EFFECTS OF DIFFERENT SOWING TIMES ON YIELD AND YIELD-RELATED TRAITS IN BREAD WHEAT GROWN IN ÇANAKKALE*

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Abstract

The study was conducted in the Experimental Field of Agriculture Faculty of Çanakkale Onsekiz Mart University during the 1997-1998 and 1998-1999 growing seasons. In this trial four bread wheat cultivars were sown at four different times. Grain yield, plant height, plant number per plant, head number per m^2 and plant, head length, grain weight and number per head, 1000 grain weight, biological yield and harvest index were investigated. According to two years' average data, the effects of variety and sowing times on grain yield were found to be significant. The highest grain yield (3731 kg·ha^{-1}) was obtained from cultivar Pehlivan. On the other hand, the highest grain yields were obtained at the sowing times of 30 October and 20 November. The effects of variety and sowing time on yield components investigated in the research were generally significant. Correlations between grain yield and plant height, plant and head number per m^2, head number per plant, grain weight per head, 1000 grain weight, biological yield and harvesting index were positively significant. As a result, under the ecological conditions of Çanakkale winter bread wheat should be sown from 30 October to 20 November. Gönen variety should be preferred if the sowing time was late (20 November), but Pehlivan variety should be used early sowing.

Keywords: Bread wheat, sowing time, grain yield, yield components, correlation

Çanakkale Şartlarında Farklı Ekim Zamanlarının Ekmeklik Buğday Çeşitlerinde Verim ve Verim ile İlişkili Öğelere Etkileri

Özet

Bu araştırma Çanakkale Onsekiz Mart Üniversitesi Ziraat Fakültesi'nin deneme alanında 1997-98 ve 1998-99 büyüme dönemlerinde yürütülmüştür. Dört ekmeklik buğday çeşidinin (Pehlivan, Gönen, Kate A-1 ve Saraybosna) dört ayrı zamanda (20 Eylül, 10 Ekim, 30 Ekim ve 20 Kasım) ekildiği denemede dane verimi, bitki boyu, m^2'deki bitki sayısı, m^2'deki başak sayısı, bitkideki başak sayısı, başak uzunluğu, başaktaki dane ağırlığı, başaktaki dane sayısı, bin dane ağırlığı, biyolojik verim ve hasat indeksi incelenmiştir. İki yıllık ortalama verilere göre dane verimi üzerine çeşitlerin ve ekim zamanlarının etkisi önemli bulunmuştur. En yüksek dane verimi (373.1 kg·da^{-1}) Pehlivan çeşidinde belirlenmiştir. Ekim zamanlarına göre en yüksek dane verimleri 30 Ekim ve 20 Kasım tarihlerinde yapılan ekimlerden elde edilmiştir. Genel olarak denemede çeşitler ve ekim zamanlarının incelenen verim unsurlarına etkileri önemli olmuştur. Ayrıca dane verimi ile bitki boyu, m^2'deki bitki sayısı, m^2'deki başak sayısı, bitkideki başak sayısı, başaktaki dane ağırlığı, bin dane ağırlığı, biyolojik verim ve hasat indeksi arasındaki ilişkilerin önemli ve olumlu olduğu belirlenmiştir. Sonuç olarak Çanakkale ekolojik şartlarında kışlık ekmeklik buğday 30 Ekim-20 Kasım arasında ekilmelidir. Ekimin gecikmesi (20 Kasım) halinde Gönen, daha önce yapılacak ekimlerde Pehlivan çeşidi kullanılmalıdır.

Anahtar Kelimeler: Ekmeklik Buğday, Ekim Zamanı, Verim, Verim Unsurları, Korelasyon.

1. Introduction

Wheat is an important crop as food and feed, and as a raw material for different industry branches. Turkey, with 2% annual population increase and 200-250 kg annual wheat consumption per person (Akkaya, 1994), must increase production in per unit area in order to overcome this requirement and become as a self sufficient country.

One of the most important factors influencing the wheat yield is sowing time (Reitz, 1976; Alessi, 1979). Many researchers have carried out some studies on sowing times of wheat in Turkey and other countries and found different results

*: The first year results of the research were submitted as a Master Thesis by Mesut Akdamar

(Chougule, 1993; Dahlke, 1993; Jedel and Salmon, 1994). Various researchers also conducted investigations related the subject in Turkey.

Five different wheat varieties were sown at seven different sowing times in Sakarya in 1991-1993 growing seasons. For grain yield the most suitable sowing time was found to be 30th October (Bostancıoğlu and Bayram, 1993). Öztürk et. al. (1997) carried out an investigation in 1990-1993 growing periods to determine the most suitable sowing times of 3 bread wheat varieties in Samsun. They sowed seeds with 10 different sowing time intervals. According to the results obtained from the study, the most suitable sowing time interval for the region was from 1st November to 15th November. Another research was conducted in Tekirdağ to find out the most suitable sowing times and sowing density of 3 bread wheat varieties that are grown widely in Thrace Region (Gençtan and Sağlam, 1987). Varieties were sown at 5 different sowing times. The highest grain yield were obtained from Bezostaja 1 and Sadova 1 varieties in the sowing date of 11th November, and from Libelüla variety in the sowing time of 21st October.

Therefore, this research was carried out in order to determine the most appropriate wheat varieties and the most suitable sowing time of the genotypes for Çanakkale Province.

2. Materials and Methods

The study was conducted in the Experimental Field of Çanakkale Onsekiz Mart University, Yahya Çavuş Campus during the 1997-1998 and 1998-1999 growing seasons. The field soils contain 0.83% organic matter, 55 kg ha^{-1} P_2O_5, 270 kg ha^{-1} K_2O and 7% $CaCO_3$. Soil pH is 7.7 and texture clay. Both annual total precipitation and relative humidity of Çanakkale in 1997-98 and 1998-99 were higher than long term, but average temperature was similar.

The study consisted of the factorial combination of four sowing dates (20 September, 10 October, 30 October and 20 November) and four bread wheat cultivars (Gönen, Kate A-1, Pehlivan and Saraybosna). Treatments were arranged in a split-plot experimental design with sowing dates as main plots and cultivars as sub-plots completely randomized in four replications. Each sub-plot had 6 rows, 20 cm row spacing and 5 m plot length. Seeds were sown by hand with a sowing density of 500 seeds m^{-2}.

Sub-plots were fertilized at sowing with 40 kg ha^{-1} P as diammoniumphosphate (DAP). 100 kg ha^{-1} total nitrogen was applied in two parts, first part at sowing as DAP and second part in the beginning of stem elongation as ammoniumsulphate.

In the present study, a range of characters (grain yield (GY), plant height (PH), number of plants per m^2 (NPM), number of heads per m^2 (NHM) and number of heads per plant (NHP), head length (HL), grain weight per head (GWH) and number of grain per head (NGH), 1000 grain weight (GW), biological yield (BY) and harvest index (HI)) were investigated. Combined analyses of variance were conducted to determine the significance of main effect of sowing dates and cultivars and their first and second degree interactions on the characters measured by using TARIST statistical computer package program (Açıkgöz et al., 1994).

3. Results

3.1. Grain yield (GY)

According to the GYs obtained from the wheat varieties and sowing times used in the study, the highest GYs for the first year, second year and average of both years were obtained from Pehlivan variety (3458 kg ha^{-1}, 4004 kg ha^{-1} ve 3731 kg ha^{-1} respectively) whereas Saraybosna and Kate A-1 had the lowest yields. GY differences between varieties were significantly important (Table 1).

The GY for the first year was 2979 kg ha^{-1} and the GY for the second year was 3332 kg ha^{-1}. It was seen that differences between sowing times both research years and average were found to be significant. In general, the grain yield was high with late

Table 1. The grain yields of winter bread wheat varieties sown at different times (kg·ha^{-1}).

Sowing time	Varieties				Mean
	Gönen	Kate A-1	Pehlivan	Saraybosna	
1997-1998					
20 September	1745	1816	3267	3051	2470 B
10 October	2119	3132	3836	2894	2995 A
30 October	3085	3788	3579	2414	3216 A
20 November	4499	2675	3149	2615	3234 A
Mean	2862 B	2853 B	3458 A	2743 B	2979
F values	Variety (V): 6.77** Sowing time (S): 22.23** V x S: 10.56**				
1998-1999					
20 September	2254	1798	2993	2759	2451 C
10 October	2573	2983	4676	3454	3421 B
30 October	4021	3701	3913	2619	3563 B
20 November	5244	3058	4434	2840	3894 A
Mean	3523 B	2885 C	4004 A	2918 C	3332
F values	Variety (V): 16.09** Sowing time (S): 85.57** V x S: 7.92**				
Mean					
20 September	2000	1807	3130	2905	2460 C
10 October	2346	3057	4256	3174	3208 B
30 October	3553	3745	3746	2516	3390 AB
20 November	4871	2866	3791	2727	3564 A
Mean	3192 B	2869 C	3731 A	2831 C	3156
F values	V: 19.00** S: 110.19** V x S: 15.41** Year: 160.90**				

Means shown by the same letter are not significantly different within columns and rows.
** indicates significance at 1%.

sowing times. The yield increasing with sowing time was significant up to 10th October for the first year, 20th November for the second year and 30th October for two-year average. Variety x sowing time interaction was found highly significant for both years and average. In this respect the highest GY was obtained from Gönen variety sown in 20 November. Average yield of two years was found 4871 kg ha^{-1}

3.2. Yield components

In the study, all parameters examined over two years were analyzed, and the results for PH, NPM, NHM, NHP and HL were shown in Table 2 and GWH, NGH, GW, BY and HI in Table 3.

In general, variety, sowing time and their interactions were found significant in terms of investigated characters. The highest PH, NHM, NHP, GWH, GW and BY were obtained from cultivar Pehlivan while Kate A-1 produced the highest HL. Saraybosna and Gönen have a higher amount of NGH. However the HI of three cultivars (Gönen, Kate A-1 and Pehlivan) was higher than Saraybosna.

NPM, NHM, NHP, NGH, BY and HI were generally higher at the latest sowing. So PH and HL were higher at the sowing of 10th and 30th October. On the other hand GW was the highest when the plants were sown on 20th September and 10th October.

3.3. Correlations

The result was showed that the correlations between GY with NPM, NHM, NHP, PH, GWH, GW, BY and HI were significant and positive, while correlations between GY with HL and NGH were not significant (Table 4).

4. Discussion

According to mean values obtained from a two-year trial, cultivars Pehlivan gave the highest GY (3731 kg/ha), followed by cultivars Gönen with 3192 kg/ha yield whereas Kate A-1 (2689 kg/ha) and Saraybosna (2831 kg/ha) produced the lowest GY. Hadjichristodoulou (1997)

Table 2. Plant height, number of plants and heads per m^2, number of heads per plant and head length of winter bread wheat varieties sown at different times as two-year average.

Sowing time	Varieties				Mean
	Gönen	Kate A-1	Pehlivan	Saraybosna	
Plant height (cm)					
20 September	69.0	90.5	94.0	77.0	82.6 B
10 October	72.8	97.2	102.8	77.1	87.5 A
30 October	75.6	100.8	97.9	73.6	87.0 A
20 November	73.6	87.1	90.9	67.0	79.7 B
Mean	72.7 C	93.9 B	96.4 A	73.7 C	84.2
F values	Variety (V): 281.66**	Sowing time (S): 21.27**	V x S: 5.75**		
Number of plants per m^2					
20 September	267.5	307.5	333.1	345.0	313.3 B
10 October	285.0	328.8	372.5	311.3	324.4 B
30 October	365.6	416.3	368.1	397.5	386.9 A
20 November	422.5	375.0	342.5	335.0	368.8 A
Mean	335.2	356.9	354.1	347.2	348.4
F values	Variety (V): 1.36ns	Sowing time (S): 17.10**	V x S: 5.24**		
Number of heads per m^2					
20 September	516.9	469.4	578.8	583.1	537.1 C
10 October	410.0	470.6	658.8	535.0	518.6 C
30 October	621.3	714.4	701.9	686.9	681.1 B
20 November	870.6	683.8	659.4	716.9	732.7 A
Mean	604.7 BC	584.6 C	649.7 A	630.5 AB	617.4
F values	Variety (V): 6.47**	Sowing time (S): 96.29**	V x S: 14.33**		
Number of heads per plant					
20 September	1.93	1.61	1.81	1.80	1.79 B
10 October	1.54	1.47	1.86	1.81	1.67 B
30 October	1.70	1.72	1.92	1.73	1.77 B
20 November	2.06	1.82	1.91	2.15	1.99 A
Mean	1.81 A	1.65 B	1.87 A	1.87 A	1.80
F values	Variety (V): 10.79**	Sowing time (S): 12.02**	V x S: 3.78**		
Head length (cm)					
20 September	8.24	8.64	8.34	7.11	8.08 AB
10 October	8.51	8.94	8.43	7.28	8.29 A
30 October	8.75	8.74	8.65	7.33	8.37 A
20 November	7.89	9.03	7.97	6.34	7.81 B
Mean	8.35 B	8.84 A	8.35 B	7.02 C	8.14
F values	Variety (V): 41.51**	Sowing time (S): 13,56**	V x S: 1.17ns		

Means shown by the same letter are not significantly different within columns and rows.
** indicates significance at 1% and ns is not significant.

pointed out that the variation in the yield depends on cultivars and environment, particularly amount of rainfall received. The differences between the cultivars were significant for all characters, except NPM. Not surprisingly, different cultivars having different genetic potential levels would have different yield capacities.

When the sowing dates from 20th September to 20th November are considered, the GY increased with the later sowing dates. On the other hand, the increase in the yield was not significant in the sowing dates later than 30th October. In Çanakkale where the winter starts late, early sown plants in the fall produce a considerable amount of vegetative part and therefore, the plants may be more affected and damaged from the freeze. In addition, early sown seeds could face with drought problem due to late coming rainfalls. Especially, in September 1997, a scarce amount of precipitation (0.8 mm) was received in the Region. In contrast, in September 1998, a sufficient amount of

Table 3. Grain weight and number per head, 1000 grain weight, biological yield and harvesting index of winter bread wheat varieties sown at different times as two-year average.

Sowing time	Varieties				Mean
	Gönen	Kate A-1	Pehlivan	Saraybosna	
Grain weight per head (g)					
20 September	11.2	11.8	14.8	12.9	12.7
10 October	12.5	11.6	13.1	11.1	12.1
30 October	14.7	13.0	13.6	10.7	13.0
20 November	12.8	12.5	12.2	8.2	11.4
Mean	12.8 AB	12.2 B	13.4 A	10.7 C	12.3
F values	Variety (V): 9.21**	Sowing time (S): 3.56ns	V x S: 3.40**		
Number of grain per head					
20 September	35.8	31.9	32.2	39.4	34.8 AB
10 October	33.5	31.1	29.4	39.6	33.4 B
30 October	38.1	34.3	31.5	39.9	36.0 AB
20 November	42.7	39.4	31.7	35.3	37.3 A
Mean	37.5 A	34.2 B	31.2 C	38.6 A	35.4
F values	Variety (V): 10.85**	Sowing time (S): 4.33*	V x S: 2.03*		
1000 grain weight (g)					
20 September	33.6	34.7	47.3	32.4	37.0 A
10 October	34.7	36.0	46.9	30.5	37.0 A
30 October	36.6	35.6	43.9	28.0	36.0 B
20 November	34.8	34.1	45.5	29.6	36.0 B
Mean	34.9 B	35.1 B	45.9 A	30.1 C	36.5
F values	Variety (V): 368.67**	Sowing time (S): 4.93**	V x S: 4.69**		
Biological yield (kg ha^{-1})					
20 September	6424	5819	10414	10250	8227 C
10 October	7044	8006	11167	9333	8888 BC
30 October	9197	10103	10243	7881	9356 AB
20 November	10545	8335	11309	8853	9761 A
Mean	8303 C	8066 C	10783 A	9079 B	9058
F values	Variety (V): 29.42**	Sowing time (S): 13.58**	V x S: 10.16**		
Harvesting index (%)					
20 September	31.1	31.1	30.4	28.4	30.3 B
10 October	33.3	37.9	38.6	33.7	35.9 A
30 October	38.6	36.8	36.8	32.0	36.1 A
20 November	46.2	34.7	33.4	30.8	36.3 A
Mean	38.4 A	35.1 A	34.8 A	31.2 B	34.7
F values	Variety (V): 10.56**	Sowing time (S): 27.41**	V x S: 3.16**		

Means shown by the same letter are not significantly different within columns and rows.
ns, * and ** indicate not significant, significance at 5% and 1%, respectively.

precipitation was received. In both years, as a result of receiving sufficient precipitation in October and November, later sowing dates sustained a successful plant growth. In optimum conditions, not facing with high temperature and drought problems, early sown plants should have produced higher GYs as they have a longer growing period (Smid and Jenkinson, 1979; Akkaya and Akten, 1988; Anderson and Smith, 1990; Anderson and Olsen, 1992; Witt, 1996). However, some investigations indicating that higher GYs could be obtained from late sowings, if there is no any inhibitory effect on seedling growth (Sticker and Paulu, 1964; Gençtan and Sağlam, 1987). In overall, the GY obtained in the second year was higher than the first year as the rainfall received in the second year was higher than the first year and also rain fall distribution in wheat growing period was more appropriate.

According to variance analyses, sowing time x cultivars interaction was highly significant. Yield of Gönen increased with later sowing dates and the highest GY was obtained with 20th November sowing

Table 4. Correlations between grain yield and yield components.

	GY	PH	NPM	NHM	NHP	HL	GWH	NGH	GW	BY
PH	0.332**	-								
NPM	0.564**	0.232*	-							
NHM	0.657**	0.029ns	0.773**	-						
NHP	0.327**	-0.211ns	0.018ns	0.574**	-					
HL	0.100ns	0.547**	-0.016ns	-0.168ns	-0.288*	-				
GWH	0.416**	0.321**	0.161ns	0.120ns	-0.074ns	0.506**	-			
NGH	0.113ns	-0.474**	0.111ns	0.295*	0.216ns	-0.167ns	0.254*	-		
GW	0.445**	0.671**	0.064ns	0.077ns	0.074ns	0.400**	0.467**	-0.511**	-	
BY	0.847**	0.357**	0.458**	0.558**	0.374**	-0.097ns	0.335**	0.039ns	0.502**	-
HI	0.653**	0.372**	0.371**	0.306**	-0.074ns	0.436**	0.344**	0.002ns	0.283*	0.250*

ns, * and ** indicate not significant, significance at 5% and 1%, respectively.

date. This for Pehlivan and Saraybosna was 10th October whereas for Kate A-1 it was 30th October. This variation among cultivars is due to their differential responses to the environmental factors.

Grain yield was highly and positively correlated with PH, NPM, NHM, NHP, GWH, GW, BY and HI. Therefore, this shows that these yield components were the most important characters in GY increase. Increasing PH, some extent, results in an increase biomass of a plant and consequently an increase in amount of photosynthesis and finally an increase in GY per area. The cultivars having higher HI produced higher grain yields. Şener et al. (1997) stated that, in a wheat-breeding program, high HI should be considered together with other characters.

As a conclusion, in this study conducted in order to investigate the effect of sowing date on yield and some yield components, the results showed that climatic conditions, especially amount and distribution of precipitation during plant growing period, significantly affected sowing date of cultivars.

In Çanakkale condition, the best sowing time for bread wheat is between 30th October and 20th November. For late sowing (20th November) cultivars Gönen whereas for early sowings (10th and 30th October) Pehlivan could be recommended.

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