DETERMINATION OF YIELD AND SOME YIELD CHARACTERISTICS OF SOME WHEAT GENOTYPES UNDER LIMITED NITROGEN CONDITIONS

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Abstract

Wheat is an important food source worldwide and plays a strategic role in terms of food security and economy. In order to meet increasing food needs, it is important to develop regionally adapted, productive and high quality wheat varieties. Nitrogen is the main nutrient that directly affects wheat yield, but its overuse can cause yield loss. Timing and management of nitrogen application are decisive factors in increasing yield. Furthermore, the interaction between water availability and nitrogen plays a major role in wheat growth and yield. Integrated management of nitrogen and water can increase yields, while stress conditions such as drought can limit yields. Future research should develop strategies to improve nitrogen efficiency while considering environmental sustainability. A total of 7 genotypes including 4 local bread wheat genotypes, 2 durum wheat varieties, 1 local siyez wheat collected from the villages of the Southeastern Anatolia region, which is the homeland of wheat plant, were used. The experiment was established with four replications according to split plots experimental design at 4 nitrogen doses. Yield and yield characteristics were determined. Svevo and fırat93 were the most favourable genotypes in terms of most traits among the genotypes. Among the local genotypes, GYE4 and GYE3 had the highest values for breeding studies.

Keywords: Durum Wheat, Limited Nitrogen, Bread Wheat

INTRODUCTION

Wheat is one of the main food sources worldwide and is one of the main products of the food sector. Most of the energy and protein needs of humans are met by cereals. Wheat, which has strategic importance in terms of both economic and food security, also plays a critical role in global trade and agricultural policies. (Aydoağan et al. 2017) Therefore, it is of great importance to identify genotypes that are well adapted to the ecological conditions of the region and have good yield and quality characteristics in meeting the increasing nutritional needs. (Mut et al. 2017) Village varieties are promising materials for transferring their quality characteristics to new varieties by breeding methods. Therefore, village varieties with genetic diversity should be collected and protected from the existing regions and used in breeding programmes.(Akçura et al. 2014; Kendal and Enver, 2020; Tekdal et al. 2018) The fact that increasing nitrogen doses do not provide the expected yield increases, cause environmental pollution and high fertiliser prices has caused research to focus on plant varieties that can take more nitrogen from the soil or use the nitrogen more efficiently.(Bırsın et al. 2000) Wheat yield and its components are significantly affected by nitrogen availability, especially under limited nitrogen conditions. Nitrogen is an important nutrient that affects various physiological and morphological traits in wheat and ultimately affects yield. Under low nitrogen conditions, wheat plants exhibit a range of adaptive responses, including changes in root architecture and alterations in metabolic pathways to enhance nitrogen uptake and utilisation efficiency (Ren et al., 2018). For example, studies have shown that low nitrogen availability can favour the growth of primary and lateral roots and enable plants to access deeper soil layers for nutrients (Ren et al., 2018). This adaptive mechanism is necessary to sustain growth and yield under nitrogen-deficient conditions. The relationship between nitrogen application and wheat yield is complex and influenced by several factors, including the timing and method of nitrogen application. Research shows that optimum nitrogen management can increase wheat grain yield by improving yield attributing traits such as tiller number, spikelet number and grain weight (Yadav, 2024). However, excessive nitrogen application, especially under stress conditions, can lead to diminishing returns in yield due to increased competition among sister farmers for available resources (Mirosavljević et al. This phenomenon highlights the importance of balancing nitrogen inputs to maximise yields while minimising environmental impacts associated with nitrogen flux and greenhouse gas emissions (Yadav, 2024). Moreover, the interaction between nitrogen and other environmental factors such as water availability plays a critical role in determining wheat yield under stress conditions. Studies have shown that integrated management of water and nitrogen can significantly improve wheat yield and quality by promoting efficient nutrient and water utilisation (Wang et al., 2013; Wu et al., 2018). For example, timely irrigation combined with nitrogen fertilisation has been shown to improve root distribution and nutrient uptake, leading to increased growth and yield (Wu et al., 2018). In contrast, drought stress can exacerbate the negative effects of nitrogen deficiency and further limit wheat yield potential (Yan et al., 2023; Xu, 2023). This means understanding the physiological responses of wheat to nitrogen stress, the importance of the timing and method of nitrogen application, and the interaction between nitrogen and water availability. Future research should focus on developing strategies that integrate these factors to improve nitrogen use efficiency and sustain wheat production in the face of environmental challenges.

MATERIAL AND METHODS

In the growing period of 2021-2022, 4 genotypes of hexaploid (bread) wheat, 2 genotypes of tetraploid (durum) wheat, 1 genotype of diploid (siyez) wheat were used as plant material and four different nitrogen fertiliser doses (3, 6, 9, 12 kg N da-1) were used. Ammonium nitrate (15-15-15% NPK) was applied as nitrogen fertiliser. In the experiment, nitrogen doses were divided into two and half of them were applied with sowing and the other half was applied before emergence (Yürür, 1998).

The experiment was established according to split-plot experimental design with four replications. Varieties were placed in the main plots and nitrogen fertiliser doses were placed in the sub-plots. Plot length was 2 m and width was 0.6 m and plot area was 1.2 m2. The variance analysis of the data obtained from the experiment was carried out according to the "Split Plots" experimental design. The statistical significance of the differences between the means were calculated with the help of JMP statistical package programmes. In significance tests, 1% and 5% probability levels were used and 5% probability level was used in determining different groups.

(soil analysis results and climate data to be added)

Table 1. Wheat genotypes used in the study

Southeast Local Bread two	Origin 12-13	Farmer's Name	Province
GYE-1	3	Mehmet ORAK	Diyarbakir/ Eğil/ Baysu
GYE-2	68	Abdurrahman DÜZEN	Adiyaman/ Gerger/ Basdaglica
GYE-3	12/1	Mehmet TÜYSÜZ	Sanliurfa/ Siverek/ Sublime
GYE-4	26/1	Osman TEYMUR	Mardin/ Midyat/ Shenkoy
Proprietary durum			
Svevo			
Firat 93			
Siyez wheat			
GYS			

Features:

-Plant height (cm)

The distance from the soil surface to the extreme point of plant height of 5 randomly selected plants from each replicate will be measured and averaged.

-Number of grains per spike

The number of grains in the spike of 5 randomly selected plants from each replicate will be calculated and averaged.

-Thousand grain weight

The grains of 5 randomly selected samples from each replicate will be counted and their weight will be calculated.

-Plant yield

The grain product obtained from the harvested plants will be determined by weighing.

RESULTS AND DISCUSSIONS

Analysis of variance results of yield components obtained from the study are given in Table 2.

As can be seen from the analysis of variance results, the effects of wheat genotypes on plant height, number of grains per spike, thousand grain weight and grain yield were found to be statistically significant at 1% probability level.(Table 2.)

Table 2. Analysis of variance results for yield and yield components of seven wheat genotypes and four different nitrogen doses

Sources of variation	SD	Plant height	Number of grains per spike	Thousand grain weight	Grain Yield
Repetition	3	307,49	11,60	19,22	793,65
Genotype	6	509,60**	1184,43**	1381,43**	38546,74**
Nitrogen Dose	3	8,15	288,43**	85,31**	12,16**
Dose*Genotype	18	206,31	17,59	29,63*	1157,24
Error	81	12236,04	27,40	14,74	753,95
Total	111	19954,25	94,97	93,05	3090,67

*: 0,05: statistically significant at probability levels. **: Statistically significant at 0,01 probability levels.

When nitrogen doses were analysed, it was found that nitrogen doses had statistically significant effects on number of grains per spike, thousand grain weight and grain yield at 1% probability level. Unlike genotypes, nitrogen doses had no statistically significant effect on plant height, N

utilisation efficiency and N utilisation efficiency (Table 2.).
When the genotype x nitrogen dose interactions were analysed, it was found that the effect of the interactions on thousand grain weight was statistically significant at 1% probability level, while the interactions had no statistically significant effect on the other traits examined (Table 2).

Plant Height
The results of the analysis of variance for the grain plant height values of four different nitrogen dose applications in seven wheat genotypes are given in Table 2 and the mean values are given in Table 6.
The differences between the values of the varieties in terms of plant height were found to be statistically significant at 1% probability level.(Table 3.)
When Table 3. is analysed, the mean values of the genotypes varied between 69,75 and 92,25 and the genotype with the highest plant height value was obtained from GY2. There were no statistically significant differences in terms of nitrogen doses.

Table 3.Mean plant height values and significance groups for seven wheat genotypes and four nitrogen doses.

Genotype	3	6	9	12	Average	
FIRAT93	70,00	75,50	76,50	76,25	74,56	BC
GY1	90,50	89,00	83,50	86,00	87,25	A
GY2	89,50	92,25	87,75	86,00	88,88	A
GY3	87,00	66,00	82,50	91,25	81,69	ABC
GY4	80,50	91,50	91,75	68,75	83,13	AB
SIYEZ	88,00	86,75	75,25	83,00	83,25	A
SVEVO	69,75	76,00	74,50	77,25	74,38	C
Average	82,18	82,43	81,68	81,21	81,88	

*: 0,05: statistically significant at probability levels.
**: Statistically significant at 0,01 probability levels.

Number of Grains per Spike
The results of the analysis of variance related to the number of grains per head values of four different nitrogen dose applications in seven wheat genotypes are given in Table 2 and the mean values are given in Table 4.
In terms of the number of grains in the spike, the differences between the values belonging to the varieties and different nitrogen doses were found to be statistically significant at 1% probability level.(Table 7)
When Table 4. is analysed, the values of the genotypes varied between 3.5 and 30.69 and the genotype with the highest grain number was obtained in svevo bread wheat variety.
The increase in nitrogen dose affected nitrogen utilisation in direct proportion. The nitrogen dose with the highest average nitrogen utilisation efficiency was determined as 12kg/ha.(Table 4.)

Table 4. Mean spike grain number values and significance groups for seven wheat genotypes and four nitrogen doses.

Genotype/Dose	3	6	9	12	Average	
FIRAT93	23	26	30,75	35,5	28,81	AB
GY1	18	24,75	26,25	22,5	22,88	C
GY2	20,5	24,5	26,25	26,25	24,38	C
GY3	19,75	26,5	27,25	29	25,63	BC
GY4	20,25	26,25	27,25	27,25	25,25	BC
SIYEZ	3,5	3,5	3,5	8	4,62	D
SVEVO	26	29,5	35,25	32	30,69	A
Average	18,71 c	23 b	25.21 ab	25,79 a	23,18	

*: 0,05: statistically significant at probability levels.
**: Statistically significant at 0,01 probability levels.

Thousand Grain Weight
The results of the analysis of variance for the thousand grain weight values of four different nitrogen dose applications in seven wheat genotypes are given in Table 2 and the mean values are given in Table 5.
Thousand grain weight was statistically significant at 1% probability level among genotypes and nitrogen doses. Nitrogen dose*genotype interaction was statistically significant at 5% probability level.

When Table 5. is analysed, the averages of the genotypes varied between 12,96 and 40 and the genotype with the highest grain number was obtained in svevo bread wheat variety.
The increase in nitrogen dose affected the thousand grain weight in direct proportion. The nitrogen dose with the highest average nitrogen utilisation efficiency was determined as 12kg/ha.(Table 5.)

Table 5. Mean thousand grain weight values and significance groups for seven wheat genotypes and four nitrogen doses.

Genotype/Dose	3		6		9		12		Average	
FIRAT93	37,25	BCDE	36,25	CDEF	42,25	AB	43,5	A	39,81	A
GY1	23,25	JK	29	HI	28,75	HI	27,5	HIJ	27,13	C
GY2	25	IJ	28	HIJ	27,25	HIJ	19,5	K	24,94	C
GY3	25,75	IJ	31,5	FGH	29,5	GHI	34,5	DEFG	30,31	B
GY4	25,25	IJ	30,25	GHI	32	EFGH	34,75	DEFG	30,56	B
SIYEZ	12,62	L	13,5	L	12,5	L	13,25	L	12,97	D
SVEVO	38,5	ABCD	40,75	ABC	39,75	ABCD	41	ABC	40	A
Average	26,8	B	29,89	A	30,29	A	30,57	A	29,39	

*: 0,05: statistically significant at probability levels.
**: Statistically significant at 0,01 probability levels.

Grain Yield
The results of the analysis of variance for the grain yield values of four different nitrogen dose applications in seven wheat genotypes are given in Table 2 and the mean values are given in Table 6.

The differences between genotypes and different nitrogen doses in terms of grain yield were found to be statistically significant at 1% probability level (Table 6.).
When Table 6. is analysed, the values of the genotypes varied between 5.44 and 196.41 and the genotype with the

highest grain number was obtained in the genotype FIRAT93, and the increase in nitrogen dose affected the grain yield in direct proportion. The nitrogen dose with the highest grain yield average was determined as 12kg/da.(Table 6.)

Table 6. Mean thousand grain weight values and significance groups for seven wheat genotypes and four nitrogen doses.

Genotype/Dose	3	6	9	12	Average	
FIRAT93	107,22	118,5	162,28	196,41	146,1	A
GY1	51,91	90,69	93,94	77,87	78,6	C
GY2	63,25	85,78	87,88	62,72	74,91	C
GY3	63,37	105,37	99,91	125,34	98,5	B
GY4	63,66	98,94	109,5	121,06	98,29	B
SIYEZ	5,52	5,87	5,44	13,56	7,6	D
SVEVO	126,28	148,88	177,5	164,5	154,29	A
Average	68,74 c	93,43 b	105.21 ab	108,78 a	94,05	

*: 0,05: statistically significant at probability levels.
**: Statistically significant at 0,01 probability levels.

CONCLUSION

In this research, it is aimed to determine the genotypes with high nitrogen use efficiency, high yield and high nitrogen use efficiency of the genotypes consisting of 4 local bread wheat village varieties collected from different locations of the Southeastern Anatolia region of Turkey, which is produced as the world's staple food, two registered durum varieties and one siyez wheat, which are the most widely cultivated in Southeastern Anatolia, and to determine the appropriate parents for the relevant breeding programmes.

The results obtained from our research: the effects of wheat genotypes on plant height, number of grains in spike, thousand grain weight, grain yield were found statistically significant.(table2.)

Svevo bread wheat variety had the highest values in terms of most yield components followed by fırat93 durum wheat variety. Among Siyez and local wheats, GYE4 was the genotype with the highest values in grain yield followed by GYE3.

As a genotype, svevo had the highest value, while GYE4 was the highest among local genotypes. The reason for the low grain yield in general is thought to be due to the small amount of sowing per unit area. Among the genotypes, svevo and fırat93 had the highest values in terms of most traits. The genotypes that we can recommend to the farmer for sowing are fırat93 if durum wheat will be sown and svevo if bread wheat will be sown. Among the local genotypes, GYE4 and GYE3 can be recommended for breeding studies.

REFERENCES

Aydoğan, S., & Soylu, S. (2017). Ekmeklik buğday çeşitlerinin verim ve verim öğeleri ile bazı kalite özelliklerinin belirlenmesi. Tarla Bitkileri Merkez Araştırma Enstitüsü Dergisi, 26(1), 24-30

Bırsın, M. A. (2000). Buğdayda azot alımı ve azot hasat indeksi. Journal of Agricultural Sciences, 6(03), 27-31

KENDAL, Enver. "Yerel Ekmeklik Buğday Popülasyonlarından Seçilen Saf Hatların Diyarbakır Ekolojik Şartlarında Özellikler Arası ilişkilerin Belirlenmesi." Kahramanmaraş Sütçü İmam

Üniversitesi Tarım ve Doğa Dergisi 23.4 (2020): 1021-1029.)

Mirosavljević, M., Aćin, V., Sabadoš, V., & Dorotić, D. (2019). Variation in nitrogen use efficiency of winter wheat. Genetika, 51(3), 1165-1174. https://doi.org/10.2298/gensr1903165m

Mut, Z., Aydın, N., Bayramoğlu, H. O., & Özcan, H. (2007). Bazi Ekmeklik Buğday (Triticum Aestivum L.) Genotiplerinin Verim Ve Başlica Kalite Özelliklerinin Belirlenmesi. Anadolu Tarım Bilimleri Dergisi, 22(2), 193-201

Ren, Y., Yue, H., Li, L., Yan, X., Wang, Z., Xin, Z., … & Lin, T. (2018). Identification and characterization of circrnas involved in the regulation of low nitrogen-promoted root growth in hexaploid wheat. Biological Research, 51(1). https://doi.org/10.1186/s40659-018-0194-3

TEKDAL, Sertaç, Hasan KILIÇ, and Ç. A. M. Belgizar. "Makarnalık Buğdayda Çeşit, Hat ve Yerel Genotiplerin Verim ve Kalite Özellikleri Yönünden Karşılaştırılması." International Journal of Agricultural and Natural Sciences 1.3 (2018): 194-200.)

Wang, J., Xu, C., Gao, S., Han, X., & Ju, D. (2013). Effects of water and nitrogen utilized by means of dripping on growth of root and canopy and matter distribution in spring wheat. Advance Journal of Food Science and Technology, 5(4), 474-481. https://doi.org/10.19026/ajfst.5.3294

Wu, B., Zhang, H., & Wang, D. (2018). Timely supplemental irrigation changed nitrogen use of wheat by regulating root vertical distribution. Journal of Plant Nutrition and Soil Science, 181(3), 396-408. https://doi.org/10.1002/jpln.201700350

Xu, Z. (2023). Impact of drought stress on yield-related agronomic traits of different genotypes in spring wheat. Agronomy, 13(12), 2968. https://doi.org/10.3390/agronomy13122968

Yadav, M. (2024). Nitrogen uptake in wheat: a comprehensive study. International Journal of Research in Agronomy, 7(4), 101-103. https://doi.org/10.33545/2618060x.2024.v7.i4b.535

Yan, J., Wang, D., Kang, S., Zhang, H., Li, X., Tang, W., … & Pang, C. (2023). Ethylene regulates combined drought and low nitrogen tolerance in wheat: proteomic analysis. Agronomy, 13(7), 1950. https://doi.org/10.3390/agronomy13071950

YILDIZ, Ayşe; KADIR, A. K. A. N.; AKÇURA, Mevlüt. Türkiye'nin Doğu Bölgesinden toplanan bazı yerel ekmeklik buğday popülasyonlarından seçilen saf hatların yüksek molekül ağırlıklı glutenin alt birimlerinin incelenmesi. Journal of Agricultural Sciences, 2014, 21.3: 346-354.