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Planting Date in Relation to Yield and Yield Components of Wheat in Al-Qassim Region

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ABSTRACT. The present investigation was carried out during the 1990/91 and 1991/92 seasons to determine the optimum planting date for maximizing wheat production under Al-Qassim conditions. The experiments were conducted at the Agricultural experimental Station, College of Agriculture and Veterinary Medicine, King Saud University, Al-Qassim Branch, Saudi Arabia. Two high - yielding spring wheat cultivars; Yecora Rojo and West Bread, were planted in six dates; November 16, December 1 and 16, January 1 and 16 and February 1. The experiments were set up in a split plot design with four replications. Results revealed that planting dates had significant effects on all studied traits. Significant cultivar x planting date, planting date x season and cultivar x planting date x season interactions existed for grain yield and its components, plant height and days to heading. The best planting date for Yecora Rojo cultivar was January 1st and for West Bread cultivar was December 16 in the first season while the first of December was the best planting date for both cultivars in the second season for maximizing grain yield. Spikes per square meter and kernels per spike significantly increased while kernel weight non-significantly decreased as planting date was delayed from November to December. It could be concluded that the optimum period for planting date in Al-Qassim region lies within the first two weeks of December. Expanding planting to January 1st could be possible, while planting after this period would result in yield reduction.

Due to the continuous encouragement and subsidization offered by the government of Saudi Arabia to wheat growers, several high yielding semi-dwarf wheat cultivars were introduced to the Kingdom. Although, these cultivars are well known to have high yield potentialities they are greatly influenced by many cultural practices that can be

controlled by wheat producers. Among these practices, date of planting which is probably one of the most important factor affecting wheat production. It could indirectly affect yield components by affecting number of tillers and consequently number of spikes per unit area, and kernel weight (Campbell *et al.* 1991)

Most of wheat growers in Saudi Arabia grow their crop under variant planting dates and only few adhere to the recommended dates. In fact, planting date in the Kingdom may not only vary from one location to another, but also from one farm to another within the same location.

Several investigators in different countries studies the effect of planting date on grain yield and its components. In Canada, Briggs and Aytenfisu (1979) found that seeding date had significantly influenced grain yield of wheat. They also indicated significant cultivar x seeding date, cultivar x seeding rate and cultivar x seeding date x seeding rate interactions for grain yield of spring wheat at several locations. In the United States, Chia (1983) reported that significant cultivar x seeding date, and cultivar x seeding date x year interactions existed for grain yield of wheat. Large yield reduction attributable to late planting have been reported by Knapp and Knapp 1978 and Rocheford *et al.* 1988.

In Egypt, Eissa (1991) reported that early planting (November 10) increased grain yield/ha, number of spikes/m^2, spike length, plant height and increased days to heading. In Cyprus, the optimum period for planting date is mid-November to mid-December as indicated by Photiades and Hadjichristodoulou(1984).They also reported that grain yield was reduced by up to 70%, while number of tillers and plant height tended to decline with late sowing.

In Saudi Arabia, several extension bulletins presented by Ministry of Agriculture and Water indicated that the period for wheat planting lies between mid-November to mid-December. Planting until the end of December could be possible. However, planting wheat before or after this period may result in yield reduction. On the other hand, most of the agricultural companies in Saudi Arabia plant their crop over an extended period of time. This is due to two reasons,(1)the wide cultivated wheat area for each company and (2) the limited number of planting machines available to sow the wheat crop. For example, Al-Qassim company planted wheat crop over a range of 78 days; from December 10 to February 25 in the 1985/86 season (Annual report for Al-Qassim company 1985/86).

The objectives of this study were to measure yield and its components of two spring wheat cultivars planted over a range of 77 days, and to determine the optimum planting date for maximizing wheat production in Al-Qassim region.

Materials and Methods

The present investigation was conducted at the Agricultural Experimental Station, College of Agriculture and Veterinary Medicine, King Saud University, Al-Qassim Branch, Saudi Arabia, during the two successive wheat growing seasons 1990/91 and 1991/92. Two high-yielding spring wheat cultivars; Yecora Rojo and West Bread were planted in six dates; November 16, December 1 and 16 January 1st, January 16, and February 1st.

The experiment was set up in split plot design with four replications. Cultivars and planting dates were randomly assigned to main- and sub-plots, respectively. The experimental unit was 1.20 x 5.0 m^2. The plots were hand sown in rows 20 cm apart. The soil type of the site is classified as sandy (Rabie *et al.* 1991). During land preparation, 180 kg P_2O_5/ ha were applied each season. Seeding rate used was 180 kg seeds/ha, the recommended rate for Al-Qassim region (Eissa and Shehab El-Din 1992). In addition, 240 kg N/ha were splitted into four equal doses and applied during the critical wheat stages; seedling, tillering, booting and heading. The irrigation was applied by a center pivot system during the two growing seasons.

Grain yield was obtained from the weight of the clean seeds harvested from the four central rows of each sub-plot and it was adjusted to tons/ha. Number of spikes/m^2, was determined from a random sample of one m^2 taken from each sub-plot, whereas number of kernels/spike was recorded from a sample of 10 main spikes collected from 10 randomly selected plants in each sub-plot. Kernel weight was obtained from the weight of a random sample of 1000-kernels taken from each sub-plot. Plant height, expressed as the distance from the ground level to the top of spikes, excluding owns, was determined by the measurement of 5 randomly selected plants from each sub-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.

Analysis of variance was computed for each experiment and the two factors considered fixed (Steel and Torri 1980). A combined analysis of variance over the two seasons was also calculated and the season effect was considered random. Means were separated for significant main effects and interactions using the LSD test at the 0.05 probability level.

Results and Discussion

The analysis of variance of each season (Table 1) revealed highly significant effects of planting dates on all studied traits. However, cultivars significantly influenced grain yield, number of spikes/m^2 and number of kernels/spike in the first season, while they showed highly significant effects on 1000-kernel weight, plant height and days to heading in both seasons. The significant cultivar x planting date on all studied traits indicated that the two cultivars respond differently to planting date.

Table 1. Source of variation, degrees of freedom and mean squares of the analysis of variance of the studied traits during the two growing seasons of 1990/91 and 1991/92.

Mean-squares													
S.O.V.	d.f.	Grain yield (tons/ha)		No. of spikes /m^2		No. of Kernels/spike		1000-kernel weight		Plant height		days of heading	
		1990/91	1991/92	1990/91	1991/92	1990/91	1991/92	1990/91	1991/92	1990/91	1991/92	1990/91	1991/92
Reps (R)	3	0.1789	0.2707	1087.24	1227.02	2.5808	2.582	0.7803	2.682	1.4722	38.167	0.0764	0.076
Cultivars (C)	1	0.1683	2.7889*	1250.52	17442.19*	3.1008	72.03*	223.474*	914.38**	5808.0**	9520.33**	875.521**	346.69**
Error (a)	3	0.0593	0.1343	1336.02	923.63	0.9364	4.190	13.7052	2.315	2.0555	15.50	0.3542	0.687
Dates (D)	5	17.0731**	21.3726**	10802.44**	110665.2**	86.3013**	121.214**	283.052**	477.05**	302.18**	742.38**	1071.82**	1904.77**
C * D	5	3.5484**	0.5771*	7376.07**	11088.5**	29.9153**	73.256**	52.265**	40.332**	80.500**	101.18**	38.021**	4.337**
Error (b)	30	0.1067	0.1990	1250.93	962.00	3.3874	3.449	3.3321	3.575	3.264	3.95	0.2319	0.465

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

The data indicated that Yecora Rojo was superior to West Bread in grain yield in both seasons (Table 2). However, the superiority of Yecora Rojo in grain yield was not significant in the first season. Significant differences in average grain yield were observed among planting dates for the two cultivars in each season (Table 2). Planting in January 1st and December 16 in the first season resulted in the highest grain yields of Yecora Rojo (5.38 ton/ha) and West Bread (5.82 ton/ha) cultivars, respectively. On the other hand, the first of December was the best planting date for maximizing grain yield for both cultivars in 1991/92 season (Table 2). Grain yields obtained with this date were 5.93 and 5.59 tons/ha for Yecora Rojo and West Bread cultivars, respectively. Moreover, significant yield reduction was observed for both cultivars with later planting dates. These results are in agreement with those reported by Anderson and Henning 1964, Nass *et al.* 1975, Blue *et al.* 1990, Eissa 1991 and Andrews *et al.* 1992. However, Rocheford *et al.* 1988 reported no significant differences in average grain yield among planting dates in the first year, whereas a significant and progressive decline in average grain yield occurred with each delay in planting in the second year.

Although Yecora Rojo was lower in number of spikes/m^2, in the first season, it was superior to West Bread for this trait in the second season (Table 2). However, the largest number of spikes per square meter for both cultivars was obtained when wheat planted in December 1 in both seasons (Table 2). The average number of spikes per square meter obtained with that date were 256 and 520 for Yecora Rojo and 353 and 516 for West Bread in the two seasons, respectively. Planting before or after December 1 resulted in less spikes. Remarkable reduction in number of spikes was observed with late planting for Yecora Rojo and West Bread in the second season. However, the reduction in spikes/m^2, for late planting dates in the first season was not pronounced and insignificant among dates for both cultivars (Table 2). This reduction could be attributed to warm temperatures prevailing during tellering stage in the earlier planting (November 16) and later planting dates which reduce tillers initiations. These resullts are in general agreement with those found by Ibrahim *et al.* 1977 and Eissa 1991.

The two cultivars were similar in number of kernels/spike in the first season (Table 2). On the other hand, Yecora Rojo was lower for this trait in the second season. Planting in January 1 and December 16 in the first season incresaed number of kernels per spike of Yecora Rojo (39.1) and West Bread (40.2) cultivars, respectively (Table 2). On the other hand, in the second season December 16 and December 1st were the best planting dates for increasing number of kernels per spike for Yecora Rojo (44.8) and West Bread (48.9), respectively.

Table 2. Means of grain yield and number of spikes/m^2 for the two wheat cultivars at six planting dates during the two growing seasons of 1990/91 and 1991/92

Planting date	Grain yield (tons/ha)						No. of spikes/m^2					
	1990/91			1991/92			1990/91			1991/92		
	(*YR)	**(WB)	$\bar{X}$	(YR)	(WB)	$\bar{X}$	(YR)	(WB)	$\bar{X}$	(YR)	(WB)	$\bar{X}$
Nov. 16	3.21	3.58	3.39	4.30	4.77	4.53	238.7	147.5	193.0	421.5	392.0	406.7
Dec. 1	3.98	4.92	4.45	5.93	5.59	5.76	255.7	353.5	304.5	520.0	516.3	518.0
Dec. 16	4.19	5.82	5.00	4.69	4.07	4.38	251.5	258.7	255.0	463.8	409.8	437.0
Jan. 1	5.38	3.72	4.55	3.92	2.80	3.36	247.5	250.0	248.5	367.8	298.5	333.0
Jan. 16	3.30	1.79	2.54	2.70	1.89	2.29	227.2	242.2	334.5	298.8	251.8	275.5
Feb. 1	1.39	0.92	1.15	1.50	1.02	1.26	213.0	243.0	228.0	204.8	179.5	192.0
Average	3.58	3.45	3.52	3.84	3.36	3.60	238.9	249.17	244.1	379.4	341.3	360.3

* YR = Yecora Rojo ** WB = West Bread

LSD 0.05

$C_1 - C_2$ =	0.22	0.34	33.63	27.96
$D_1 - D_6$ =	0.33	0.45	36.07	31.64
$C_1D_1 - C_0D_2$ = or $C_0D_0 - C_1D_0$	0.47	0.64	51.07	44.79

Table 2. *Continued* : Number of kernels/spike and 1000-kernel weight

Planting date	No. of kernels/spike						1000-kernel weight (gm)					
	1990/91			1991/92			1990/91			1991/92		
	(*YR)	**(WB)	$\bar{X}$	(YR)	(WB)	$\bar{X}$	(YR)	(WB)	$\bar{X}$	(YR)	(WB)	$\bar{X}$
Nov. 16	31.47	32.10	31.78	35.50	41.05	38.30	36.62	31.65	34.14	44.65	38.27	41.46
Dec. 1	32.72	37.00	34.86	36.00	48.90	42.45	36.52	34.32	35.42	43.30	36.00	39.65
Dec. 16	36.55	40.15	38.35	44.80	42.40	43.60	34.87	34.32	34.59	38.82	24.77	31.79
Jan. 1	39.07	34.87	36.97	34.54	37.15	35.80	35.97	22.27	29.12	36.87	23.05	29.96
Jan. 16	33.75	29.90	31.82	35.55	34.40	34.97	27.35	22.39	24.87	30.57	22.25	26.41
Feb. 1	31.77	28.27	30.02	36.10	33.25	34.67	20.68	21.17	20.92	22.52	20.02	21.27
Average	34.22	33.72	33.97	37.07	39.52	38.30	32.00	27.69	29.85	36.12	27.40	31.76

* YR = Yecora Rojo ** WB = West Bread

LSD 0.05				
$C_1 - C_2$	=	0.89	1.88	3.41	1.40
$D_1 - D_6$	=	1.88	1.89	1.86	1.93
$C_1D_1 - C_0D_2$ or $C_0D_0 - C_1D_0$	=	2.66	2.68	2.63	2.73

Table 2. *Continued* : Plant height and days to heading

Planting date	Plant height (cm)						Days to heading					
	1990/91			1991/92			1990/91			1991/92		
	(*YR)	**(WB)	$\bar{X}$	(YR)	(WB)	$\bar{X}$	(YR)	(WB)	$\bar{X}$	(YR)	(WB)	$\bar{X}$
Nov. 16	62.75	92.00	77.37	63.25	94.25	78.75	90.25	94.75	92.50	96.50	104.75	100.60
Dec. 1	66.75	94.75	80.75	66.25	104.50	84.87	85.50	89.00	87.00	98.25	103.50	100.80
Dec. 16	68.75	94.00	81.00	65.50	95.00	80.25	74.50	88.00	81.00	96.75	101.75	99.30
Jan. 1	75.00	91.25	83.12	60.25	89.75	75.00	70.00	83.50	76.50	88.50	93.25	90.80
Jan. 16	66.50	85.50	76.00	57.00	83.00	70.00	64.00	73.50	68.50	77.50	81.50	79.50
Feb. 1	59.00	73.25	66.12	49.75	65.50	57.62	58.00	64.75	61.50	59.75	64.75	62.25
Average	66.46	88.46	77.46	60.33	88.50	74.42	73.71	82.25	77.98	86.20	91.60	88.90

* YR = Yecora Rojo ** WB = West Bread

LSD 0.05

$C_1 - C_2$ =	1.32	3.62	0.35	0.76
$D_1 - D_6$ =	1.84	2.03	0.49	0.70
$C_1D_1 - C_0D_2$ = or $C_0D_0 - C_1D_0$	2.61	2.87	0.70	0.98

Yecora Rojo was significantly higher than West Bread in kernel weight in both seasons (Table 2). Keneral weight was greater for early planted wheat (November 16) than subsequently planting for the two cultivars in both seasons (Table 2). The heaviest kernel weight obtained with that date were 36.6 and 44.7 for Yecora Rojo and 34.7 and 38.3 for West Bread in the two seasons, respectively.

The results showed that spikes per square meter and kernels per spike significantly increased while kernel weight non significantly decreased as planting delayed from November to December. Increased spikes per square meter and kernels per spike may be a compensatory physiological response to reduction in kernel weight. Likelly, it vice versa, increased tillers and kernels/spike increase kernels/area^2, will reduce the amount of photosynthates available for each kernel, thus reduce its size. This is the senario, since the formation of tillers occur before anthesis and grain filling. Frederich and Marshall 1985, indicated that the three components of grain yield; spikes per square meter, kernels per spike and kernel weight have interdependent relationships and compensate for one another to stabilize yield as cultural and climatic condition change. Similar results were found by Evans *et al.* 1975, Darwinkel *et al.* 1977 and Thill *et al.* 1978.

Plant height increased with planting in January 1 and December 1 for Yecora Rojo cultivar in the two seasons, respectively. The tallest plants measured with these two dates were 75 and 66 cm. On the other hand, the first of December was the best planting date to obtain the tallest plants from West Bread cultivar (95 and 103 cm) in the two seasons, respectively (Table 2). However, significant decline in plant height occurred with each delay in planting for both cultivars in the two seasons. Generally, West Bread plants were taller than Yecora Rojo in the two seasons. The average plant height over the six dates were 66.5 and 60.3 for Yecora Rojo, and 88.5 and 88.0 for West Bread in the two seasons, respectively (Table 2). These results are in line with those reported by photiades and Hadjichristodoulou 1984 and Eissa 1991.

Delayed planting decreased significantly number of days to heading of the two cultivars in both seasons (Table 2). The results indicated that Yecora Rojo headed after 74 days over the six dates in the first season, while it required twelve days more in the second season. However, West Bread cultivar headed at 82 and 91 days in the two seasons, resspectively. This could be attributed to the prevailing environmental conditions in the two seasons in Al-Qassim region. Delayed planting has been reported to decrease the pre-heading development period (Darwinkel *et al.* 1977 and Thill *et al.* 1978), resulting in a greater proportion of less developed, intermediate, and late tillers contributing to grain yield than in earlier planted wheat. Similar results were reported by Kassem and Eissa 1989.

Combined analysis of variance over the two seassons (Table 3) revealed significant effects of season on all studied traits except grain yield. This could be due to the large error variance obtained for grain yield.Which in turn could be due to large variation in the environmental conditions in the two seasons. However, planting dates showed highly significant effects on all studied traits (Table 3). Except for number of spikes/m^2, effects of cultivars on the evaluated traits were also significant.

The significant cultivar x season, planting date x season, and cultivar x planting date x season interactions on all traits indicated that the effect of cultivars and planting dates on these traits were not the same in the two seasons (Table 3).

The average of all studied traits over seasons showed significant differencess between the two cultivars (Table 4). Yecora Rojo was significantly higher than West Bread in grain yield, number of spikes/m^2 and kernel weight. On the other hand, Yecora Rojo was lower in number of kernels/spike. Also, Yecora Rojo was shorter and earlier than West Bread. Moreover, the data indicated significant differences in all studied traits over seasons among planting dates (Table 4). December 1st was the best planting date to obtaine the highest grain yield, largest number of spikes/m^2, heaviest kernel weight and tallest plants (Table 4). However, planting in December 16 increased number of kernels/spike and days to heading.

In conoclusion, our data indicated that the response of the two spring wheat cultivars to planting dates in Al-Qassim region varied with environment. The best planting date to be recommended for Al-Qassim region lies between December 1 and 16. Expanding planting to January 1 could be possible, while, planting after this period would result in yield reduction.

Table 3. Combined analysis of variance for yield and its components and other agronomic traits for the two wheat cultivars as affected by six planting dates over the two seasons of 1990/91 and 1991/92

S. O. V.	df	Grain yield	No. of spikes/m^2	No. of kernels/spike	1000-kernel weight	Plant height	Days to heading
Reps. (R)	3	0.03	253.30	3.75	3.01	20.15	0.12
Seasons (S)	1	0.16	324570.04**	449.80**	87.80**	222.04*	2860.16**
Error (a)	3	0.41	2060.96	1.41	0.45	19.48	0.03
Cultivars (C)	1	2.16**	4676.04	22.62*	1020.96**	15100.16**	1162.04**
S X C	1	0.79*	14016.66*	52.51**	116.89**	228.16**	60.16**
Error (b)	6	0.10	1129.82	2.56	8.01	8.78	0.52
Dates (D)	5	34.57**	78980.06**	169.10**	711.61**	933.42**	2835.42**
S X D	5	3.87**	42487.54**	38.41**	48.49**	111.14**	141.16**
C X D	5	2.78**	5285.64**	75.78**	69.87**	160.61**	14.54**
S X C X D	5	1.34**	3178.96*	27.39**	22.72**	21.06**	27.82**
Error (C)	60	0.15	1106.64	3.42	3.45	3.60	0.35
Total	95						

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

Table 4. Means over seasons of the two studied cultivars and six planting dates for grain yield no. of spikes/m^2, no. of kernels/spike, 1000-kernel weight, plant height and days to heading

Factor	Grain yield (tons/ha)	No. of spikes/m^2	No. of kernels/spike	1000-kernel weight (gm)	Plant height (cm)	Days to heading
Cultivars :						
Yecora Rojo	3.71	309.19	35.65	34.06	63.40	79.96
West Bread	3.41	295.23	36.62	27.54	88.48	88.92
Planting date						
Nov. 16	3.97	299.94	35.04	37.80	78.06	96.56
Dec. 1	5.10	411.37	38.65	37.54	82.81	94.06
Dec. 16	4.69	345.94	40.97	33.20	80.81	90.25
Jan. 1	3.95	290.94	36.39	29.54	79.06	83.81
Jan. 16	2.42	255.00	33.40	25.64	73.00	74.12
Feb. 1	1.21	210.06	32.35	21.10	61.87	61.81
L.S.D. 0.05						
$C_1 - C_2 =$	0.158	16.79	0.80	1.41	1.48	0.36
$D_1 - D_6 =$	0.390	33.27	1.85	1.86	1.90	0.59

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موعد الزراعة وعلاقته بالمحصول ومكوناته في القمح بمنطقة القصيم

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أجري هذا البحث خلال الموسمين ١٩٩١/٩٠، ١٩٩٢/٩١م، لتقدير موعد الزراعة الأمثل للحصول على أقصى انتاجية للقمح تحت ظروف منطقة القصيم. أجريت التجارب في محطة البحوث الزراعية ـ كلية الزراعة والطب البيطري ـ جامعة الملك سعود فرع القصيم ـ المملكة العربية السعودية، ولقد استخدم صنفان من الأقماح الربيعية العالية المحصول هما يكورا روجو، ووست برد حيث زرعت في ست مواعيد هي ١٦ نوفمبر، أول ديسمبر، ١٦ ديسمبر، أول يناير، ١٦ يناير، أول فبراير وقد استخدم تصميم القطاعات المنشقة في أربعة مكررات لكل تجربة في الموسمين.

أوضحت النتائج أن لمواعيد الزراعة تأثيراً معنوياً على جميع الصفات التي درست. وأظهر التفاعل بين الأصناف ومواعيد الزراعة، وبين الأصناف والمواسم، وبين الأصناف ومواعيد الزراعة والمواسم تأثيراً معنوياً على محصول الحبوب ومكوناته وارتفاع النبات وتاريخ التزهير. ولقد دلت النتائج على أن موعد الزراعة المفضل للصنف يكورا روجو هو أول يناير وللصنف ويست برد

هو ١٦ ديسمبر في الموسم الأول ولكن أول ديسمبر كان الموعد الأمثل للحصول على أقصى محصول للحبوب لكلا الصنفين في الموسم الثاني. ولقد أدى تأخير الزراعة من نوفمبر إلى ديسمبر إلى زيادة معنوية في عدد السنابل في المتر المربع وعدد حبوب السنبلة ولكن انخفض وزن الحبوب انخفاضاً غير معنوياً. هذه النتائج تدل على أن الفترة المثلى لموعد الزراعة في منطقة القصيم تقع ما بين أول ديسمبر إلى ١٦ ديسمبر ومن الممكن امتداد فترة الزراعة حتى أول يناير بينما الزراعة بعد هذه الفترة تؤدي الى انخفاض المحصول.