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The effect of different nitrogen doses on the nitrogen uptake and use efficiency in bread wheat in Eskişehir conditions

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Abstract

This study was carried out in Eskişehir Osmangazi University Faculty of Agriculture Department of Field Crops research and application area in 2011-2012 and 2012-2013 production seasons. Different nitrogen doses (0-5-10-15-20 kg N/ ha^{-1}) were found in bread wheat varieties / lines (ES09-SE7, ES09-SE9, ES10-KE2, Çetinel 2000, Alpu-01, Nacibey, Bezostaja-1, Harmankaya 99) recommended for irrigated conditions in Eskişehir. The effects of 15-20 kg N / ha^{-1}) on nitrogen utilization efficiency properties nitrogen utilization efficiency, nitrogen utilization efficiency, nitrogen uptake efficiency were investigated. With increasing nitrogen doses, nitrogen intake efficiency and efficiency of benefiting from nitrogen increased, while nitrogen use efficiency increased up to 15 kg / ha^{-1} nitrogen dose and suddenly started to decrease in the next dose. In the study investigating the effect of watery wheat on nitrogen utilization efficiency, it was determined that Harmankaya variety at a nitrogen dose of 15 kg / ha^{-1} had the highest performance in terms of nitrogen use efficiency.

Keywords: Bread wheat, nitrogen utilization efficiency, nitrogen use efficiency, nitrogen uptake efficiency.

Introduction

Wheat production has an economic and strategic importance in the world and in our country. Wheat, which has the largest share in agricultural products, is one of the most important nutrients used in human nutrition (Anonymous, 2001). For this reason, the priority of the studies for plant production should be on this product. In order to increase the yield and improve the quality of wheat, the need for plant nutrients must be met. With nitrogen fertilizer applications, both yield and quality can be increased (Mcneal et al., 1971; Galleghre et al., 1983; Gauer et al., 1992). Therefore, nitrogen fertilizers are an important factor in obtaining maximum yield and quality from plants (Russel and Ballko, 1980).

Nitrogen utilization efficiency, in other words, agronomic activity is defined as the ability to increase the yield per unit of nitrogen applied to the plant (Novao and Loomis, 1981). In other words, the nitrogen use efficiency is the percentage recovery of the applied unit fertilizer nitrogen at the harvest time (Moll et al., 1982). In order for bread wheat to provide optimum vegetative and generative development, it is of great importance to meet the nitrogen need and the need for nitrogen is higher than the need for other nutrients (Frederick and Camberato, 1995). Determining the optimum nitrogen dose to be applied to wheat in the world is still an important problem today. The high amount of nitrogen application causes a decrease in nitrogen utilization efficiency as it increases the amount of loss. The decrease in the efficiency of nitrogen use causes increase in production costs and pollution of ground water. For this reason, it is very important to apply as much of the wheat as nitrogen needs (Limon-Ortega et al., 2002). Capuro and Vos (1981) reported that by improving the efficiency of nitrogen use, high yields can be obtained by using less nitrogen fertilizers and thus environmental pollution due to excessive use of fertilizers can be prevented. In order to improve nitrogen utilization efficiency, both nitrogen uptake efficiency and nitrogen utilization efficiency should improve together (Moll et al., 1982).

The aim of the study was to determine the different nitrogen doses (0- 5-10-15-20 kg N / ha^{-1}) nitrogen utilization efficiency, nitrogen utilization efficiency and nitrogen intake efficiency.

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Material and Method

The study was carried out for two years in Eskişehir Osmangazi University Faculty of Agriculture, Field Crops Department research and application area in 2011-2012 and 2012-2013 production seasons. Five wheat varieties (Alpu-01, Bezostaja-1, Çetinel 2000, Harmankaya 99, Nacibey) and 3 wheat lines (ES09-SE7, ES09-SE9, ES10-KE20) were used in the study.

Ammonium nitrate (AN) (33%) and triple super phosphate (P_2O_5) (42%) fertilizers were used in the experiment. Nitrogen doses were applied without fertilizers and in a pure form of 5-10-15-20 kg N / ha^{-1}, 1/2 of which was applied in October with the remaining 1/2 in the spring tillering period. With planting, triple super phosphate fertilizer was given to each plot in a pure form of 8 kg P_2O_5 per decare. Sowing, 500 seeds per square meter, 1.2 m x 8 m parcels (9.6 m^2), 20 cm row spacing, 6 rows of trial drills were made. Irrigation was applied as sprinkler irrigation twice, in the upturning period and in the post-flowering period. The climate data for the years and long terms of the research are given in Table 1.

Table 1. Meteorological data for long years (1970-2011) and 2011-2012 and 2012-2013 during the vegetation period in Eskişehir province

Aylar	Year (2011-2012)		Year (2012-2013)		Long-Term (1970-2011)	
	Total Precipitation (mm)	Avarege Temperature (°C)	Total Precipitation (mm)	Avarege Temperature (°C)	Total Precipitation (mm)	Avarege Temperature (°C)
September	7,1	18,3	0,3	19,1	17,9	17,9
October	64,0	9,1	72,2	14,5	32,8	11,7
November	0,1	1,5	19,0	7,8	34,0	5,6
December	42,4	1,7	70,3	3,0	40,5	1,7
January	52,4	-2,5	17,6	2,3	30,6	-0,2
February	46,0	-4,3	36,2	5,0	26,1	0,9
March	50,2	2,6	40,1	7,1	27,6	4,9
April	23,7	12,8	30,9	10,8	43,1	9,6
May	50,6	15,5	18,5	18,2	40,0	14,9
June	12,6	21,7	31,3	20,0	23,7	19,1
Total	**349,1**		**336,4**		**316,3**	
Average		**7,64**		**10,78**		**8,61**

The soil structure of the experimental area is clay loam and slightly alkaline. The soil is classified as poor (1.07-1.13) in terms of organic matter and middle class in terms of lime ratio (4.43-4.91).

Sampling, Plant Analysis and Calculations Regarding Nitrogen Usage Sampling was done from the whole plant at harvest. In this period, samples of aboveground parts were taken and established at 70 oC until they reach a constant weight (Walsh & Beaton, 1973) and prepared for chemical analysis by grinding. The Kjeldahl wet combustion method was used to determine the total nitrogen content in the plant samples taken (Bremner, 1960). Nitrogen utilization efficiency parameters Moll et al. (1982), Delagu et al. (1998) and Kara (2010) are calculated as follows.

Nitrogen use efficiency = [yield at Nx (kg/ha^{-1}) - yield at N0 (kg/ha^{-1})]/applied N (kg/ha^{-1}).

Nitrogen utilization efficiency = [yield at N x (kg/ha^{-1})-yield at N0 (kg/ha^{-1})] / [total aboveground plant N at Nx (kg /ha^{-1}) - total aboveground plant N at N0 (kg/ha^{-1})].

Nitrogen uptake efficiency = [total aboveground plant N at Nx (kg/ha^{-1}) - total aboveground N at N0 (kg/ha^{-1})] /applied N (kg/ha^{-1}). In this study nitrogen use efficiency, nitrogen uptake efficiency, nitrogen utilization efficiency availability were investigated. Evaluations of these parameters were analyzed in SAS and MİNITAB package programs according to the divided parcels divided into random blocks. In order to see the effective differences, "F" test was performed and coefficients of variation were calculated. The actual values comparisons between the 'AÖF' test were shown (Düzgüneş et al., 1987; Açıkgöz, 1988).

Results and discussion

Variance analysis results of trial parameters are given in Table 2. When Table 2 is examined, nitrogen doses in all characteristics, the difference between varieties was found to be significant at the level of 1% and the difference between the years according to the analysis results in both years and the combined years. Nitrogen dose x cultivar interaction was found to be significant at the level of 5% in the first year in the efficiency of nitrogen utilization, and at the level of 1% in all other characteristics with the other years and combined analysis. Year x nitrogen dose interaction, year x type interaction and year x nitrogen dose x variety interaction were significant at the level of 1% in all parameters considered.

Table 2. Variance Analysis Results of the Parameters

	D.K.	Nitrogen Use Efficiency	Nitrogen Utilization Efficiency	Nitrogen Uptake Efficiency
		2011-2012		
Replication	3	1,61ns	0,80ns	0,77ns
N dose	4	968,96**	82,07**	38,16**
Genotype	7	412,78**	217,94**	1186,05**
N dose x Genotypes	28	55,15**	40,25*	257,88**
CV (%)		55,04	65,95	43,89
		2012-2013		
Replication	3	1,85ns	0,62ns	1,25ns
N dose	4	1415,50**	66,25**	271,20**
Genotype	7	1076,45**	8,56**	141,10**
N dose x Genotypes	28	132,73**	4,17**	59,23**
CV (%)		44,74	68,46	31,27
		Years		
Replication	3	0,62ns	0,10ns	1,79ns
Year	1	14,19*	25,67*	1230,36**
N dose	4	2140,59**	127,33**	345,42**
Year x N dose	4	54,11**	11,34**	456,73**
Genotype	7	355,91**	43,66**	405,56**
Year x Genotype	7	734,37**	70,07**	465,55**
N dose x Genotypes	28	78,03**	13,64**	132,83**
Year x N dose x Genotypes	28	63,02**	11,34**	97,59**
CV (%)		50,31	68,18	38,40

*: p<0,05, **: p<0,01, ns: Not significant

Nitrogen use efficiency

The fact that the year x genotype was important indicates that the nitrogen use efficiency was affected by the environment. Similar to our study, Semercioğlu et al. (2009) reported that the year, N dose, variety and year x N dose was statistically significant in the nitrogen use efficiency, and the variety and nitrogen dose at the level of 1% in Maral (2009)'s study were statistically significant. While the average nitrogen use efficiency value in 2011-2012 was 12.19, the average nitrogen use efficiency value for 2012-2013 was determined as 11.71, and in the variance analysis performed, it was determined that years were important on nitrogen use efficiency (Table 2-3). The amount of precipitation, distribution, temperature and humidity in the first production year were more suitable for wheat cultivation compared to the second year (Table 1). On the other hand, looking at the soil properties, it is seen that the total nitrogen in the soil in the first year of production is higher than in the second year. Melaj et al. (2003) stated that the temperature increases and low air humidity that occur during the spiking period increase nitrogen losses, so nitrogen use efficiency may decrease. When Table 3 is examined, it is seen that the highest nitrogen use efficiency value in the 2011-2012 production year was obtained from the ES09SE9 line (28.98), where 5 kg N / ha^{-1} nitrogen dose was applied. In 2012-2013 production year and the average of years, the highest nitrogen use efficiency value was obtained from the Alpu variety (25,13-25,68), which was applied nitrogen dose of 5 kg N / ha^{-1}. It has been reported by many researchers that the efficiency of nitrogen use in wheat varies significantly depending on the genotypes (Ortiz-Monasterio et al., 1997; Gouis et al., 2000; Karaman and Şahin, 2004).

Table 3. Average values for nitrogen use efficiency

	Genotypes	N Dose (kg/da)				
		5 N	**10 N**	**15 N**	**20 N**	**Mean**
2011-2012	**Çetinel**	5,79	5,52	8,32	2,84	5,62**H**
	Alpu	26,23	15,01	11,29	6,17	14,67**C**
	Bezostaja	13,54	11,62	8,89	4,71	9,69**F**
	Nacibey	7,76	9,59	8,89	4,88	7,78**G**
	Harmankaya	28,97	17,71	20,47	11,80	19,74**A**
	ES09-SE7	18,41	9,97	13,69	6,84	12,23**D**
	ES09-SE9	28,98	16,35	14,13	8,95	17,10**B**
	ES10-KE20	13,40	10,36	13,45	5,58	10,69**E**
	Mean	17,88**A**	12,02**B**	12,39**B**	6,47**C**	**12,19A**
	LSD (%)	**N Dose:** 0,69, **Genotype:** 0,87, **N Dose x Genotype:** 1,74				

Table 3. Continue.

	Genotypes	N Dose (kg/da)				
		5 N	10 N	15 N	20 N	Mean
2012-2013	**Çetinel**	21,10	18,56	14,38	7,92	15,49**B**
	Alpu	25,13	16,90	14,58	7,97	16,14**A**
	Bezostaja	19,54	11,81	10,96	7,22	12,38**D**
	Nacibey	17,19	15,79	14,82	10,18	14,50**C**
	Harmankaya	13,58	11,88	16,27	9,18	12,73**D**
	ES09-SE7	13,18	8,22	7,94	3,88	8,31**E**
	ES09-SE9	6,78	8,06	4,78	2,97	5,65**F**
	ES10-KE20	8,00	8,49	11,46	5,99	8,49**E**
	Mean	15,56**A**	12,46**B**	11,90**C**	6,91**D**	**11,71A**
	LSD (%)	**N Dose:** 0,44, **Genotype:** 0,44, **N Dose: x Genotype:** 0,87				
Mean	Genotypes	N Dose (kg/da)				
		5 N	10 N	15 N	20 N	Mean
	Çetinel	13,44	12,04	11,35	5,38	10,55**DE**
	Alpu	25,68	15,96	12,93	7,07	15,41**B**
	Bezostaja	16,54	11,71	9,93	5,97	11,04**CD**
	Nacibey	12,47	12,69	11,85	7,53	11,14**C**
	Harmankaya	21,27	14,79	18,37	10,49	16,23**A**
	ES09-SE7	15,79	9,10	10,82	5,36	10,27**E**
	ES09-SE9	17,88	12,21	9,45	5,96	11,38**C**
	ES10-KE20	10,70	9,42	12,46	5,79	9,59**F**
	Mean	16,72**A**	12,24**B**	12,15**B**	6,69**C**	**11,95**
	LSD(%)	**Year:** 0,75, **N Dose:** 0,36, **Year x N Dose x Genotype:** 1,37, **Year x N Dose:** 0,51 **Genotype:** 0,49, **Year x Genotype:** 0,69, **N Dose x Genotype:** 0,97				

In the 2011-2012 production year, the lowest nitrogen use efficiency value was obtained from the Çetinel variety, which was applied 20 kg N / ha^{-1} of nitrogen with a value of 2.84, while in the 2012-2013 production year, 20 kg / ha^{-1} nitrogen was applied from the ES09SE9 line (2.97), and 20 kg / da was obtained from the ES09SE7 line (5.36) where nitrogen was applied. In the first year, the highest value was obtained from the ES09-SE9 line, while the lowest value in the second year was obtained from the same variety candidate. In this case, we can say that nitrogen use efficiency was affected by the variety in our study, but environmental conditions were more effective on nitrogen use efficiency. Similarly, some varieties (Nacibey, Çetinel and ES09SE9) gave different values on yearly basis. We can say that these varieties have a high reaction to nitrogen and are highly affected by the environment. May et al. (1991) stated that nitrogen use efficiency and other features related to nitrogen use efficiency are affected too much by the environment and therefore their use in breeding programs is difficult. Considering the Table 3, it is seen that the effect of nitrogen doses on the efficiency of nitrogen use varies according to the varieties, but it is generally in the form of a decrease. As the nitrogen dose applied increases, nitrogen losses in the soil-plant system increase (Hawkesford, 2014). Many studies show that as a result of increasing nitrogen fertilizer dosage, the nitrogen use efficiency value decreases (Alpaslan, 2001; Bozkurt et al., 2001; Büyük, 2006; Semercioğlu et al., 2009; French et al., 2014). Some researchers, on the other hand, reported that nitrogen use efficiency increased with increasing nitrogen doses (Ramussen & Rodhe, 1989; Okudan & Kara, 2005).

Nitrogen utilization efficiency

Nitrogen utilization efficiency, also known as physiological or agro-physiological activity, is calculated by proportioning the yield of the plant with the amount of nitrogen in the plant (grain yield / amount of nitrogen removed by the above-ground part) and shows how much of the nitrogen taken into the plant turns into grain yield (Moll et al., 1982). Atar et al. (2017), in their study by applying three different nitrogen doses to four winter bread wheat varieties, stated that, similar to our study, the nitrogen utilization efficiency was very important in statistical understanding ($p < 0.01$). Gülmezoğlu and Kutlu (2017) reported in their study that years and varieties are important on nitrogen utilization efficiency.

Table 4. Nitrogen utilization efficiency average values

	Genotype	N Doses (kg/da)				
		5 N	10 N	15 N	20 N	Mean
2011-2012	**Çetinel**	2,47	2,85	5,13	1,57	3,00**F**
	Alpu	9,35	10,16	7,28	5,66	8,11**E**
	Bezostaja	24,92	12,98	6,48	4,85	12,31**D**
	Nacibey	7,72	9,12	8,32	3,10	7,07**E**
	Harmankaya	28,75	22,08	16,68	15,89	20,85**A**
	ES09-SE7	22,18	5,76	12,15	26,81	16,72**B**
	ES09-SE9	20,74	15,31	13,03	10,56	14,91**C**
	ES10-KE20	9,02	8,20	10,27	4,24	7,93**E**
	Mean	15,64**A**	10,81**B**	9,92**BC**	9,09**C**	**11,36A**
	LSD(%)	**N Dose:** 1,49, **Genotype:** 1,49, **N Dose x Genotype:** 2,98				

Table 4. Continue.

	Genotype	N Doses (kg/da) 5 N	10 N	15 N	20 N	Mean
2012-2013	**Çetinel**	18,59	12,35	7,97	4,91	10,96**A**
	Alpu	17,02	9,66	9,12	4,14	9,99**A**
	Bezostaja	12,39	5,94	5,12	4,36	6,95**C**
	Nacibey	18,51	14,89	8,83	4,87	11,77**A**
	Harmankaya	18,40	5,58	9,92	6,00	9,97**A**
	ES09-SE7	12,49	4,74	3,66	2,40	5,82**C**
	ES09-SE9	25,26	9,25	2,71	2,11	9,83**AB**
	ES10-KE20	10,07	7,25	7,10	4,16	7,15**BC**
	Mean	16,59**A**	8,71B	6,80**BC**	4,12**C**	**9,06A**
	LSD (%)	**N Dose:** 3,02, **Genotype:** 2,72, **N Dose x Genotype:** 5,43				
Mean	**Genotype**	**N Doses (kg/da) 5 N**	**10 N**	**15 N**	**20 N**	**Mean**
	Çetinel	10,53	7,60	6,55	3,24	6,98**E**
	Alpu	13,19	9,91	8,20	4,90	9,05**CD**
	Bezostaja	18,65	9,46	5,80	4,61	9,63**C**
	Nacibey	13,11	12,01	8,57	3,99	9,42**C**
	Harmankaya	23,58	13,83	13,30	10,95	15,41**A**
	ES09-SE7	17,33	5,25	7,91	14,60	11,27**B**
	ES09-SE9	23,00	12,28	7,87	6,34	12,37**B**
	ES10-KE20	9,55	7,73	8,68	4,20	7,54**DE**
	Mean	16,12**A**	9,76**B**	8,36**B**	6,60**C**	**10,21**
	LSD (%)	**Year:** 2,66, **N Dose:** 1,50, **Year x N Dose x Genetype:** 4,36 **Year x N Dose:** 2,12 **Genotype:** 1,54, **Year x Genotype:** 2,18, **N Dose x Genotype:** 3,09				

It is seen that the utilization efficiency value was obtained from the Harmankaya variety with a nitrogen dose of 5 kg /ha^{-1} with 28.75 and 23.58. In the 2012-2013 production year, the highest nitrogen utilization efficiency value was obtained from the ES09SE09 line (25,26), where nitrogen dose of 5 kg / ha^{-1} was applied. It has been reported by many researchers that the efficiency of nitrogen utilization in cereals varies significantly depending on the genotypes (Cengiz & Koç, 2008; Maral 2009; Gökmen Yılmaz, 2015; Gülmezoğlu & Kutlu, 2017). In the 2011-2012 production year and the average of the years, the lowest nitrogen utilization efficiency value was obtained from the Çetinel variety, which was applied with 20 kg / ha^{-1} nitrogen with values of 1.57 and 3.24, while the ES09SE9 line where 20 kg / ha^{-1} nitrogen was applied in the 2012-2013 production year was obtained. Some researchers reported that the efficiency of benefiting from nitrogen was also low in years when yield was low, as in our study (Lopez-Belligo et al., 2006; Kara, 2010; Atar et al., 2017). While the lowest nitrogen utilization efficiency value was obtained from 20 kg / ha^{-1} nitrogen dose in both years and the average of years, the highest value was obtained from 5 kg / ha^{-1} nitrogen dose. The highest nitrogen utilization efficiency value was obtained from Harmankaya variety (20.85, 15.41) and the lowest value was obtained from Çetinel variety (3.00, 6.98) in the 2011-2012 production season and the average of the years. In the 2012-2013 production season, the highest value was obtained from the Nacibey variety (11.77) and the lowest value was obtained from the ES09SE07 line (5.82).

When Table 4 is examined according to nitrogen utilization efficiency values, it is seen that the increase in nitrogen dose in both years causes a decrease in nitrogen utilization efficiency values. The reason for this decrease occurring with the increase in nitrogen dose; The efficiency can be explained by the increase in the amount of nitrogen removed by the above-ground component. Apart from this, as the nitrogen dose applied increases, nitrogen losses in the soil and plant system increase (Bozkurt et al., 2001; Hawkesford, 2014). The decrease in nitrogen utilization efficiency due to the increasing nitrogen dose in our study may be attributed to this reason. In some studies, it has been stated that there is a negative relationship between nitrogen fertilizer dose and nitrogen utilization efficiency, that is, the nitrogen utilization efficiency value decreases with increasing nitrogen dose (Bozkurt et al., 2001; Semercioğlu et al., 2009; Gökmen Yılmaz, 2015; Okudan and Kara, 2015; Atar et al., 2017). In some studies, on the contrary, it has been reported that nitrogen utilization efficiency increases with the increase in nitrogen dose (Büyük, 2006; Kara, 2006; Maral, 2009). The reason for the differences between the mentioned studies is due to the different climates (especially temperature and humidity) and environmental conditions and the varieties used (Staley and Perly, 1995; Muscow, 1998).

Nitrogen uptake efficiency

Nitrogen uptake efficiency is calculated by proportioning the amount of nitrogen removed from the above-ground parts of the plant (stem + grain) to the applied nitrogen doses (0-5-10-15-20 kg / ha^{-1}) (Moll et al., 1982). It can be defined as the ratio of useful nitrogen in the soil to the amount taken by the plant (Karaşahin, 2014). If there is more nitrogen in the above-ground part of the plant due to the increase in nitrogen dose, the amount of removed nitrogen decreases as it will be divided into a high nitrogen dose, and vice versa. The nitrogen uptake efficiency of the plant is especially important when there is a low amount of nitrogen in the soil (Moll et al., 1982; Ortiz-Monasterio et al., 1997). Nitrogen uptake efficiency is a feature that shows how economical nitrogen is used.The fact that the interaction of type x nitrogen dose was significant indicates that the nitrogen dose to be applied for each variety should be calculated separately. Many researchers reported in their studies that genotypes differ significantly in terms of nitrogen uptake efficiency and that this difference between varieties is due to their genetic structure (Gökmen Yılmaz, 2015; Okudan & Kara, 2015; Atar, 2017). Since the year x variety interaction was important, nitrogen intake efficiency was It is understood that it varies according to climate and soil conditions. (Semercioğlu et al., 2009; Okudan and Kara, 2015; Atar, 2017).

It is seen that the highest nitrogen intake efficiency value in 2011-2012 production year was obtained from Alpu variety (2.82), which was applied nitrogen dose of 5 kg / ha^{-1}. The lowest nitrogen intake efficiency value was obtained from ES09-SE7 variety candidate (0.12), which was applied nitrogen dose of 5 kg / da. The increase in nitrogen doses in 2011-2012, which is the first production year, caused a decrease in the efficiency of nitrogen use in Çetinel variety and ES09-SE9, ES10-KE20 lines, while it caused an increase in other variety and variety candidates. This shows that each variety reacts differently to nitrogen uptake efficiency depending on environmental conditions. While some researchers argue that nitrogen intake efficiency decreases with nitrogen doses (Büyük, 2006; Kara, 2006; Semercioğlu et al., 2009; Gökmen Yılmaz, 2015), some argue the opposite, arguing that nitrogen intake efficiency increases with the increase in nitrogen dose (Delogu et al., 1998; Atar et al., 2017). Büyük (2006) and Gökmen Yılmaz (2015) attribute the negative relationship between nitrogen dose and nitrogen uptake efficiency to the elimination of nitrogen administered in high doses from the environment.

In the 2012-2013 production year, the highest nitrogen intake efficiency value was obtained from the ES09-SE7 line (2.17), where 15 kg / ha^{-1} nitrogen dose was applied, while the lowest nitrogen use efficiency value was obtained from the ES09-SE9 line, where 5 kg / ha^{-1} nitrogen dose was applied (0,33) were obtained. In the second production season, with the increase in nitrogen doses in all varieties, it increased up to a certain dose (15 kg / ha^{-1} N) and then decreased. The types and lines in our study differ greatly in terms of nitrogen uptake efficiency. Similarly, it has been observed that there are differences between varieties in terms of nitrogen intake efficiency in studies conducted (Gökmen Yılmaz, 2015; Okudan & Kara, 2015; Atar, 2017). While the average nitrogen intake efficiency value for 2011-2012 was 1.21, the average nitrogen intake efficiency value for 2012-2013 was 1.50. In the analysis of variance, it is seen that years are important on nitrogen intake efficiency. In studies on nitrogen mechanism in cereals, the climatic conditions during the trial period of the plant are effective (Avcı Birsin, 2000). In addition to temperature differences affecting the growth and development of the plant between climatic conditions, different precipitation amounts, which are related to the movement and availability of nitrogen in the soil, can be effective. Liao et al. (2004) emphasized that root and shoot growth rate affects nitrogen uptake in wheat, and nitrogen uptake efficiency increases in root shoot development that occurs rapidly. Cengiz and Koç (2008) reported in their study that nitrogen uptake efficiency values decreased with increasing temperature. This difference between the two production years is thought to be due to environmental conditions. Studies on nitrogen uptake efficiency in cool climate cereals show that nitrogen uptake, transport and accumulation are largely affected by environmental conditions (Gallagher et al., 1983).

Table 5. Average values for Nitrogen uptake efficiency

	Genotypes	**N Doses (kg/da)**				
		5 N	**10 N**	**15 N**	**20 N**	**Mean**
2011-2012	**Çetinel**	2,32	1,94	1,62	1,81	1,92**A**
	Alpu	2,82	1,48	1,45	1,16	1,73**B**
	Bezostaja	0,20	0,90	1,32	1,03	0,86**F**
	Nacibey	1,04	1,05	1,07	1,57	1,18**D**
	Harmankaya	0,80	0,81	0,99	0,92	0,88**F**
	ES09-SE7	0,12	0,52	1,13	0,87	0,66**G**
	ES09-SE9	1,42	1,07	1,08	0,85	1,11**E**
	ES10-KE20	1,49	1,27	1,31	1,32	1,35**C**
	Mean	1,28**A**	1,13**C**	1,25**A**	1,19**B**	**1,21B**
	LSD (%)	**N dose:** 0,05, **Genotype:** 0,05, **N dose x Genotype:** 0,09				
2012-2013	**Genotypes**	**N Doses (kg/da)**				
		5 N	**10 N**	**15 N**	**20 N**	**Mean**
	Çetinel	1,14	1,52	1,81	1,62	1,52**C**
	Alpu	1,48	1,75	1,60	1,93	1,69**B**
	Bezostaja	1,59	1,99	2,14	1,66	1,85**A**
	Nacibey	1,00	1,08	1,69	2,09	1,47C**D**
	Harmankaya	0,38	2,13	1,64	1,53	1,42**D**
	ES09-SE7	1,09	1,75	2,17	1,62	1,66**B**
	ES09-SE9	0,33	0,89	1,77	1,41	1,10**F**
	ES10-KE20	0,82	1,17	1,63	1,44	1,27**E**
	Mean	0,98**D**	1,54**C**	1,81**A**	1,66**B**	**1,50A**
	LSD (%)	**N Dose:** 0,07, **Genotype:** 0,08, **N dose x Genotype:** 0,15				

Table 5. Continue.

	Genotypes	N Doses (kg/da)				
		5 N	10 N	15 N	20 N	Mean
Mean	**Çetinel**	1,73	1,73	1,72	1,71	1,72**A**
	Alpu	2,15	1,62	1,52	1,54	1,71**A**
	Bezostaja	0,90	1,44	1,73	1,34	1,36**B**
	Nacibey	1,02	1,07	1,38	1,83	1,32B**C**
	Harmankaya	0,59	1,47	1,32	1,23	1,15**D**
	ES09-SE7	0,61	1,13	1,65	1,25	1,16**D**
	ES09-SE9	0,87	0,98	1,42	1,13	1,10**E**
	ES10-KE20	1,16	1,22	1,47	1,38	1,31**C**
	Mean	1,13**D**	1,33**C**	1,53**A**	1,43**B**	**1,35**
	LSD (%)	**Year:** 0,05, **N Dose:** 0,04, **Year x N Dose x Genotype:** 0,13, **Year x N Dose:**0,05, **Genotype:** 0,04, **Year x Genotype:** 0,06, **N Dose x Genotype:** 0,09				

Nitrogen uptake of the plant from the soil; sowing time depends on the amount of mineral nitrogen in the soil (especially nitrate) and the nitrogen mineralized from the organic matter during the growth period (Sarımehmetoğlu, 2007). Potassium deficiency at the beginning of the growth period reduces nitrogen intake efficiency (Swain et al., 2006). Sulfur application applied during the growing season can prevent nitrogen leaching from the soil and increase the nitrogen uptake efficiency (Brown et al., 2006). Since the root systems of plants with a long vegetative period will be more developed, their nitrogen uptake efficiency is higher (Cengiz, 2007; Karaşahin, 2014). Nitrogen uptake is closely related to water availability in the soil. Having nitrogen and water at optimum levels facilitates nitrogen intake. If there is too much water, nitrogen is lost by washing, if it is not found, it is possible to use cell sap for fertilizer intake with an increase in osmatic pressure and plant deaths (Martin et al., 1982).

Conslusion

Significant differences were observed in terms of year, nitrogen doses and varieties in terms of all the characteristics examined, and in this case, it was concluded that all parameters examined were shaped under the influence of genotype x environment interaction. Although it varies according to the parameters, the differences between the years, nitrogen doses and varieties have emerged in different effect rates in the parameters examined. Nitrogen utilization efficiency, nitrogen utilization efficiency and nitrogen uptake efficiency are the factors that best define nitrogen dosage applications. Therefore, the explanation of nitrogen doses can be done successfully by considering these factors. The factors affecting genotypic performance most were determined as nitrogen dose and variety in nitrogen utilization efficiency, nitrogen dose in nitrogen utilization efficiency, nitrogen dose in nitrogen intake efficiency and variety factors, respectively. The highest values are in nitrogen utilization efficiency, 5 kg / ha^{-1} nitrogen dose application (16,72) and Harmankaya variety (16,23), 5 kg / ha^{-1} nitrogen dose application in nitrogen utilization efficiency (15,41) and Harmankaya variety (16,12). was obtained from application of 15 kg / ha^{-1} nitrogen dose in nitrogen intake efficiency (1,53) and Çetinel variety (1,72). As a result, the differences in the parameters examined in the bread wheat varieties were caused by the differences in performance between the genotypes and the differences in nitrogen doses depending on the differences between the genotypes. In other words, genotypic performance occurs depending on different agronomic practices such as climatic conditions, fertilizer dosage and genetic potential differences. Application of 15 kg / ha^{-1} nitrogen dose in the production of high-yielding and high-quality varieties in wet conditions will make a significant contribution to the increase of bread wheat production. In addition, Harmankaya variety can be recommended in terms of nitrogen use efficiency and yield characteristics.

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Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

References

Açıkgöz N. 1988, Tarımda araştırma ve deneme metodarı, Ege Üniv. Ziraat Fak., yayın no:478, Ders Kitabı, İzmir.

Alpaslan, M., 2001. Farklı buğday genotiplerinin azot, fosfor ve potasyum kullanım etkinlikleri. Tarım Bilimleri Dergisi, 7, 122-7.

Anonim 2001. Bitkisel üretim (tahıl ve baklagil) özel ihtisas komisyonu raporu. Sekizinci beş yıllık kalkınma planı. DPT yayın no: 2644, ÖİK-652, s.146, Ankara.

Atar, B., Kara, B., Küçükyumuk, Z., 2017. Kışlık Ekmeklik Buğday Çeşitlerinin Azot Etkinliklerinin Belirlenmesi. Tarım Bilimleri Dergisi, 23:119-127.

Avcı Birsin, M., 2000. Buğdayda Azot Alımı ve Azot Hasat İndeksi. Tarim Bilimleri Dergisi, 6 (3), 27-31.

Bozkurt, M.A., Çimrin, K.M., Şekeroğlu, N. 2001. Azotlu gübrelemenin bazı tritikale genotiplerinde azot kullanım özelliklerine etkisi. Ankara Üniversitesi Ziraat Fakültesi Tarım Bilimleri Dergisi, 7 (39): 35-41.

Bremner, J. M., 1960. Determination of Nitrogen in Soil by the Kjeldahl Method. Journal Agrich. Sci., 55:11-33.

Brown, S. S., et al. (2006), Variability in nocturnal nitrogen oxide processing and its role in regional air quality, Science, 311(5757), 67–70.

Büyük, G., 2006. Çukurova Koşullarında Mısır Çeşitlerine Değişik Dönemlerde Uygulanan Farklı Azot Dozlarının Azot Kullanım Etkinliğine, Tane Verimine ve Kaliteye Etkisi, Çukurova Üniversitesi Fen Bilimleri Enstitüsü, Doktora Tezi, 143s.

Caputo, E., Vos, R., 1981. An index of nutrient efficiency and its application to corn yield response to fertilizer, I. Derivation, estimation and application. Agronomy J, 73 128-135.

Cengiz M, 2007. Güncel ekmeklik buğday çeşitlerinde azot alım ve kullanımının yüksek sıcaklıktan etkilenişi. Çukurova

Üniveristesi Fen Bilimleri Enstitüsü, Yüksek Lisans Tezi, 126s.

Cengiz, M., Koç, M., 2008. Güncel Ekmeklik Buğday Çeşitlerinde Azot Alım ve 19(5): 107-117.

Delogu, G., Cattivelli, L. Pecchioni, N., De Falcis, D., Maggiore T. and Stanca, A.M., 1998. Uptake and agronomic efficiency of nitrogen in winter barley and winter wheat, Eur. J. Agron. 9:11-20.

Düzgüneş O, Kesici O, Kavuncu F, Gürbüz İ. 1987. araştırma ve deneme metodları (İstatistik metodları-2) Ankara Üniv. Ziraat Fak., yayın no:1021, Ders Kitabı, Ankara. 295s.

Frederick, J.R., Camberato, J.J. 1995. Water and Nitrogen Effectes on Winter Wheat in the Southeastern Coastal Plain: I. Grain Yield and Kernel Traits. Agron. J., 87(3): 521526.

French, R., Bowling, R., Abbott, A., Stewart, M.G., 2014. High yield irrigated corn: implementing research and adapting for profitable production. Great Plains Soil Fertility Conference, 15, 78-83.

Gallegher LW, Soliman KM, Rains DW, Qualset CO, Huffaker RC. 1983. Nitrogen assimilation in common wheats differing in potential nitrate reductase activity and tisue nitrate concentrations. Crop sience, 23:913.

Gauer LE, Grant CA, Gehl DT, Bailey LD. 1992. Effect of nitrogen fertilization on grain potein content, nitrogen uptake and nitrogen use efficiency of six spring wheat (Triticuj aestivum L.) cultivars, in releation to estimated moisture supply. Can. J. Plant Sci., 72:234-241.

Gouis, J.L., Beghin, D., Heumez, E., Pluchard, P., 2000. Genetic differences for nitrogen uptake and nitrogen utilisation efficiencies in winter wheat. European Journal of Agronomy, 12, 163-73.

Gökmen Yılmaz, F., 2015. Orta Anadolu Bölgesinde Yetiştirilen Bazı Ekmeklik Buğday Çeşitlerinin Azot Kullanım Etkinlikleri ile Verim ve Kalite Özellikleri Arasındaki İlişkilerin Belirlenmesi. Selçuk Üniversitesi, Fen Bilimleri Enstitüsü, Toprak Bilimi ve Bitki Besleme Anabilim Dalı, Doktora Tezi, Konya, 145s.

Gülmezoğlu, N., Kutlu, İ., 2017. Nitrogen use efficiency of eleven triticale (x Triticosecale Wittmack) genotypes. Biological Diversity and Conservation 10(2):26-31.

Hawkesford M J (2014). Reducing the reliance on nitrogen fertilizer for wheat production. Journal of Cereal Science 59: 276-283.

Kara, B., 2006. Çukurova Koşullarında Değişik Bitki Sıklıkları ve Farklı Azot Dozlarında Mısırın Verim ve Verim Özellikleri ile Azot Alım ve Kullanım Etkinliğinin Belirlenmesi. Çukurova Üniv. Fen Bilimleri Enstitüsü. Yüksek Lisans Tezi. Adana.

Kara, B., 2010. Influence of Late-Season Nitrogen Application on Grain Yield, Nitrogen Use Efficiency and Protein Content of Wheat under Isparta Ecological Conditions. Turkish Journal of Field Crops, 15(1)1-6.

Karaman, R.M., Şahin, S., 2004. Potential to select wheat genotypes with improved Ptilisation characters. Acta Agriculturae Scandinavica, Section B — Soil & Plant Science Volume 54 (3).

Karaşahin, M., 2014. Bitkisel üretimde azot alım etkinliği ve reaktif azotun çevre üzerine olumsuz etkileri. APJES II-III, 15-21.

Liao, M.T., Fillery, I.R.P., Palta, J.A. 2004. Early vigorous growth is a major factor influencing nitrogen uptake in wheat. Functional Plant Biology, 31 (2): 121–129.

Limon-Ortega A, Sayre K.D, Drijber R.A, Francis C.A, 2002. Soil attributes in a furrowirrigated bed planting system in northwest Mexico. Soil Tillage Res. 63, 123-132.

Lopez-Bellido, L., Lopez-Bellido, R.J., Lopez-Bellido, F.J. 2006. Fertilizer nitrogen efficiency in durum wheat under rainfed Mediterranean conditions: effect of split application. Agronomy Journal, 98: 55-62.

Maral, H., 2009. Yulaf Çeşitlerinin Azotlu Gübrelemeye Tane Verimi, Azot Kullanımı Ve Verim Özellikleri Yönünden Tepkisi. Kahramanmaraş Sütçü İmam Üniversitesi Fen Bilimleri Enstitüsü Tarla Bitkileri Anabilim Dalı Yüksek Lisans Tezi, 51s.

Martin, D.L., Watts, D.G., Mielke, L.N., Frank, K.D., Eisenhauer, D.E., 1982. Evaluation of nitrogen and irrigation management for corn production using water high in nitrate. Soil Sci. Soc. Am. J. 46, 1056-1062.

May, L., Van Stanford, D.A., Mackown, C.T., And Cornelıus, P.L., 1991. Genetic Variation For Nitrogen Use İn Soft Red X Hard Red Winter Wheat Populations. Crop Sci., 31, 626-630.

Mcneal FH, Berg MA, Brown, PL, Mcguire, CF. 1971. Productivity and quality response of five spring wheat genetypes, Triticum aestivum L., to nitrogen fertilizer. Agron. J., 63:908-910.

Melaj, M.A., HernˋAn, E. E., LˋOpez, S.C., Studdert, G., Andrade, F., And BˋArbaro, N.O. 2003. Timing Of Nitrogen Fertilization İn Wheat Under Conventional And NoTillage System. Agron. J. 95:1525-1531.

Moll, R.H., Kamprath, E.J., and Jackson, W.A., 1982. Analiysis and İnterpretation of Factors Which Contribute to Efficiency of Nitrogenutilization. Agronomy Journal, 74; 562-564.

Muchow RC, 1998. Nitrogen utilization efficiency in maize and grain sorghum. Field Crops Research, 209-216.

Novoa, R., And Loomıs, R.S., 1981. Nitrogen and plant production. Plant Soil, 58:177- 204.

Okudan, D., Kara, B., 2015. Farklı azot dozlarının karabuğdayın (Fagopyrum esculentum Moench) tane verim ve kalitesine etkisi. SDÜ Fen Bilimleri Enstitüsü Derisi 19: 74-79.

Ortiz Monasterio, J.I., Sayre, K.D., Rajaram, S., McMahon, M., 1997. Genetic progress in wheat yield and nitrogen use efficiency under four nitrogen rates. Crop Sci.,37, 898-904.

Ramussen, P.E., Rohde, C.R., 1989. Stubble Burning Effects On Winter Wheat Yield and Nitrogen Utilization Under Semiarid Conditions. Soils and Fertilizers, 52 (10): 1443.

Russel W, Balko LG. 1980. Response of Corninbred Lines and Single Crosses to Nitrojen Fertilizer. 35 th Annual Corn & Sorgum Research Conference, 48.67.

Sarımehmetoğlu, G., 2007. Farklı sulama uygulamaları altında mısır çeşitlerinin sulama suyu ve gübre kullanım etkinliği Çukurova Üniversitesi, Fen Bilimleri Enstitüsü, Tarla Bitkileri Anabilim Dalı, Yüksek Lisans tezi, 58s.

Staley, T.E., Perly, H.D., 1995. Maize Silage Utilization of Fertilizer and Soil Nitrogen on a Hill-Land Ultisol Relative to Tillage Method. Agronomy Journal, 87; 835-842.

Swain, D.K., Bhaskar, B.C., Krishnan, P., Rao, K.S., Nayak, S.K., Dash, R.N., 2006. Variation in yield, N uptake and N use efficiency of medium and late duration ice varieties. J. Agric. Sci., 144: 69-83.

Walsh, L.M. and Beaton, J.D., 1973. Soil Testing Aand Plant Analysis. Soil Sci. Soc. of Am. Inc. Madison, Wisconsin, USA.