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Effect of Different Sowing Rates and Nitrogen Levels on Grain Yield, Yield Components and Some Quality Traits of Triticale

Zeki Mut, İsmail Sezer and Ali Gülümser
Department of Field Crops, Faculty of Agriculture, Ondokuzmayis University, Samsun, Turkey

Abstract: The study was carried out to determine the effects of nitrogen level (0, 60 120, 180 kg ha^{-1}), sowing rate (200, 350, 500, 650 seed m^{-2}) on grain yield, yield components and some quality traits of two triticale cultivars under rainfed conditions in Samsun, Turkey, in the 2001-02 and 2002-03. Increasing nitrogen applications increased grain yield, plant height, number of ear m^{-2}, number of kernel ear^{-1}, thousand-grain weight, test weight and grain protein content. Plots treated with 500 number seed m^{-2} recorded maximum grain yield. This study indicated that sowing rate should be 500 number seed per square meter and nitrogen dose should be between 120 and 180 kg ha^{-1} to obtain high grain yield from triticale in Samsun located in the middle Blacksea region and similar ecological conditions.

Key words: Triticale, sowing rate, nitrogen application, grain yield

INTRODUCTION

Triticale (*X Triticosecale* Wittmack), a cross between wheat and rye, is gaining in popularity as an alternative to wheat and barley world-wide. The crossing of wheat and rye aims to combine the high yield potential and grain quality of wheat with the favourable characteristics of rye such as increased pest and disease resistance, winter hardiness, drought tolerance and adaptability to marginal conditions[1,2]. Triticale is, therefore, a crop which is particularly suited for marginal environments or where disease pressure is high.

The majority of triticale production is destined for animal feed. However, it can be used for human consumption. While most of the varieties available are not suitable for leavened breadmaking on their own because of a weak and sticky gluten they can be used in leavened products when blended with wheat flour. Triticale is suitable for producing a range of unleavened products such as cakes, waffles, noodles, flour tortillas and spaghetti[3].

Optimum sowing rate and fertilizer plays a vital role in increasing yield and quality of plants. Seed rates above the optimum level impose nutrients, light, moisture stresses and hence adversely affect crop yield while seed rate below optimum level usually have lower yield. Nitrogen is the most important nutrient and affects physiological events in plant development. If there is sufficient nitrogen in surroundings, plants grow healthy and turn a bold green colour. But in high concentration of nitrogen the vegetation period will be longer and plants will ripe later. Also with high nitrogen doses, plants grow feeble and become susceptible to diseases; they grow very tall. With low concentrations of nitrogen, plant development is weak, flower, fruit and seed formations are low and root development is weak[4,5]. The main purpose of nitrogen fertilization is to increase grain yield and quality[6].

Compared to other mineral nutrients, N is required in relatively high quantities by cereals for optimum vegetative and reproductive growth[5]. Ford *et al.*[7] compared the nitrogen responses of two triticale breeding lines to the response of two winter wheat varieties and found little difference between the two species.

Graham *et al.*[8] reported that a triticale variety and a wheat variety responded similarly to nitrogen. As triticale produces a larger biomass, it is responsive to nitrogen.

MATERIALS AND METHODS

This field experiment was carried out at Ondokuz Mayis University, Faculty of Agriculture, Department of Field Crops in Samsun located in the Blacksea coastal area (41° 21'N; 36° 15' E; 190 m altitude) during 2001-02 and 2002-03 growing seasons.

Some soil characteristics were found to be as follows; in the first year, the soil texture was clay; organic matter was 3.10%; P content was 75.0 mg kg^{-1}; K content was 34.0 mg kg^{-1}. The soil was non-limy and non-salty, also

Corresponding Author: Dr. Zeki Mut, Department of Field Crops, Faculty of Agriculture, Ondokuzmayis University, Samsun, Turkey Tel: +90 362 312 19 19 Fax: +90 362 457 60 34

Table 1: Climatic data of the experimental area

Months	Precipitation (mm) 1974-2002	2001-2002	2002-2003	Aver. temperature (°C) 1974-2002	2001-2002	2002-2003
November	78.6	94.0	29.7	11.9	12.5	14.1
December	73.3	138.1	71.3	8.9	8.0	6.6
January	59.5	105.4	28.1	6.8	4.5	9.3
February	47.8	35.2	77.8	6.6	8.7	4.8
March	52.0	34.1	73.5	7.8	9.8	5.0
April	58.7	61.9	45.0	11.2	10.2	8.7
May	50.5	10.9	54.7	15.3	15.8	16.2
June	49.4	53.8	3.3	20.0	20.8	20.7
July	31.1	79.9	37.2	23.1	25.6	23.7
Total	500.9	613.3	420.6	-	-	-
Mean	-	-	-	12.4	12.9	12.1

pH value of soil was 7.00. It had N content 0.21%. In the second year, the soil texture was clay; organic matter was 2.90%; P content was 72.0 mg kg^{-1}; K content was 40.0 mg kg^{-1}. The soil was non-limy and non-salty, also pH value of soil was 6.90. It had N content 0.18%. The monthly precipitation and temperature of the experimental area are presented (Table 1).

Treatments applied consisted of two triticale cultivars, four sowing rates and four nitrogen levels. The two cultivars were Tatlıcak and Melez 2001, Sowing rates were calculated for each cultivar using percentage germination and thousand kernel weights to achieve plant densities of approximately 200, 350, 500 and 650 seed m^{-2}. Sowing rate treatments will then be indicated as 200, 350, 500 and 650. Nitrogen treatments was applied as 0, 60, 120 and 180 kg ha^{-1}. In each season, treatments were randomised in a split-split plot design with three replications. Within each replication, cultivars was assigned to the main plot, which was split for the sowing rate treatment and then for the four nitrogen application.

In case of fertilizer application, a basal dose of 60 kg P_2O_5 ha^{-1} was applied in the form of TSP (triple super phospahe) while N was applied in the form of ammonium nitrate.

The fields were sown on 2 November 2001 and 5 November 2002 with a cone seeder. Plots were 0.50 m apart and consisted of six rows 0.18 m apart, 6 m long in 2001 and 2002. Weeds were chemically controlled by an application of Bromoxynil + MCPA in post-emergence. Means of treatments were evaluated and ranged according to Duncan test. The software package program MSTAT-C program was used for all statistics.

In this study, the effects of increasing nitrogen application and sowing rates on grain yield, plant height, number of ear m^{-2}, number of grain ear^{-1}, thousand-grain weight, test weight and grain protein ratio of two triticale cultivars were investigated.

RESULTS AND DISCUSSION

Grain yield: The results of combined variance analysis showed that the effects of factors and interactions, except for the cultivar, year x cultivar and year x sowing rate x nitrogen levels interaction effects, on grain yield were significant (Table 2).

While grain yield was 3.765 t ha^{-1} in first year, it was 3.251 t ha^{-1} in second year (Table 3). Climate and soil conditions might have caused differences among the years. Tatlıcak cultivar had higher grain yield than Melez 2001 cultivar as an average of two years (3.574 and 3.541 t ha^{-1}, respectively). The highest grain yield was obtained from Melez 2001 cultivar with 500 number seed ratio m^{-2} and 120 kg Nitrogen application ha^{-1}, while the lowest grain yield was also obtained from the same cultivar (Melez 2001) with 200 number seed ratio m^{-2} and without nitrogen (Table 3). Considering nitrogen application rates, the highest grain yield was 4.052 t ha^{-1} with 120 kg N application ha^{-1} and 4.079 t ha^{-1} with 180 kg N application ha^{-1} (Table 3). The lowest grain yield was obtained from the control (2.790 t ha^{-1}). Grain yield was increased by raising nitrogen applications in small grains[9-14].

Considering sowing rates, the highest average grain yield was obtained from the 500 number seed ratio application, while the lowest seed yield was obtained from the 200 number seed ratio application. Considering N x sowing rate interaction, the highest average grain yield was obtained from 120 kg N ha^{-1} application rate x 500 number sowing rate (4.521 t ha^{-1}) while the lowest average grain yield was obtained from the lowest sowing rate and without Nitrogen (2.392 t ha^{-1}) (Table 3). These findings are conformed by Yağbasanlar *et al.*[11] and Çakır and Köycü [15]

Plant height: The results of variance analysis showed that the effects of year, cultivar, nitrogen level, sowing rate, cultivar x sowing rate and nitrogen level x sowing rate interactions on plant height were significant (Table 2).

Averaged over 2 years, the plant height was 99.0 cm in 2002-2003 growing seasons, while the plant height was 102.8 cm in 2001-2002 growing seasons (Table 4).

Tatlıcak cultivar had higher plant height than Melez 2001 cultivar. The highest plant height was obtained from the 180 kg Nitrogen application in both cultivars. As sowing ratio increased, plant height increased as well. While plant height was measured 98.1 cm with 200 number seed ratio application, plant height reached 103.9 cm when seed ratio was 650 numbers m^{-2}. According to Nitrogen x sowing rate interaction, the highest plant height was

Table 2: Analysis of varyans for triticale cultivars grown in Samsun during 2001-2003

Source of variation	df	Grain yield	Plant height	No. of ear m^{-2}	No. of grain ear^{-1}	1000 grain weight	Test weight	Grain protein ratio
Year (Y)	1	82253**	678**	3754	1417**	140**	105**	0.2
Replication x (Y)	4	738	20	1553	11	2	0.9	0.3
Cultivar ©	1	520	822**	5281*	75*	21**	138**	0.1
Y x C	1	1716	51	1906	51*	12**	0.5	0.2
Error 1	4	317	7	638	5	0.3	0.2	0.1
Sowing rate (S)	3	70379**	291**	171749**	688**	82**	34**	0.9**
Y x S	3	1201**	16**	282	24**	7**	0.9*	0.2*
C x S	3	610*	9*	132	37**	0.7	2**	0.03
Y x C x S	3	1223**	25**	326	4	9**	1.4**	0.2*
Error 2	24	185	2	256	3	0.7	0.3	0.06
Nitrogen (N)	3	186878**	1793**	27474**	1417**	201**	106**	76.0**
Y x N	3	991**	29**	2041**	20**	17**	15**	0.68**
C x N	3	7059**	106**	419*	76**	4**	2.7**	1.6**
Y x C x N	3	254**	7	91	52**	4**	2.6**	0.65**
S x N	9	1382**	11**	580**	49**	1.7**	1.3**	0.26**
Y x S x N	9	362	4	669**	16**	1.3**	0.9**	0.06
C x S x N	9	824**	3	157	28**	0.9*	0.6*	0.05
Y x c x S x N	9	538**	3	173	6	0.9*	0.5	0.14**
Error 3	96	196	4	181	4	0.4	0.27	0.05

*, ** significant at the 0.05 and 0.01 probability levels, respectively

Table 3: Grain yield (t ha^{-1}) of triticale as affected by Cultivars (C), Sowing rate (S) and Nitrogen application (N)

		Applied N (kg ha^{-1})				
		(CxSxN)				CxS
Cultivars	Sowing rate seed m^{-2}	0	60	120	180	Means
Tatlıcak	200	2.508r	3.063m-o	3.278lm	3.418j-l	3.067e
	350	2.91.7op	3.208lm	3.892fg	3.827gh	3.461d
	500	3.26.7lm	3.772gh	4.500ab	4.350a-d	3.972a
	650	3.150mn	3.417j-l	4.208de	4.408a-d	3.796b
Melez 2001	200	2.275s	2.792pq	3.520i-k	3.617h-j	3.051e
	350	2.592qr	3.100m-o	4.053ef	4.297b-d	3.510d
	500	2.970n-p	3.733g-I	4.542a	4.475a-c	3.930a
	650	2.642qr	3.383kl	4.425a-d	4.242c-e	3.673c
		SxN				S
	200	2.392i	2.928 g	3.399e	3.518e	3.060d
	350	2.754h	3.154f	3.973c	4.062c	3.486c
	500	3.118f	3.753d	4.521a	4.413ab	3.951a
	650	2.896gh	3.400e	4.317b	4.325b	3.734b
		CxN				C
Tatlıcak		2.960e	3.365c	3.970b	4.001b	3.574
Melez 2001		2.620f	3.252d	4.135a	4.158a	3.541
	Means (N)	2.790c	3.309b	4.052a	4.079a	

Table 4: Plant height (cm) of triticale as affected by Cultivars (C), Sowing rate (S) and Nitrogen application (N)

		Applied N (kg ha^{-1})				
		CxSxN				CxS
Cultivars	Sowing rate seed m^{-2}	0	60	120	180	Means
Tatlıcak	200	95.3	99.1	101.2	104.1	99.9d
	350	95.8	100.5	104.2	106.2	101.7c
	500	98.1	102.2	104.9	110.0	103.8b
	650	99.3	105.3	108.1	113.3	106.5a
Melez 2001	200	88.0	94.1	99.3	103.4	96.2f
	350	89.9	94.8	101. 7	107.1	98.4e
	500	91.8	94.4	102.2	109.9	99.6d
	650	93.0	96.7	104.6	110.6	101.2c
		S x N				S
	200	91.7I	96.6gh	100.3ef	103.7c	98.1d
	350	92.9i	97. 7g	102.9cd	106.6b	100.0c
	500	95.0h	98.3fg	103.6c	109.9a	101.7b
	650	96.1gh	101.0de	106.3b	111.9a	103.9a
	CxN					C
Tatlicak		97.1d	101.8c	104.6b	108.4a	103.0a
Melez 2001		90.7f	95.0e	102.0c	107.7a	98.8b
	Means (N)	93.9d	98.4c	103.3b	108.1a	

Mean in the same column followed by the same letter(s) were not significantly different at the 0.05 level measured with 180 kg N ha^{-1} application and 500-650 number seed ratio m^{-2} application, whereas the lowest plant height was measured without N and with 200 number seed ratio m^{-2} application.

These findings are conformed by Woodword[16], Bishnoi and Hughes[17], Ahmad *et al.*[13] and Çakır and Köycü[15].

Number of ear m^{-2}: Cultivar, sowing rate, Nitrogen dose, year x nitrogen dose interaction, cultivar x nitrogen dose interaction, sowing rate x nitrogen dose interaction and year x sowing rate x nitrogen dose interaction significantly affect the number of plant m^{-2} (Table 2). Plant number means were close to each others in both years, in first year 304.3 number per square meter, in second year 295.4 number m^{-2} (Table 5). Plant number mean of Tatlıcak cultivar (305.1 numbers m^{-2}) was higher than plant number mean of Melez 2001 cultivar (295.4 numbers m^{-2}). Mazurek and Kus[18], Piench and Stankowski[12] and Şekeroğlu and Yılmaz[14] reported that nitrogen application increases the number of ears m^{-2} in cereals. In present study, As Nitrogen dose increased, ear number increased m^{-2} and the highest ear number m^{-2} (317.3 and 320.1) was counted with the application of 120 and 180 kg N ha^{-1}, respectively.

Considering sowing rate, with increased sowing rate application increased ear number m^{-2}. The highest ear number m^{-2} was counted with plots treated with higher rates of sowing. Similar results were also indicated in the literatures[11,15].

Considering sowing rate x N interaction, the lowest number of ear m^{-2} was counted with 200 number kernel m^{-2} x without N and the highest one was at 500-650 number m^{-2} x 120- 180 kg ha^{-1} nitrogen application rate (Table 5).

Present findings are in agreement with the results of Yağbasanlar *et al.* [11] and Çakır and Köycü[15].

Number of kernel ear^{-1}: Statistical analysis of the data revealed that kernel ear^{-1} were significantly affected by year, cultivar, sowing rates, N levels, cultivar x sowing rate interaction, sowing rate x N levels interaction and cultivar x sowing rate x nitrogen levels interaction (Table 2).

While average kernel number ear^{-1} was 45.0 number in first year, it was 39.5 number in second year (Table 6). Tatlıcak cultivar had higher grain number ear^{-1} than Melez 2001 cultivar as an average of two years (respectively, 42.9 and 41.6 grain numbers ear^{-1}). There is close relationship among kernels ear^{-1}, ear height and ear[14,16].

With relation to Nitrogen applications, the highest kernel numbers ear^{-1} was 46.4 numbers with 120 kg N ha^{-1} and 46.8 numbers t ha^{-1} with 180 kg N ha^{-1} (Table 6). The lowest kernel numbers ear^{-1} was obtained from the control (35.3 numbers). Piench and Stankowski[12], Yağbasanlar *et al.*[11], Şekeroğlu and Yılmaz[14] observed that the number of kernels ear^{-1} were increased with increasing N application.

Regarding seed ratio applications, kernel number ear^{-1} was decreased by increasing sowing rate. As the highest kernel number ear^{-1} was 45.8 numbers for the 200 seed numbers m^{-2}, the lowest kernel number ear^{-1} was 38.2 numbers for the 650 seed number m^{-2} (Table 6). According to sowing rate x nitrogen level interaction, the highest kernel number ear^{-1} was obtained with 120 kg N ha^{-1} application with 200 number seed ratio m^{-2} application and 180 kg N ha^{-2} application with 200-350 number seed ratio m^{-2} application. Present findings are in accord with the results of Yağbasanlar *et al.*[11], Şekeroğlu and Yılmaz[14] and Çakır and Köycü[15].

Thousand-grain weight: The results of combined variance analysis showed that the effects of factors and interactions, except for year x cultivar interaction and year x cultivar x sowing rate x nitrogen levels interaction effects, on 1000 grain weight were significant (Table 2).

While mean 1000 grain weight was 39.5 g in first year, it was 37.8 g in second year. Melez-2001 cultivar had higher 1000-grain weight mean than that of Tatlıcak cultivar as an average of two years (Table 7). By increasing nitrogen levels, 1000 grain weight is increased in small grain cereals. With 0, 60, 120 and 180 kg ha^{-1} nitrogen applications, 1000 grain weight mean was 36.0, 38.0, 40.3 and 40.1 g, respectively. Mazurek and Kus[18] and Çakır and Köycü[15] indicated that raising nitrogen doses increased the 1000 grain weight in small grains.

Regarding sowing ratio applications, As the highest mean 1000 grain weight was 39.5 g for the 200 and 350 seed numbers m^{-2}, the lowest mean 1000 grain weight was 36.7 g for the 650 seed number m^{-2}. Piech and Stankowski[12] found that 1000 grain weight of cereals decreased by increasing seed ratio m^{-2} application.

In this study, while 1000 grain weight increased raising the nitrogen levels, it decreased by increasing seed ratio m^{-2} application (Table 7). The highest 1000 grain weight was obtained with of 120-180 kg nitrogen ha^{-1} and with 200-350 number seed ratio application.

Test weight: The results of combined variance analysis showed that the effects of factors and interactions, except for cultivar x sowing rate interaction and year x cultivar x sowing rate x nitrogen levels interaction effects, on test weight were significant (Table 2).

Table 5: Number of ear m^{-2} of triticale as affected by Cultivars (C), Sowing rate (S) and Nitrogen application (N)

Cultivars	Sowing rate seed m^{-2}	Applied N (kg ha^{-1}) CxSxN 0	60	120	180	CxS Means
Tatlıcak	200	195.5	223.0	254.2	261.3	277.9
	350	247.5	265.3	301.0	307.3	295.3
	500	321.2	341. 7	365.0	367.8	321.3
	650	347.5	351.0	365.0	367.2	325.9
Melez 2001	200	186. 7	215.3	238. 7	240.8	259.8
	350	231.8	263.2	288.3	298.3	291.1
	500	298.3	332.0	360.8	352.8	313.2
	650	322.5	353.8	365.0	365.2	314.3
		SxN				S
	200	191.1h	219.2g	246.4f	251.1ef	226.9d
	350	239.7f	264.3e	294.7d	302.8cd	275.4c
	500	309.8c	336.8b	362.9a	360.3a	342.5b
	650	335.0b	352.4a	365.0a	366.2a	354.6a
		CxN				C
Tatlıcak		233.5d	280.3c	348.9b	357. 7a	305.1a
Melez 2001		220.4d	270.4cd	336.0b	351.6a	294.6b
	Means (N)	268.9c	293.2b	317.3a	320.1a	

Table 6: Number of grain ear^{-1} of triticale as affected by Cultivars (C), Sowing rate (S) and Nitrogen application (N)

Cultivars	Sowing rate seed m^{-2}	Applied N (kg ha^{-1}) CxSxN 0	60	120	180	CxS Means
Tatlıcak	200	35.0j	43.1cd	53.6a	53.4a	46.3a
	350	35.2ij	44.4c	49.7b	49.1b	44.6b
	500	34.6j	39.6e-g	45.2c	44.8c	41.1c
	650	31.6k	39.0f-h	42.9c-e	45.1c	39.6cd
Melez 2001	200	38.5f-I	42.7c-e	49.0b	51.3ab	45.4ab
	350	37.2g-j	43.3cd	48.3b	53.8a	45.7ab
	500	34.8j	37.1g-j	42.5c-e	40.6d-f	38.8d
	650	35.8h-j	35.0j	40.2d-g	36.0h-j	36.7e
		SxN				S
	200	36.7ef	42.9c	51.3a	52.3a	45.8a
	350	36.2ef	43.9c	49.0b	51.4a	45.1a
	500	34.7fg	38.3e	43.8c	42.7cd	39.9b
	650	33.7g	37.0e	41.6cd	40.5d	38.2c
		CxN				C
Tatlıcak		34.1f	41.5c	47.8a	48.1a	42.9a
Melez 2001		36.6e	39.5d	45.0b	45.4b	41.6b
	Means (N)	35.3c	40.5b	46.4a	46.8a	

Table 7: Thousand grain weight (g) of triticale as affected by Cultivars (C), Sowing rate (S) and Nitrogen application (N)

Cultivars	Sowing rate seed m^{-2}	Applied N (kg ha^{-1}) CxSxN 0	60	120	180	CxS Means
Tatlıcak	200	36.5i-k	39.0fg	40.6cd	41.1bc	39.3
	350	36.8ik	38.2gh	40.7cd	40.3cd	39.0
	500	36.0k	38.0h	39.9de	39.5ef	38.4
	650	34.3l	36.5i-k	38.2gh	36.9ij	36.5
Melez 2001	200	36.3jk	38.9f-h	42.2a	41.9ab	40.0
	350	37.2i	38.7f-h	42.3a	41.8ab	39.8
	500	36.2jk	38.4gh	40.6cd	40.6cd	39.0
	650	34.5 l	36.6i-k	38.2gh	38.8f-h	37.0
		SxN				S
	200	36.4ef	38.9c	41.4a	41.5a	39.5a
	350	37.0e	38.4cd	41.5a	41.1a	39.5a
	500	36.1f	38.2cd	40.3b	40.0b	38.7b
	650	34.4g	36.5ef	38.2cd	37.9d	36.7c
		CxN				C
Tatlıcak		35.9d	37.9c	39.9b	39.4b	38.3b
Melez 2001		36.0d	38.1c	40.8a	40.8a	38.9a
	Means (N)	36.0c	38.0b	40.3a	40.1a	

Means in the same column followed by the same letter(s) were not significantly different at the 0.05 level

Table 8: Test weight of triticale as affected by Cultivars (C), Swing rate (S) and Nitrogen application (N)

		Applied N (kg ha^{-1})				
		CxSxN				CxS
Cultivars	Sowing rate seed m^{-2}	0	60	120	180	Means
Tatlıcak	200	70.5pq	72.9e-h	74.6bc	75.3a	73.3b
	350	72.4g-j	73.6de	75.0ab	75.4a	74.1a
	500	71.0n-p	72.8f-I	75.1ab	74.1cd	73.2b
	650	69.7rs	71.6k-n	72.2i-k	73.0e-g	71.6d
Melez 2001	200	69.6s	71.4l-o	72.9f-I	72.3h-k	71.5d
	350	70.5pq	71.9j-m	73.3ef	72.9f-I	72.1c
	500	69.6rs	70.8o-q	73.0e-g	71.8j-m	71.3d
	650	68.7t	70.2qr	72.0j-l	71.3m-o	70.6e
		SxN				S
	200	70.0f	72.2c	73.7a	73.8a	72.4b
	350	71.5de	72.7b	74.1a	74.1a	73.1a
	500	70.3f	71.8cd	74.0a	72.9 b	72.2b
	650	69.2g	70.9e	72.1c	72.1c	71.1c
		CxN				C
Tatlıcak		70.9d	72.7b	74.2a	74.4a	73.1
Melez 2001		69.6e	71.1d	72.8b	72.1c	71.4
	Means (N)	70.3c	71.9b	73.5a	73.2a	

Table 9: Grain protein ratio (%) of triticale as affected by Cultivars (C), Sowing rate (S) and Nitrogen application (N)

		Applied N (kg ha^{-1})				
		CxSxN				CxS
Cultivars	Sowing rate seed m^{-2}	0	60	120	180	Means
Tatlıcak	200	9.7	10.5	11.5	11.9	10.9
	350	9.6	10.7	11.8	12.0	11.0
	500	9.7	10.5	12.0	12.1	11.1
	650	9.7	10.2	11.6	11.8	10.8
Melez 2001	200	9.3	10.1	11.6	12.4	10.8
	350	9.4	10.4	12.0	12.3	11.0
	500	9.5	10.3	12.3	12.4	11.1
	650	9.1	9.7	12.0	12.2	10.7
		SxN				S
	200	9.5g	10.3e	11.6d	12.1a	10.9b
	350	9.5g	10.6e	11.9bc	12.2a	11.0a
	500	9.6g	10.4e	12.1ab	12.3a	11.1a
	650	9.4g	9.9f	11.8cd	12.0a-c	10.8b
		CxN				C
Tatlıcak		9.7f	10.5d	11.7c	12.0b	11.0
Melez 2001		9.3g	10.1e	12.0b	12.3a	10.9
	Means (N)	9.5d	10.3c	11.8b	12.1a	

Mean in the same column followed by the same letter(s) were not significantly different at the 0.05 level

Tatlıcak cultivar (73.1 kg) had higher test weight than that of Melez-2001 (71.4 kg) cultivar as an average of two years (Table 8). Yağbasanlar *et al.*[11] reported that test weight in small grains were increased by raising nitrogen levels.

The 2 year average test weight from the 0, 60, 120, 180 kg ha^{-1} nitrogen applications were 70.3, 71.9, 73.5 and 73.2 kg, respectively (Table 8). The highest test weight was obtained from 120 and 180 kg ha^{-1} nitrogen levels (73.5 and 73.2 kg, respectively). Regarding sowing ratio applications, As the highest mean test weight was 73.1 kg for the 350 seed numbers m^2, the lowest mean test weight was 71.1 kg for the 650 seed number m^{-2} (Table 8).

Grain protein ratio: As seen Table 2 that nitrogen levels, sowing rates and nitrogen level x sowing rate interaction were significant for grain protein ratio. Grain protein ratio were close to each others in both years. Considering N application rates, grain protein ratio ranged from 9.5% (control) to 12.1% (180 kg ha^{-1}). Increased nitrogen application increased grain protein ratio. Mahdi[19] Mazurek and Kus[18], Şekeroğlu and Yılmaz[14], Hunter and Stanford[20] and Altenbach *et al.*[21] reported that grain protein ratio in small grains were increased by raising nitrogen levels.

Considering sowing rates, The 2 year average grain protein ratio from the 200, 350, 500 and 650 seed numbers m^{-2} were 10.9, 11.0, 11.1 and 10.8%, respectively

(Table 9). Considering N x sowing rate interaction, the highest grain protein ratio was obtained with of 180 kg nitrogen ha^{-1} and with 200, 350 and 500 number seed ratio application.

The research results indicated that for high yield, yield components and quality 500 number seed m^{-2} and 120-180 kg ha^{-1} nitrogen application would be optimal for triticale grown in regions similar to the area in Samsun where this study was conducted.

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