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RESPONSE OF BREAD WHEAT CULTIVAR TO DIFFERENT SOWING DENSITIES FOR YIELD AND YIELD TRAITS

Huseyin GUNGOR[1]*, Mehmet Fatih CAKIR[2], Ziya DUMLUPINAR[3]

[1]*Duzce University, Faculty of Agriculture, Department of Field Crops, 81620, Duzce, Türkiye*
[2]*Duzce University, Environment and Health Coordination, 81620, Duzce, Türkiye*
[3]*Kahramanmaras Sutcu Imam University, Faculty of Agriculture, Department of Agricultural Biotechnology, 46100, Kahramanmaras, Türkiye*

Abstract: This study was conducted at Edirne, Tekirdağ and Kırklareli locations in 2017-2018 growing season. The experiment was arranged in a randomized complete block design with four replications. In the study, it was aimed to determine the effects of five different sowing densities (200, 300, 400, 500 and 600 seed m^{-2}) on grain yield and yield components of bread wheat cultivar Aslı. In the experiment, the effect of sowing density and location on grain yield and yield components was found significant. In addition, sowing density × location interaction was found to be statistically significant in terms of grain yield. Grain yield was found among 693.2-849.7 kg da^{-1}, while spike length was ranged from 8.3 to 9.5 cm. However, number of spikelets per spike was in the range of 17.4-19.7, while number of grains per spike was 35.2 to 44.1 and grain weight per spike was 1.43 to 1.75 g. Among the locations, the highest grain yield was determined at Edirne location. In terms of grain yield, the most appropriate sowing density was determined as 400 seed m^{-2} rate.

Keywords: Bread wheat, Grain yield, Sowing density, Yield traits

***Corresponding author:** Duzce University, Faculty of Agriculture, Department of Field Crops, 81620, Duzce, Türkiye
E mail: hgungor78@hotmail.com (H. GUNGOR)
Huseyin GUNGOR https://orcid.org/0000-0001-6708-6337
Mehmet Fatih CAKIR https://orcid.org/0000-0003-1354-9476
Ziya DUMLUPINAR https://orcid.org/0000-0003-3119-6926

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1. Introduction

Since the world's population grows each year, the demand for food rises as well. Wheat production in Türkiye ranks first in terms of cultivation area (6.7 million ha) and production amount was 17.65 million tons in 2021 growing season. Bread wheat production took place 82.1% (14.5 million tons) of total wheat production in 2021. Thrace region had a share of 6.5% in wheat agricultural areas and 12.5% in wheat production in Türkiye, with a wheat cultivation area of 445.042 ha and a production of 2.2 million tons. The average yield of bread wheat production at the Thrace region (496 kg da^{-1}) was 1.89 times higher than the average yield of bread wheat production (262 kg da^{-1}) countrywide (TUIK, 2022).

In order to increase the yield per unit area in wheat production, it is necessary to develop varieties with high yielding potential, suitable for the conditions of the region where production will be made and bring them into production (Gungor et al., 2022a, 2022b).

Other factors affecting grain yield in wheat cultivation are good quality seeds, the number of seeds to be utilized per unit area, sowing time and method, fertilization and cultivation practices (Bayramoglu and Gundogmus, 2010).

Sowing density is an important breeding technique that varies depending on genotype and environmental factors. It is necessary to determine the most suitable seed amount to be used per unit area in order to obtain high yield (Chen et al., 2008).

In some studies, high grain yield was obtained as sowing density was increased in wheat (Madan and Munjal, 2009; Costa et al., 2013). Baloch et al. (2010) and Ahmadi et al. (2011) indicated that sowing density had no effect on grain yield, while Carr et al. (2003) reported a grain yield increase until a certain plant density, and then decreased.

This study was carried out to determine the effects of different sowing densities on grain yield and yield components of Aslı bread wheat variety under the conditions of the Thrace region.

2. Materials and Methods

This research was conducted at Edirne, Kırklareli and Tekirdağ locations during 2017-2018 cropping years. The study was arranged in a randomized complete blocks design with four replications and bread wheat cultivar Aslı was used as plant material. The experiments were sown in the first week of November, with 200, 300, 400, 500 and 600 seed m^{-2} rates. The experiment plots were 6 rows with a 20 cm a part and 5 m length. In addition, the plot sizes were 6 m² for both planting and harvesting in the trial (6 m x 1 m). Weed control was done manually, and there were no applications for pests.

With sowing, 5 kg da^{-1} of nitrogen and 5 kg da^{-1} of phosphorus were applied and top dressing was divided into two and applied as 9 kg da^{-1} N during tillering and 6 kg da^{-1} N during jointing stages. The harvest of the locations was done in the first week of July. In the study, spike length (SL), number of spikelets per spike (SS), number of grains per spike (GNS), grain weight per spike (GWS) and grain yield (GY) were investigated.

The data obtained over the experiments were subjected to variance analysis in the JMP statistical program, and Duncan test was applied to compare the means (JMP 15.1 SAS Institute Inc, 2020).

3. Results and Discussion

The average spike length and number of spikes per spike are given in Table 1. While the sowing density and locations were found to be statistically significant for spike length and number of spikelets per spike, the interaction of sowing density × location was determined as insignificant for those traits. In terms of sowing density, average spike lengths ranged from 8.3 to 9.5 cm. The longest spike length was obtained from a sowing density of 200 seed m^{-2} (9.5 cm), while the shortest spike length was obtained from a sowing density of 600 seed m^{-2} (8.3 cm). The longest spike length was measured at Edirne (9 cm) location and the shortest was measured at Tekirdağ (8 cm) location (Table 1). As increasing the sowing density, the spike length was decreased (Naveed et al., 2014), and with the increase in sowing density, the amount of nutrients, water and light for the plants decreases and the competition between the plants increases, which shortens the spike length (Mutlu, 2022). Naveed et al. (2014), reported a 10.5-11.9 cm of spike lenght, while Atak et al. (2021), indicated 7.78-8.15 cm and Mutlu (2022) reported a 6.7 to 8 cm variation.

Tekirdağ location had the lowest number of spikelets per spike (17.2), while Edirne location had the highest (19.8) one (Table 1). The average number of spikelets per spike varied between 17.4 and 19.7 for sowing density. The largest number of spikelets per spike was found at 200 seed m^{-2} (19.7), and the lowest number of spikelets per spike was found at 500 seed m^{-2} (17.4). The number of spikelets per spike was determined as 15.9-16.6 by Ulucan and Atak (2020), and there were differences in the number of spikelets with varied sowing density, but these changes were statistically insignificant.

Table 1. Average of sowing density of spike length and number of spikelets per spike

SD (m^{-2})	SL (cm)				SS (no)			
	Edirne	Kırklareli	Tekirdağ	Mean	Edirne	Kırklareli	Tekirdağ	Mean
200	10.1	9.9a	8.5	9.5a	21.0	20.3a	17.7	19.7a
300	8.7	8.4b	7.8	8.3b	19.3	17.0bc	16.3	17.5b
400	8.6	9.2ab	8.0	8.6b	19.7	18.7ab	17.8	18.7ab
500	8.8	8.4b	8.1	8.4b	19.0	16.0c	17.3	17.4b
600	8.8	8.3b	7.9	8.3b	20.0	17.0bc	17.0	18.0b
Mean	9.0a	8.8a	8.0b	8.6	19.8a	17.8b	17.2b	18.3
SD	ns	*	ns	*	ns	*	ns	*
Location (L)			**				**	
SD × L			ns				ns	

SD= sowing densities, SL= spike length, SS= number of spikelets per spike, ** P < 0.01, * P < 0.05, and ns: not significant

The average number of grains per spike and grain weight per spike are given in Table 2. While the differences in number of seeds per spike and grain weight per spike between sowing density and locations were statistically significant, the sowing density × location interaction was found insignificant. According to the sowing density, the largest number of grains per spike was 400 seed m^{-2} (44.1), while the lowest was 600 seed m^{-2} (35.2). The number of grains per spike varied among the locations, ranging from 34.4 to 40.6, with an average of 38.5 grains per spike. The maximum number of grains per spike was obtained from Edirne location, while the lowest amount was determined at Tekirdağ location (Table 2).

In other researches, the number of grains per spike decreased as the sowing density increased: Mutlu (2022), 37.21-44.36, Dinc and Erekul (2010), 47.1-51.7, Ulucan and Atak (2020), 32.2-35.7, Atak et al. (2021), 39-42.1, Yagmur et al. (2021), 26.9-39.6. The grain weight per spike varied among locations, ranging from 1.36 to 1.89 g. The lowest grain weight was found at Tekirdağ location, while the highest grain weight was found at Edirne location. In sowing density applications, average grain weight per spike ranged from 1.43 to 1.75 g. The maximum grain weight values were found at sowing density of 200 seed m^{-2} and 400 seed m^{-2} (1.75 g), while the lowest grain weight per spike was found at 600 seed m^{-2} (1.43 g) (Table 2). Mutlu (2022), 1.66-1.84 g, Atak et al. (2021), 2.04-2.25 g, Yagmur et al. (2021), 0.9-1.32 g, Kazan and Dogan (2005), reported that grain weight in spike varied between 1.65 to 1.99 g.

Table 2. Average of sowing density of grain number/spike and grain weight/spike

SD (m^{-2})	GNS (no)				GWS (g)			
	Edirne	Kırklareli	Tekirdağ	Mean	Edirne	Kırklareli	Tekirdağ	Mean
200	44.0	47.3	34.0b	41.8a	2.02	1.74	1.50a	1.75a
300	38.3	39.0	30.8b	36.0b	1.85	1.36	1.15b	1.45b
400	44.3	46.0	42.0a	44.1a	2.06	1.66	1.54a	1.75a
500	39.7	31.3	35.3b	35.4b	1.74	1.28	1.45a	1.49b
600	36.8	39.0	30.0b	35.2b	1.76	1.35	1.17b	1.43b
Mean	40.6a	40.5a	34.4b	38.5	1.89a	1.48b	1.36b	1.58
SD	ns	ns	*	**	ns	ns	**	*
Location (L)			**				**	
SD × L			ns				ns	

SD= sowing densities, GNS= number of grains per spike, GWS= grain weight per spike, ** P < 0.01, * P < 0.05, and ns: not significant

According to the statistical analysis for grain yield, the difference among sowing density, locations and sowing density × location interaction was found statistically significant (Table 3). The maximum grain yield was obtained at 934.9 kg da^{-1} Edirne location, and the minimum grain yield was obtained at 662.6 kg da^{-1} Tekirdağ location. Grain yield varied between 693.2-849.7 kg da^{-1} and the average grain yield was determined as 768.5 kg da^{-1}. The maximum grain yield (849.7 kg da^{-1}) was obtained at 400 seed m^{-2} rate (Table 3). In similar studies; Dalkilic et al. (2016), reported higher grain yield (506 kg da^{-1}), at 600 seed m^{-2} sowing rate, Ulucan and Atak (2020) indicated a 559.2 kg da^{-1} grain yield at 550 seed m^{-2} rate, while Atak et al. (2021), 566.9 kg da^{-1} at 450 seed m^{-2} rate, Yagmur et al. (2021), 293.3 kg da^{-1} at 650 seed/m^2 rate, Mutlu (2022), 634.17 kg da^{-1} at 650 seed m^{-2} rate.

On the other hand, Dinc and Erakul (2010), stated that different sowing density do not have an effect on grain yield, while Mutlu (2022), reported an increase up to a certain seed density and then decrease. However, Dalkilic et al. (2016) reported that as the sowing density increases, the grain yield in wheat also increases.

Table 3. Average of sowing density and grain yield

SD (m^{-2})	Grain Yield (kg da^{-1})			
	Edirne	Kırklareli	Tekirdağ	Mean
200	918.6a	584.7c	576.4b	693.2c
300	1000.3a	726.4b	692.8a	806.5b
400	1007.5a	841.4a	700.3a	849.7a
500	1020.3a	693.6b	671.1a	795.1b
600	727.8b	694.2b	672.2a	698.1c
Mean	934.9a	708.1b	662.6c	768.5
SD	**	**	**	**
Location (L)			**	
SD × L			**	

SD= sowing densities, ** P < 0.01, * P < 0.05, and ns: not significant

4. Conclusion

One of the most important agricultural practices that determine the grain yield in wheat cultivation is sowing density. Determination of the most suitable seed density of the varieties produced is important to increase the yield.

Among the locations, the highest grain yield was determined at Edirne location. In terms of grain yield, the most appropriate sowing density was 400 seed m^{-2}, and then the grain yield decreased with increasing sowing density. It is concluded that sowing density is a crucial factor in terms of yield and yield components in bread wheat.

Author Contributions

HG (%34), MFC (%33) and ZD (%33) design of study. HG (%34), MFC (%33) and ZD (%33) data acquisition and analysis. HG (%34), MFC (%33) and ZD (%33) writing up. HG (%34), MFC (%33) and ZD (%33) submission and revision. All authors reviewed and approved final version of the manuscript.

Conflict of Interest

The authors declared that there is no conflict of interest.

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