئية ، ولكن بصفة عامة يمكن الاستنتاج بأن المعدل الأمثل للتقاوي في منطقة القصيم يقع ما بين ١٥٠-١٨٠ كجم/هكتار .