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The Effect of Different Sowing Dates on Growing Periods, Yield and Yield Components of Some Bread Wheat (*Triticum aestivum* L.) Cultivars Grown in the East-Mediterranean Region of Turkey

Tevrican Dokuyucu, Aydin Akkaya and Didem Yigitoglu
Field Crops Department, Agricultural Faculty, Kahramanmaras Sutcu Imam University,
46060, Kahramanmaras, Turkey

Abstract: The aim of this research was to determine the effect of different sowing dates on growing period, yield and some yield components of three bread wheat (*Triticum aestivum* L.) cultivars grown Kahramanmaras, in the East-Mediterranean region of Turkey. Experiment was carried out in a split-plot on randomized complete block design with four replications, between the year 1997-1999. Seven planting dates were planned with the first on 9th October and the others followed at about 15 day intervals. Two cultivars (Seri-82, Dogankent-1 and Panda) were the main plots and 7 different sowing dates were the subplots. According to the results of two years, sowing dates had significant effect on vegetative period (VP), grain filling period (GFP), days to maturity (DM), head number m^{-2} (HN m^{-2}), 1000-grain weight (1000-GW) and grain yield (GY). Grain yields obtained from the first five sowing dates were not significantly different. Consequently, the period from first week of November to middle of December could be concluded as optimum sowing period for maximum grain yield for the region.

Key words: Wheat, sowing date, grain yield, yield components, growing period

INTRODUCTION

Wheat is a major crop in the most of countries of the world as well as Turkey. Wheat has 230.2 million ha sowing area and 585 million ton total production per year in the world[1] and 9.4 million ha sowing area and 18.5 million ton total production per year in Turkey[2].

Kahramanmaras province, located in the East-Mediterranean region of Turkey, has 196399 ha wheat sowing area and 386910 ton total production per year[2]. In this region, wheat is generally grown in rotation with cotton, sugar beet and corn in irrigated lands or in rotation with chickpea at rainfed conditions. In some years, sowing of wheat can be delayed to the middle of December or January due to late harvesting of previous crop, especially after corn as a second crop in irrigated lands. In addition, farmers do not take the sowing time into account due to suitable climatic conditions during planting time in the region. Therefore, sowing time in the region lasts from October to the middle of January. There is no research related with wheat sowing dates in the region, although there are a lot of experiments related with sowing dates all over the world. Many authors indicated that growing period, yield and yield components were significantly changed due to sowing dates, cultivars and years[3-10]. For this reason, it was aimed to determine the effects of different sowing dates on yield and yield components of three bread wheat (*Triticum aestivum* L.) cultivars, commonly grown in the region.

MATERIALS AND METHODS

This research was carried out Kahramanmaras, during the year 1997-1999. Kahramanmaras province located in the East-Mediterranean region of Turkey between 37° 36' north parallel and 46° 56' east meridian. Climatic type of the region is the typical Mediterranean climate and its some climatic data are given in Table 1.

It can be seen from Table 1, the second year generally had higher mean temperatures and lower total rainfalls than the first year. Especially less rainfall than average of the long periods and previous year in the March, April, May and June months made it necessity to irrigation. In addition, relative humidity in the second year was also generally lower than those the average of the long periods and previous year except January and February.

According to analysis of soil samples which obtained from first 0-30 cm depth structure of soil is clay-loamy, pH

Corresponding Author: Tevrican Dokuyucu, Field Crops Department, Agricultural Faculty, Kahramanmaras Sutcu Imam University, 46060, Kahramanmaras, Turkey

is 7.6, $CaCO_3$ content is 24.3%, organic matter content is 0.8%.

Bread wheat (*Triticum aestivum* L.) cultivars; Seri-82, Dogankent-1 and Panda, commonly grown in the region, were used as plant material.

Seven planting dates were planned with the first on 9th October and the others followed at about 15-day intervals (date-1: 9th October, date-2: 23rd October, date-3: 6th November, date-4: 25th November, date-5: 11th December, date-6: 26th December, date-7: 15th January).

The experimental design was a split-plot arrangement on randomized complete block with four replications. Three cultivars were the main plots and 7 different sowing dates were the subplots. Sowing density was 550 seeds m^{-2}. Plot area was 6 m^2. There were 6 plant rows in plots. Sixty kg ha^{-1} nitrogen and 60 kg ha^{-1} phosphorus were applied at sowing time and 80 kg ha^{-1} addition nitrogen was also given at the end of tillering period. The experiment was carried out in rainfed conditions in the first year. However, irrigation was applied at heading period due to lower rainfall occurred in March, April, May and June months in the second year. Vegetative period (VP), grain filling period (GFP), days to maturity (DM), head number m^2 (HN m^{-2}), grain number per head (GN/H), grain weight per head (GW/H), 1000-grain weight (1000-GW) and grain yield (GY) were investigated and data were analysed by the MSTAT-C statistical programme and LSD test was used to rank the means.

RESULTS AND DISCUSSION

Vegetative period: The differences among the sowing dates for vegetative period were significant (P<0.01). The longest vegetative period was obtained from date-1 with 190 days. Vegetative periods decreased as sowing dates were delayed. Vegetative periods for date-2, date-3, date-4, date-5, date-6 and date-7 were 179, 170, 157, 145, 135 and 122 days, respectively (Table 2). These results indicated that delayed sowing dates significantly reduced vegetative period. Similar results were also obtained by earlier researchers[4,11].

The differences among cultivars for vegetative period were not significant and vegetative period of Seri-82, Dogankent-1 and Panda cultivars were 155 and 157 days, respectively.

Grain filling period: The effect of sowing dates on grain filling period was significant (P<0.01). The longest grain filling period (44 d) obtained from date-1. Grain filling period for other sowing dates 2, 3, 4, 5, 6 and 7 were 42, 38, 34, 32, 29 and 27 days, respectively (Table 2). These results showed that grain filling period significantly decreased due to delayed sowing dates. Akkaya and Akten[5] and Witt[12] have also reported to the similar results.

The differences among the cultivars were not significant for grain filling period and Seri-82, Dogankent-1 and Panda cultivars had 35 and 35 day-grain filling period, respectively. Years were significantly different for grain filling period (P<0.05), due to the differences of climate between the years. Grain filling period in the first and second years were 34 and 36 days, respectively. Irrigation at heading period in second year probably caused longer grain filling period. Year x sowing date (P<0.01) and year x cultivar x sowing date interactions (P<0.05) for grain filling period were significant due to different response of cultivars to the years and sowing dates.

Days to maturity: The effects of sowing dates on days to maturity were significant. Date-1 had the longest days to maturity with 235 days and days to maturity for date-2, 3, 4, 5, 6 and 7 were 221, 208, 191, 178, 164 and 148 days, respectively (Table 2). Delayed sowing dates significantly decreased days to maturity. Similar results such as gradually decreasing of days to maturity due to delaying sowing dates have been reported by the other researchers[13,3].

Table 1: Monthly mean temperature, rainfall and relative humidity during the experiment years and long- period averages

	Mean Temperature (°C)			Rainfall (mm)			Relative Humidity (%)		
Months	97-98	98-99	30-97	97-98	98-99	30-97	97-98	98-99	30-97
October	18.4	20.2	18.7	60.4	42.0	43.2	63.2	44.4	48.7
November	12.0	14.6	17.2	98.0	127.4	101.5	66.5	66.4	61.0
December	7.2	8.3	6.3	141.9	179.6	130.9	71.2	70.7	72.8
January	5.1	6.8	4.5	80.2	83.9	114.8	63.0	73.7	69.4
February	7.1	7.9	5.3	80.4	103.7	106.3	48.6	63.6	66.1
March	9.4	11.1	10.0	134.0	86.5	87.5	61.0	53.5	62.1
April	16.6	15.7	13.5	166.7	50.2	63.3	57.8	54.5	58.2
May	19.8	22.2	19.7	39.4	9.9	49.5	57.0	44.6	55.7
June	25.0	25.5	24.6	15.6	0.0	5.4	54.9	49.6	51.0
Total				816.6	683.2	702.4			

Table 2: Data belong to vegetative period (VP), grain filling period (GFP), days to maturity (DM) and head number (HN m^{-2}) for sowing dates, cultivars and years

	VP (day)	GFP (day)	DM(day)	HN m^{-2}
Sowing Dates	**	**	**	**
Date-1	190.00a	44.00a	235.00a	494.0ab
Date-2	179.00b	42.00a	221.00b	504.0a
Date-3	170.00c	38.00b	208.00c	554.0a
Date-4	157.00d	34.00c	191.00d	557.0a
Date-5	145.00e	32.00c	178.00e	544.0a
Date-6	135.00f	29.00d	164.00f	501.0a
Date-7	122.00g	27.00d	148.00g	405.0b
LSD	3.28	3.04	2.54	94.5
Cultivars	NS	NS	**	**
Seri-82	155.00	35.00	190.00b	503.0ab
Dogankent-1	158.00	36.00	194.00a	557.0a
Panda	157.00	35.00	192.00ab	464.0b
LSD			2.46	69.3
Years	**	*	**	**
1997-98	160.00a	34.00b	194.00a	569.0a
1998-99	154.00b	36.00a	191.00b	449.0b
Mean	157.00	35.00	192.00	509.0

*, P<0.05; **, P<0.01; NS, not-significant

Table 3: Data belong to grain number per head (GN/H), grain weight per head (GW/H), 1000-grain weight (1000-GW) and grain yield (GY) for sowing dates, cultivars and years

	Grain number per head	Grain weight per head	1000-grain weight	Grain yield
Sowing dates	NS	NS	**	**
Date-1	49	1.98	41.6a	6602ab
Date-2	50	2.07	39.6a	6496ab
Date-3	50	2.05	40.2a	7494a
Date-4	50	2.12	40.0a	7160ab
Date-5	52	2.00	38.0ab	7770a
Date-6	52	2.01	39.2ab	5657b
Date-7	51	1.77	34.1b	3744c
LSD			5.41	1560
Cultivars	NS	NS	*	NS
Seri-82	53	1.95	36.1b	5966
Dogankent-1	50	1.92	37.5ab	7003
Panda	49	2.15	43.3a	6285
LSD			6.68	
Years	NS	NS	**	**
1997-98	52	1.94	35.6b	4326b
1998-99	49	2.06	42.3a	8509a
Mean	51	2.00	38.9	6418

*, P<0.05; **, P<0.01; NS , non-significant

Table 4: Correlation coefficients among the VP, GFP, DM, HNm^{-2}, GN/H, GW/H, 1000-GW and grain yield (GY)

	GFP	DM	HN m^{-2}	GN/H	GW/H	1000-GW	GY
VP	0.74**	0.97**	0.25**	-0.04	0.09	0.16*	0.14
GFP	--	0.83**	0.06	-0.02	0.20**	0.34**	0.35**
DM	--	--	0.20**	-0.04	0.12	0.23**	0.21**
HN m^{-2}	--	--	--	0.11	0.08	-0.15*	0.004
GN/H	--	--	--	--	0.70**	-0.08	0.11
GW/H	--	--	--	--	--	0.55**	0.44**
1000-GW	--	--	--	--	--	--	0.57**

*, P<0.05; **, P<0.01

Cultivars were significantly different for days to maturity (P<0.01). Days to maturity of Seri-82, Dogankent-1 and Panda cultivars were 190 and 194 days, respectively (Table 2). Furthermore, differences of years for days to maturity were significant (P<0.01). Days to maturity in first and second year was 194 and 191 days, respectively (Table 2).

Head number (m^{-2}): The differences among sowing dates for head number m^{-2} were not significant except the last sowing date (date-7). There were gradually decreases on head number m^{-2} with earlier or later sowing dates. The last sowing date (date-7) had the least head number m^{-2} (405). The head numbers on date-1, 2, 3, 4, 5 and 6 were 494, 504, 554, 557, 544 and 501, respectively. These results showed that earlier and later sowings cause lower head numbers. Similarly, previous authors had pointed out same results[5,7,11].

Cultivars were also significantly different for head number m^{-2} (P<0.01). Although they had been sown at the same sowing densities, they had different head number m^{-2}. Seri-82 and Panda have 503 and 464 Head number m^{-2}, respectively (Table 2). This result could be due to genotypical differences of cultivars. Years were significantly different for head number m^{-2} (P<0.01). According to the averages, head number m^{-2} in first year was 569, while it was 449 in the second year. These results might be caused by less tillering in the second year because of less rainfall.

Grain number per head: Differences of sowing dates for grain number per head were not significant. Grain number per head values for date-1, 2, 3, 4, 5, 6 and 7 were 49, 50, 50, 50, 52, 52 and 51, respectively (Table 3). Earlier researchers had pointed out different results in this subject. Some of them indicated significant decreases in grain number per head comply with the lasting of sowing dates[9,12,14], while other ones reported increases[15,16].

The effects of cultivars on this trait were not significant, either. However, Seri-82, Dogankent-1 and Panda cultivars had grain number per head with 53 and 49 grains/head, respectively (Table 3). Similarly, years were not significantly different for grain number per head and the grain number per head values were 52 and 49 in the first and second years, respectively.

Grain weight per head: The effect of sowing dates on the grain weight per head was not significant. Grain weight per head values for date-1, 2, 3, 4, 5, 6 and 7 were 1.98, 2.07, 2.05, 2.12, 2.0, 2.01 and 1.77 g, respectively (Table 3). Earlier researchers had reported that there were significant decreases in grain weight per head on the earlier and later sowing dates[14,15].

Cultivar's effects were not significant and grain weight per head values of Seri-82, Dogankent-1 and Panda cultivars were 1.95 and 2.15 g, respectively (Table 3). Year's effect on grain weight per head was not significant and grain weight per head values were 1.94 and 2.06 g in the first and second year, respectively.

1000-grain weight: There were significant differences among sowing dates for 1000-grain weight ($P<0.01$). 1000-grain weight values for date-1, 2, 3, 4, 5, 6 and 7 were 41.6, 39.6, 40.2, 40.0, 38.0, 39.2 and 34.1 g respectively (Table 3). It was founded that, delaying of sowing dates significantly decreased 1000-grain weight. Other researchers had also reported similar results[4,9,17,18].

Cultivars were also significantly different for this trait ($P<0.05$). Seri-82, Dogankent-1 and Panda cultivars had 1000-grain weight: with 36.1 and 43.3 g, respectively. These differences could be due to genotypical differences among the cultivars. Years were also significantly different for 1000-grain weight: ($P<0.01$). 1000-grain weight in the first and second years were 35.6 and 42.3 g, respectively. Higher 1000-grain weight in second year was probably due to irrigation at heading period which caused longer grain filling period in the second year.

Grain yield: The effects of sowing dates on grain yield were significant ($P<0.01$). Grain yield values for date-1, 2, 3, 4, 5, 6 and 7 were 6602, 6496, 7494, 7160, 7770, 5657 and 3744 kg ha^{-1}, respectively (Table 3). First five sowing dates were not significantly different for grain yield. However, later plantings than date-5 caused significant decreases in grain yield. On the other hand, earlier plantings caused excessive vegetative growth before winter season. This excessive vegetative growth may cause cold damage risks. Consequently, it is possible to realize sowing of wheat in the region at the period from first week of November to middle of December. After this period there was significant decrease on grain yield. Similarly other researchers have pointed out that later sowing dates than optimum sowing date decreased grain yield[4,19-21].

The cultivars were not significantly different for grain yield. Seri-82, Dogankent-1 and Panda cultivars had 5966 and 6285 kg ha^{-1} grain yield, respectively. But years were significantly different for grain yield ($P<0.01$). The irrigation resulted in considerably higher grain yield in second year. In addition, there were intensive aphid (*Aphid* spp.) population in first year, too. The year x sowing dates interaction was significant for grain yield ($P<0.01$). Compared to the other sowing dates, the last two sowing dates in second year resulted in a sharply decrease in grain yield. These different effects by years caused the significant year x sowing dates interaction for grain yield (Fig. 1).

Correlation coefficients among the investigated traits: Calculated correlation coefficients between the investigated traits were given in Table 4. Grain yield was

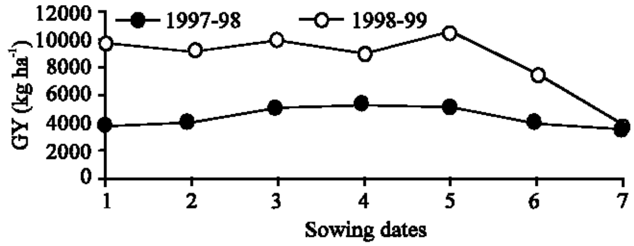

Fig. 1: Year x sowing dates interaction for grain yield

positively and significantly correlated with grain filling period (r=0.356**), days to maturity (r=0.212**), grain weight per head (r=0.447**) and 1000-grain weight (r=0.574**) (Table 4). These significant positive correlations indicated that grain yield can be increased by increasing of grain filling period, days to maturity, grain weight per head and 1000-grain weight.

According to the results of two years, sowing dates had significant effect on grain yield. The period, from first week of November to middle of December, could be concluded as optimum sowing period for maximum grain yield, in bread wheat, in the region.

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