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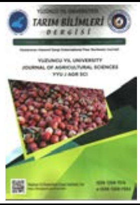

Araştırma Makalesi (Research Article)

# Determination of Nitrogen Use Efficiencies of Some Bread Wheat Grown in the Central Anatolia Region

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Bread wheat,
Nitrogen,
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**Abstract:** This study was carried out in order to determine nitrogen use efficiency of some bread wheat varieties widely grown in Central Anatolia Region under field conditions. Field experiment was established according to the split plot in randomized complete block design with four replications under dry conditions in Konya. In the work carried out with the aim of determination of nitrogen use efficiencies (physiologic -NPE, agronomic-NAgE and uptake-NUE) of genotypes two treatments (control; 0 kg da$^{-1}$ N and 8 kg da$^{-1}$ N) and 8 bread wheat species (Gerek 79, Bezostaya 1, Altay 2000, Bayraktar 2000, Kate A–1, İzgi 2001, Sönmez 2001 and Karahan 99). In trial, nitrogen doses formed main plots and wheat varieties formed sub-plots. In the results of study, effects of N application on physiological, agronomic and uptake efficiency were found statistically significant. In addition, when the average N use efficiency of varieties analysed, while the highest physiological efficiency of N was determined in the Bayraktar 2000 (50.5), the highest agronomic and uptake efficiencies of N were found in the Kate A -1 (15.9 and 0.33).

# Orta Anadolu Bölgesi'nde Yaygın Yetiştirilen Bazı Ekmeklik Buğday Çeşitlerinin Azot Kullanım Etkinlikleri Belirlenmesi

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**Anahtar kelimeler**

Ekmeklik buğday,
Azot,
Azot kullanım etkinliği.

**Öz:** Bu çalışma, Orta Anadolu Bölgesi'nde yaygın olarak yetiştirilen bazı ekmeklik buğday çeşitlerinin azot kullanım etkinliklerin belirlenmesi amacıyla tarla şartlarında yürütülmüştür. Tarla denemesi kuru koşullarda Konya'da tesadüf bloklarında bölünmüş parseller deneme desenine göre dört tekerrürlü olarak kurulmuştur. Genotiplerin azot kullanım etkinliklerinin belirlenmesi amacıyla yürütülen çalışmada kontrol (0 kg/da N) ve 8 kg/da N olmak üzere iki uygulama ile 8 adet ekmeklik buğday çeşidi (Gerek 79, Bezostaya 1, Altay 2000, Bayraktar 2000, Kate A–1, İzgi 2001, Sönmez 2001 and Karahan 99) kullanılmıştır. Azot dozları ana parselleri ve buğday çeşitleri alt parselleri oluşturmuştur. Çalışma sonunda, azot uygulamasının azotun fizyolojik, agronomik ve alım etkinliği üzerine olan etkileri istatistiki bakımdan önemli bulunmuştur. Ayrıca genotiplerin ortalama azot kullanım etkinlikleri incelendiğinde azotun fizyolojik etkinliği en yüksek Bayraktar 2000 (50.5) çeşidinde belirlenirken, azotun agronomik ve alım etkinliği en yüksek Kate A-1 (15.9 ve 0.33) çeşidinde belirlenmiştir.

## 1. Introduction

Cereals have an important place in the nutrition of the population of the world and our country. In the world, wheat is ranked first with approximately 68.5 million planting areas and 18 million tons of production in cereals, while average wheat yield per decare was 326 kg in the world, while in Turkey it was 278 kg (FAO, 2018). In our country, wheat ranks first among cultivated plants in terms of cultivation and production. In parallel with the rapidly increasing population, it is necessary to increase the production and quality, and to obtain more quality yields per unit area in order not to face the nutritional problem in the future. Considering that our production areas are limited and cannot be increased, the main ways to increase production include choosing suitable cultivation techniques, using appropriate seeds, raising awareness of the producers, making new fertilizers with high yield and quality, and making fertilizer at a suitable time in order to increase yield and quality.

In the studies conducted, it was stated that the greatest share in increasing the fertilization was in fertilization and that fertilization increased up to 50-60% (Şahin, 2016). 67% of the chemical fertilizers consumed in our country are nitrogen fertilizers and the majority of them are used in wheat production (TUIK, 2019). Nitrogen is a nutrient that affects wheat yield and quality most compared to other nutrients in wheat nutrition. In order to obtain high yields in wheat production in agricultural areas with low organic matter content, N fertilizer must be used. Nitrogen fertilizers are the most consumed fertilizers in our country and in the world (Slater, 2016). In recent years, due to the polluting effect of nitrogen on the environment and the increase in the price of fertilizers, interest in studies related to the uptake and use of nitrogen fertilizer by plants has increased. The plant's ability to uptake nitrogen, the breakdown and binding effects of nitrogen affect the uptake and use of nitrogen by the plant (Moll et al., 1982).

In a study conducted by Aydogan and Soylu (2017) to determine the yields of 14 different bread wheat (Gün-91, Sönmez-2001, Bezostaya 1, Tosunbey, Pehlivan, Demir-2000, Bayraktar-2000, Gerek-79, Karahan-99, Yunus, Ahmetağa, Konya-2002, Bozkır ve Eraybey) in dry conditions in Konya Bahri Dağdaş Agricultural Research Institute trial area, they applied 3.5 kg N per decare and 4 kg N as top fertilizer with planting. In addition, in another study conducted by Akman and Topal (2011) to determine the general condition of wheat agriculture in Konya, farmers generally applied 11-15 kg DAP per decare with planting in dry conditions. In top fertilization, it has been reported that the majority applies 6-10 kg N per decare.

It has been reported by many researchers that the efficiency of nitrogen use in plants varies significantly depending on the genotype (Tamado et al., 2015; Oktem and Oktem, 2019, Toprak, 2019). Nitrogen use efficiency (NUE) is defined by different researchers in different ways and subject to examination. For example, Raun and Johnson (1999) define the percentage of total nitrogen, which they calculated as soil nitrogen + fertilizer nitrogen + nitrogen gained from the atmosphere with precipitation, reflected on the grain expressed as the marketable product of wheat. By dividing the difference between the nitrogen concentrations in the total biomass of the fertilized and non-fertilized plants by the amount of fertilizer used, an AKE concept is used to remove the fertilizer nitrogen only from the soil. The Nitrogen use efficiency (NUE) was separated into its components in the form of use and evaluation efficiency in the 1980s (Moll et al., 1982) and this distinction simplified the examinations. They also explained the nitrogen uptake and evaluation efficiencies as the physiological, use and uptake efficieny of nitrogen. These are expressed as follows: The physiological (utilization) efficiency of nitrogen is the amount of grain yield provided to a unit of nitrogen in the plant. The efficiency of use of nitrogen the amount of nitrogen and fertilizer added in the soil and the amount of nitrogen added by the total nitrogen and fertilizer in the soil, and the nitrogen uptake efficiency are the ratio of the nitrogen in the soil to the amount removed by the plant above ground.

This study was carried out to determine the nitrogen use efficiencies (physiological, agronomic and uptake efficiencies) of some bread wheat cultivars grown in the Central Anatolia Region.

## 2. Materials and Methods

The research was carried out Konya Bahri Dağdaş Agricultural Research Institute trial area. Annual total precipitation of research station was 349.7 mm. In the experiment, Gerek 79, Bezostaya 1, Altay 2000, Sönmez 2001, İzgi 2001, Kate A-1, Bayraktar 2000 and Karahn 99 bread wheat varieties were used. Trial soil has a slightly alkaline reaction (pH=7.84), low organic matter content (1.83%), slightly saline (288 µS $cm^{-1}$), excess lime (31.4%). The amounts of useful for the plant of K (447 mg $kg^{-1}$) and Ca (3838 mg $kg^{-1}$) was high; Mg (376 mg $kg^{-1}$), B (1.21 mg $kg^{-1}$) and P (17.3 mg $kg^{-1}$), Cu (1.82 mg $kg^{-1}$) and Mn (6.254 mg $kg^{-1}$) contents were sufficient, amount of Zn (0.33 mg $kg^{-1}$) was deficient, amount of Fe (4.21 mg $kg^{-1}$) was medium (sufficient for wheat). Trial soil was in sandy clay (SC) texture with 46.2 % sand, 36.4 % clay and 17.4 % silt. The inorganic nitrogen content of the soil made according to Bremner (1965) are 19.0, 24.6 and 29.3 mg $kg^{-1}$ at a depth of 0-30 cm, 30-60 cm and 60-90 cm, respectively, and were at a medium level (Whitehead, 1981).

The trial field was left fallow a year ago and it was made ready for planting by passing the crowbar + harrow before sowing. In trial, 15 kg $da^{-1}$ triple süper phospahte (TSP, 44-44 % $P_2O_5$) was applied with sowing. Ammonium nitrate (33 % N) fertilizer was used as a nitrogen source, and half of the 8 kg $da^{-1}$ nitrogen (4 kg N $da^{-1}$), which was accepted by the farmers of the region (Akman and Topal, 2011; Aydoğan and Soylu, 2017) applied together with the other half during sowing period. Sowing process; In the last week of October, it was constructed with grain seeders, 450 seeds per $m^2$, in 8 rows ( 12 m x 1.6 m = 19.2 $m^2$) in 20 cm row spacing for 12 m long plots (10 m at harvest). In trail plots, weed control was done using weeds with 2-4-D ester when weeds had 3-5 leaves.

During the harvest period, the parcels were cut and the plants were left to dry for 1-2 days. After all plant parcel yields were obtained, grain yields were obtained by blending. Nitrogen amounts of shoots and grains were determined according to Dumas Combustion Method in AACC Method 46-30 in LECO C / N analyzer device. Then shoot and grain yields were used to determine plant total N concentrations per decare. Nitrogen use efficiencies were determined according to Moll et al. (1982) with following formulas.

Physiological efficiency of nitrogen (NPE)=yield (kg $da^{-1}$)/nitrogen taken by the plant (kg $da^{-1}$) (1)
Agronomic efficiency of nitrogen (NAgE)=yield (kg $da^{-1}$)/soil + fertilizer nitrogen (kg $da^{-1}$) (2)
Uptake efficiency of nitrogen (NUE)=nitrogen taken by the plant (kg $da^{-1}$)/soil+fertilizer nitrogen (kg $da^{-1}$) (3)

The data obtained in the experiment were evaluated according to randomized complete block design for factor A, with factor B a split plot on A in the MSTAT-C statistical package programs.

## 3. Results

The results of variance analysis for the physiological, agronomic and uptake efficiencies of nitrogen determined in different bread wheat varieties of nitrogen applied to the soil are given in Table 1, and the mean values of the effects of nitrogen on the physiological efficiency are given in Table 2.

Table 1. Results of variance analysis of the physiological, agronomic and uptake efficiency of nitrogen in different bread wheat varieties with nitrogen application

| Sources of variance | S.D. | Average of squares | | |
|---|---|---|---|---|
| | | Physiological efficiency | Agronomic efficiency | Uptake efficiency |
| General | 63 | -- | -- | -- |
| Replication(R) | 3 | 3.68 | 0.09 | 0.0001 |
| Nitrogen Application (N) | 1 | 280.10** | 109.98** | 0.014* |
| Error 1 | 3 | 0.44 | 0.78 | 0.0001 |
| Variety (V) | 7 | 28.79** | 9.17** | 0.001** |
| N x V int. | 7 | 5.02** | 2.18** | 0.001** |
| General Error | 42 | 1.30 | 0.32 | 0.0001 |
| C.V. (%) | -- | 2.41 | 3.90 | 5.03 |

According to the results of variance analysis, the effect of nitrogen application, cultivars and nitrogen application x variety interaction on the nitrogen physiological, agronomic and uptake efficiencies of bread wheat varieties was found to be statistically significant ($p < 0.01$). This shows that the effect of nitrogen application on the parameters examined varies depending on the varieties.

Table 2. Control of the difference between nitrogen physiological efficiency values and nitrogen physiological efficiency averages determined in different bread wheat varieties in nitrogen application according to LSD test

| Bread Wheat | Nitrogen physiological efficiency | | | |
|---|---|---|---|---|
| Varieties | N (-) | N (+) | Change,-% | Average[1] |
| Gerek 79 | 49.0 ***bc*** | 45.4 ***def*** | 7 | 47.2 **bcd** |
| Bezostaya 1 | 47.1***cde*** | 41.1 ***g*** | 13 | 44.1 **e** |
| Altay 2000 | 48.6 ***bc*** | 45.8 ***def*** | 6 | 47.2 **bcd** |
| Sönmez 2001 | 48.1 ***c*** | 45.0 ***ef*** | 6 | 46.5 **cd** |
| İzgi 2001 | 50.7 ***b*** | 45.4 ***def*** | 10 | 48.0 **bc** |
| Kate A-1 | 50.3 ***b*** | 47.2 ***cd*** | 6 | 48.7 **b** |
| Bayraktar 2000 | 53.8 ***a*** | 47.1 ***cde*** | 13 | 50.5 **a** |
| Karahan 99 | 47.5 ***cd*** | 44.7 ***f*** | 6 | 46.1 **d** |
| Average | 49.4**A** | 45.2**B** | 9 | -- |

$LSD_{0.01}$ (for varieties)=1.540
$LSD_{0.01}$ (for N x V interaction)= 2.178
[1] The difference between the means indicated by the same letter in each bread wheat variety is not significant compared to the 1% probability limits.

Nitrogen physiological effectiveness of bread wheat varieties with nitrogen application, in other words, the yield obtained by the unit nitrogen taken by the plant has decreased the nitrogen physiological efficiency of bread wheat varieties between 6% and 13% and an average of 9% compared to the control (N-). While nitrogen application is the highest among the wheat varieties, Kate A-1 has the highest physiological efficiency, while the lowest Bezostaya 1 bread wheat variety has also been determined. Among the wheat varieties that do not apply nitrogen, the highest nitrogen physiological activity content was found in Bayraktar 2000, while the lowest nitrogen physiological activity content was found in Bezostaya 1 wheat variety.

According to the LSD test conducted on the nitrogen physiological efficiency values of bread wheat varieties obtained as the average of nitrogen application, Bayraktar 2000 first group, Kate A-1, Izgi 2001, Gerek 79 and Altay 2000 second group, Izgi 2001, Gerek 79 and Altay 2000 third group, 79, Altay 2000 and Sönmez 2001 were the fourth group and Bezostaya 1 was the fifth group. In addition, the nitrogen physiological efficiencies of bread wheat varieties decreased with the application of nitrogen.

Table 3. Control of the difference between nitrogen agronomic efficiency values and nitrogen agronomic efficiency averages determined in different bread wheat varieties in nitrogen application according to LSD test

| Bread Wheat | Nitrogen agronomic efficiency | | | |
|---|---|---|---|---|
| Varieties | N (-) | N (+) | Change,-% | Average[1] |
| Gerek 79 | 15.0 ***def*** | 12.8 ***j*** | 15 | 13.9 **de** |
| Bezostaya 1 | 13.9 ***ghı*** | 11.5 ***k*** | 17 | 12.7 **f** |
| Altay 2000 | 15.7 ***cde*** | 14.4 ***fg*** | 8 | 15.1 **b** |
| Sönmez 2001 | 14.3 ***fgh*** | 12.6 ***j*** | 12 | 13.5 **ef** |
| İzgi 2001 | 16.4 ***bc*** | 13.2 ***ıj*** | 20 | 14.8 **bc** |
| Kate A-1 | 17.0 ***ab*** | 14.8 ***efg*** | 13 | 15.9 **a** |
| Bayraktar 2000 | 17.7 ***a*** | 13.3 ***hıj*** | 25 | 15.5 **ab** |
| Karahan 99 | 16.1 ***bcd*** | 12.4 ***jk*** | 23 | 14.2 **cd** |
| Average | 15.7 **A** | 13.1 **B** | 17 | -- |

LSD 0.01 (for varieties) = 0.761
LSD (for N x V interaction) = 1.078
[1] The difference between the means indicated by the same letter in each bread wheat variety is not significant compared to the 1% probability limits.

The average values of nitrogen applied to soil for the agronomic efficiency of nitrogen determined in different bread wheat varieties are given in Table 3. The nitrogen agronomic efficiency of bread wheat varieties with the application, in other words, the amount of yield obtained by one unit of total (soil + fertilizer nitrogen) nitrogen in the soil, the nitrogen agronomic efficiency of bread wheat varieties varying between 8% and 25% compared to control (N-).

Among the wheat varieties, nitrogen application was determined in Kate A-1 (14.8) bread wheat variety with the highest nitrogen agronomic efficiency. This was followed by Bayraktar 2000, Altay 2000, İzgi 2001, Karahan 99, Gerek 79 and Sönmez 2001 bread wheat varieties. Among bread wheat varieties, Bezostaya 1 (11.5) bread wheat variety has the lowest nitrogen agronomic activity content. The nitrogen agronomic effectiveness of the plant has been reduced with the application of nitrogen.

Table 4. The effect of nitrogen application on nitrogen uptake efficiency of different bread wheat varieties and control of the difference between nitrogen uptake averages according to LSD test

| Bread Wheat Varieties | Nitrogen uptake efficiency | | | |
|---|---|---|---|---|
| | N (-) | N (+) | Change,-% | Average[1] |
| Gerek 79 | 0.31 ***def*** | 0.28 ***gh*** | 10 | 0.29 **cd** |
| Bezostaya 1 | 0.30 ***e-h*** | 0.28 ***gh*** | 7 | 0.28**d** |
| Altay 2000 | 0.32 ***a-d*** | 0.31***c-f*** | 3 | 0.32 **ab** |
| Sönmez 2001 | 0.30***efg*** | 0.28***gh*** | 7 | 0.29**d** |
| İzgi 2001 | 0.32***abc*** | 0.29 ***fgh*** | 9 | 0.31**b** |
| Kate A-1 | 0.34***a*** | 0.31***b-e*** | 9 | 0.33**a** |
| Bayraktar 2000 | 0.33***ab*** | 0.28 ***gh*** | 15 | 0.31**bc** |
| Karahan 99 | 0.34***a*** | 0.28 ***gh*** | 18 | 0.31**b** |
| Average | 0.32**A** | 0.29 **B** | 9 | **--** |

$LSD_{0.01}$ (for varieties) = 0.0135
$LSD_{0.01}$ (for N x V interaction) = 0.019
[1] The difference between the means indicated by the same letter in each bread wheat variety is not significant compared to the 1% probability limits.

The average values of nitrogen applied to the soil for the nitrogen uptake efficiency determined in different bread wheat varieties are given in Table 4. The efficiency of the uptake of nitrogen in bread wheat varieties, in other words, the utilization rate of the plant from total (soil + fertilizer nitrogen) unit nitrogen in the soil has decreased by 3% to 18% in average compared to the control (N-) with the application of nitrogen.

The difference between Kate A-1 (a) and Altay 2000 (ab) varieties, which have the highest nitrogen uptake efficiency, compared to LSD test in the wheat nitrogen uptake values obtained as the average of nitrogen application, is statistically insignificant.

## 4. Discussion and Conclusion

As a result of the study, it was determined that the physiological, agronomic and uptake efficiencies of nitrogen in different bread wheat varieties change depending on the varieties with nitrogen application. Plant species can differ in nitrogen use efficiency as a result of disparities in the absorption of nitrate and N remobilization (Haile et al., 2012). Belete et al. (2018), determined that the nitrogen use efficiency of bread wheat varieties was different and decreased with nitrogen applications.

The physiological efficiency of nitrogen was an indicator of how much nitrogen was taken by plants. Nitrogen physiological efficiency was an indicator of how much nitrogen is taken by plants. The nitrogen physiological effectiveness of bread wheat varieties varies between 44.1 and 50.5. The physiological efficiency of nitrogen depends on the uptake of nitrogen by plants. Soil (texture, moisture), climate (temperature, precipitation) and genetic factors that prevent nitrogen uptake are important. As a matter of fact, while excessive rainfall causes nitrogen leaching in the soil, excessive temperature also causes evaporation. In our trial soil with sandy clay texture, nitrogen leaching is less than in sandy soil. However, the physiological efficiency of nitrogen was low due to the less uptake of nitrogen by plants. Nitrogen uptake also decreases heavy-textured soils through high denitrification because of limited aeration capacity (Zhang et al., 2017). With the application of nitrogen, the physiological effectiveness of nitrogen decreased on average by 9%. In previous studies (Mansour et al., 2017; Bhavana et al., 2020) were reported that the nitrogen application decreases the physiological effectiveness of nitrogen. In excessive nitrogen applications, plant N uptake decreases over the optimum doses and nitrogen loses increase through leaching nitrate nitrogen, then plant benefit ratios from nitrogen decreases (Barut et al., 2015). In relation to NPE values, Bayraktar 2000 was determined as the most appropriate variety.

The agronomical efficiency of nitrogen was an indicator of how much of total nitrogen reflects to the yield. The nitrogen agronomical effectiveness of bread wheat varieties varies between 12.7 and 15.9. The agronomic efficiency of nitrogen (NAgE) depends on yield. The increase in yield could be ascribed to variety improvement and agronomic managements, such as, increase in plant density, fertilizer application rate, planting time. Researchers reported that increased vegetative development, increased numbers of tillers but decreased spiked tiller and yields with increased nitrogen applications (Ahmed et al., 2016; Srivastava et al., 2018; Yang et al., 2019).

The uptake efficiency of nitrogen was an indicator of how much of total nitrogen (soil + fertilizer nitrogen) was up taken by plant. The nitrogen uptake effectiveness (NUE) of bread wheat varieties decreased average by 9% with nitrogen application. The NUE depends upon nitrogen dose, yield and the amount of nitrogen taken by plants. NPE was more important than NUE in relation to with yield. The high NUE was determined that the lowest nitrogen application (Atar et al., 2017; Salim and Raza, 2019). Kate A-1 was the most suitable variety in terms of NAgE and NUE.

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