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Research article

Nitrogen-Use Efficiencies of Bread and Durum Wheat Cultivars Grown in Çukurova Region

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Abstract. The present study was carried out to determine nitrogen-use efficiencies (NUE) of common bread and durum wheat cultivars grown in Çukurova region. Experiments were conducted at Doğankent Experimental Station of Eastern Mediterranean Agricultural Research Institute during the growing seasons of 2000-2001 and 2001-2002. Seven bread wheat cultivars (Adana-99, Ceyhan-99, Yüreğir-89, Doğankent-1, Panda, Seyhan-95 and Genç-99) and three durum wheat cultivars (Amanos-97, Fuatbey-2000 and Gediz-75) were used as the plant material of the study. Experiments were carried out in randomized block design with 3 replications. Nitrogen (N) doses (0, 5, 10, 20 kg da-1) were randomly placed in main plots and wheat cultivars were placed in sub-plots. As a general average, wheat cultivars had NUE values of between 29-66%. NUE values of much precipitated (737.4 mm) year were lower than the NUE values of less precipitated (346.7 mm) year (58% and 34%). The cultivars Adana-99 and Ceyhan-99 had the highest NUE values as general average. These two cultivars had both higher nitrogen-uptake efficiency (NUpE) and nitrogen-utilization efficiency (NUtE) than the year averages.

Çukurova'da Yetiştirilen Ekmeklik ve Makarnalık Buğday Çeşitlerinin Azot- Kullanım Etkinlikleri

Anahtar Kelimeler:
Azot, Azot-kullanım etkinliği, Ekmeklik buğday, Makarnalık buğday

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Özet. Bu çalışma Çukurova'da yaygın olarak yetiştirilen ekmeklik ve makarnalık buğday çeşitlerinin azot-kullanma etkinliklerinin (NUE) belirlenmesi amacıyla yürütülmüştür. Denemeler 2000-2001 ve 2001-2002 yıllarında Doğu Akdeniz Tarımsal Araştırma Enstitüsünün Doğankent lokasyonunda yürütülmüştür. Çalışmada materyal olarak, 7 ekmeklik (Adana-99, Ceyhan-99, Yüreğir-89, Doğankent-1, Panda, Seyhan-95 ve Genç-99) ile 3 makarnalık (Amanos-97, Fuatbey-2000 ve Gediz-75) buğday çeşidi kullanılmıştır. Denemeler bölünmüş parseller deseninde 3 tekerrürlü olarak kurulmuş, azot dozları (0, 5, 10, 20 kg N da^{-1}) ana parsellere, buğday çeşitleri ise alt parsellere tesadüfi olarak dağıtılmıştır. Genel ortalama olarak buğday çeşitleri, %29-66 arasında NUE değerlerine sahip olmuşlardır. İki yıl yürütülen denemelerde, fazla yağışlı yıl (737.4 mm) normal yağışlı yıldan (346.7 mm) daha düşük NUE vermiştir (%58'e karşılık %34). Adana-99 ve Ceyhan-99 çeşitleri en yüksek NUE değerine ulaşmışlardır. Her iki yılda da Adana-99 ve Ceyhan-99 çeşitleri yıl ortalaması üzerinde azot-alım etkinliği (NUpE) ve azot- değerlendirme etkinliği (NUtE) göstermişlerdir.

1. INTRODUCTION

Genetically high-yield plants and their widespread use in cultural activities resulted in higher fertilizer uses. In the year 2013, 183.4 million tons chemical fertilizer was used worldwide and corresponded to an economic value of 59.2 billion dollars and 60% of this amount was constituted by nitrogenous fertilizers (FAO 2011). Nitrogen is the most significant yield-improving nutrient but it is also the most deficient nutrient in soils (Kara 2006). Average NUE is approximately 50% worldwide, however it changed with production management practices and crop varieties. On the other hand, the annual economic value of unrecovered N is about 17.7 billion dollars (Brentrup and Palliere 2011). Nitrogen losses in soil-plant system occur in the form of gas emission from the plants, nitrification, denitrification, runoff, evaporation and leaching below root zone. To meet the food demand of ever-increasing world population and minimization of negative impacts of nitrogenous fertilizers on human and environmental health will totally depend on improved nitrogen use efficiencies (Karaşahin 2014).

Globalization in the wheat market has changed the major objective of high yield of planners and breeders. Possible destructions on environment through excessive N fertilization and high-costs have emerged new approaches in wheat culture. Decreased amount of nitrogenous fertilizer per decare will ultimately decrease the production costs and diminish negative impacts on environment, but also will result in less yield. Agronomic practices mostly should focus on clean and profitable production techniques. Decreasing N inputs through improved NUE, use of environment-friendly cultivars, timely weed control, proper irrigation, better pests and disease control are the primary agronomic practices to be considered (Parodi 2000). NUE is defined as the grain yield (dry mass productivity) per unit of available N (soil + fertilizer) and it can be divided into two major components as nitrogen-uptake efficiency (NUpE) and nitrogen-utilization efficiency (NUtE). NUpE indicates plant ability to uptake nutrient from the soil and is defined as the amount of N in plant corresponding to available N in soil (soil + fertilizer). NUtE indicates plant ability to convert the nitrogen taken from the soil into grain yield (dry mass) and is defined as grain yield corresponding to per unit N of plant. In brief, NUE = NUpE x NUtE (Moll *et al.*, 1982).

Particularly, here we sought to determine nitrogen-use efficiencies of common bread and durum wheat cultivars of Çukurova region and to find out the most suitable cultivars for the region.

2. MATERIAL AND METHODS

2.1. Experimental site

The present study was conducted at research and implementation area of Eastern Mediterranean Agricultural Research Institute during 2000-2001 and 2001-2002 wheat growing seasons. Annual total precipitation of the research station was 346.7 mm in the first year and 737.4 mm in the second year of experiments. Maize was the preceding plant in both years. Soil total N level was 3.6 kg da^{-1} in the first year and 5.3 kg da^{-1} in the second year at 0-30 cm soil layer before wheat sowing. Experimental soils were alluvial soils with clay-loam texture with 18-20 % sand, 29-35 % clay and 40-50 % loam. Soil lime content was 15-26 %, organic matter content was 0.8-1.9 %, salt content was 0.02-0.15 mmhos cm^{-1}, pH was 7.87 and P_2O_5 content was 3.02 kg da^{-1}.

Soil total nitrogen was determined in accordance with Bremner (1965). Soil available P content was determined in accordance with the methods developed by Olsen *et al.* (1954). Soil pH was determined with a digital pH meter from soil saturation extract (Jackson 1959). Soil organic matter content was determined by using Walkey-Black wet-etching method (Jackson 1959). Hydrometer method was used to determine sand, silt and clay fractions (Bouyoucus 1952). Soil lime content was measured with a Scheibler calcimeter (Çağlar 1949). Soil salt content was measured in saturation paste with Wheatstone bridge method (U. S. Salinity Laboratory Staff 1954). Climate data for 2000-2001 and 2001-2002 growing seasons are provided in Table 1.

Table 1. Long-term (1980-2000), 2000-2001 (1st year) and 2001-2002 (2nd year) climate data for wheat growing seasons of Adana Province.
Çizelge 1. Adana İlinin buğday yetiştirme sezonundaki uzun yıllar (1980-2000), 2000-2001 (I.yıl) ve 2001-2002 (II.yıl) ekim yılı ortalamalarına ait aylık sıcaklık, nisbi nem ve yağış değerleri.

Months	Long-term aver. temperature (° C)	Temperature (° C)		Long-term aver. precipitation (mm)	Precipitation (mm)		Long-term aver. rel. humidity (%)	Relative humidity (%)	
		Y-1	Y-2		Y-1	Y-2		Y-1	Y-2
November	15.1	13.6	13.9	67.2	28.25	88.1	63.3	60.5	60.5
December	11.1	8.6	11	118.1	54.7	320.9	66.0	69.4	69.4
January	9.9	8.4	8.1	111.7	10.8	109.2	66.0	72.2	72.2
February	10.4	8.7	12.3	92.0	67.1	68.1	66.0	75.8	75.8
March	13.1	14.1	14.7	67.9	46.6	40.3	66.0	79.5	79.5
April	17.1	16.1	16.5	51.4	8.8	88.8	69.0	71.2	71.2
May	21.4	21.8	22.0	46.7	130.4	22.0	67.0	60.2	60.2
Total					346.7	737.4			

2.2. Plant Materials

Seven different bread wheat cultivars (Adana-99, Ceyhan-99, Yüreğir-89, Doğankent-1, Panda, Seyhan-95 and Genç-99) and three different durum wheat cultivars (Amanos-97, Fuatbey-2000 and Gediz-75) were used as the plant material in this study.

2.3. Methods

Experiments were conducted in split plots experimental design with 3 replications. Nitrogen doses were randomly placed in main plots and wheat cultivars were placed in sub-plots. There were 8 rows in sub-plots with 5 m row length. Sowing density was 400 seed m^{-2} for all cultivars. Nitrogen doses of 0, 5, 10 and 20 kg da^{-1} were applied to main plots. Nitrogen doses were splitted into three equal portions, 1/3 at sowing, 1/3 at tillering and the remaining 1/3 was applied at spiking stages. Ammonium sulphate was applied at sowing and ammonium nitrate was applied at tillering and spiking stages as source of nitrogen. For the phosphorus source, 42- 44 % triple super phosphate was incorporated into soil at a rate of 6 kg P_2O_5 da^{-1} before sowing.

2.4. Experimental Traits

Soil samples were taken ahead of sowing from 0-30 cm layer and samples were subjected to mineral N analysis. Plant heights were measured and number of spike per unit area was determined. At physiological maturity, entire plants over a square meter were harvested from the soil level and then biological yield and harvest index values were calculated. Harvested plants were used to determine % N concentrations of shoots and grains. Then, shoot and grain yields were used to determine plant total N (shoot N + grain N) concentrations per decare. The resultant value was divided by the total nitrogen supplied to plants (soil N + supplied N) to calculate % nitrogen-uptake efficiency (NUpE) at each N dose of each cultivar. Also, grain yield per decare was divided by plant total nitrogen content (shoot N + grain N) to get % nitrogen-utilization efficiency (NUtE). Ultimately, these two values (NUpE and NUtE) were multiplied with each other to get % nitrogen-use efficiency (NUE) of each cultivar. In brief, NUpE, NUtE and NUE values were used to identify the cultivars using N more efficiently. The method developed by Moll *et al*. (1982) was employed to perform such assessments.

2.5. Plant Analyses

Shoot and grain % N concentrations of harvested plants were determined by using Kjeldahl device (Bremner 1965).

2.6. Statistical Analyses

MSTAT software was used for statistical analyses. Significant factor means were compared by using Duncan and LSD tests. Significance level was taken as 1%.

3. RESULT AND DISCUSSION

3.1. Nitrogen- Uptake Efficiency (NUpE)

Nitrogen uptake efficiency (NUpE) is a parameter expressing how much of the total of soil available nitrogen and the nitrogen supplied fertilizer is up taken by the plant and cumulative results are provided in Table 2. As the average of entire nitrogen doses, cultivars had NUpE value of 1.51% in less precipitated first year (2000-2001) and 0.88% in much precipitated second year (2001-2002). In both years, the cultivars Adana-99 and Ceyhan-99 had NUpE values higher than the year average. Considering the averages for N doses, NUpE values decreased from 3.0 to 0.6% with dose increment in the first year, the NUpE values decreased from 1.7 to 0.4% in the second year (Table 2). In combined variance analysis, Year, Cultivar, Dose, Year x Dose and Year x Cultivar interactions were found to be significant (Table 2). Higher NUpE values were observed at low nitrogen doses of less precipitated (346.7 mm) first year, very low NUpE values were observed at all N doses of much precipitated (737.4 mm) second year (Table 2).

Current measurements revealed that the cultivars with high NUpE values also had high biological yields and high shoot yields (results were not presented). In a previous study, it was reported that NUpE was more related with economic and biological yield than NUtE at all nitrogen doses and the yield under optimum conditions were related to higher biological yields, higher NUpE values and lower shoot nitrogen contents (Ginkel *et al.*, 2000). Excessive precipitation negatively affected plant nitrogen uptake. Nitrogen uptake may significantly vary with the available moisture of the soils. Nitrogen may leach out from the root zone with excessive irrigation water (Martin *et al.*, 1982). For instance, in the first year, plants of the plots without N treatment up took 3.08 times (grain + shoot) of available (3.6 kg N da^{-1}) nitrogen of the soil. In much precipitated second year, this rate was 1.71 of available 5.3 kg N da^{-1} of the soil (Table 2). Entire cultivars exhibited higher nitrogen uptake efficiencies in less precipitated first year, but the cultivar Amanos-97 also exhibited high uptake efficiency (1.05% NUpE) in much precipitated second year (Table 2).

Table 2. Effects of nitrogen doses (0, 5, 10 and 20 kg da^{-1}) on nitrogen uptake efficiency (NUpE, %) of bread and durum wheat cultivars.

Çizelge 2. Dekara 0, 5, 10 ve 20 kg azot uygulamalarının, ekmeklik ve makarnalık buğday çeşitlerinin azot- alım etkinliği (NUpE, %) üzerine etkisi.

	NUpE (%)										
	Nitrogen doses (kg da^{-1})										
	0		5		10		20		Average		General
Cultivars	**Y-1**	**Y-2**	**Y-1**	**Y-2**	**Y-1**	**Y-2**	**Y-1**	**Y-2**	**Y-1**	**Y-2**	**average**
Ceyhan-99	3.02	1.92	1.47	0.99	1.16	0.66	0.65	0.40	1.58a	0.99cd	1.28a
Adana-99	3.13	1.85	1.40	0.95	1.17	0.64	0.67	0.39	1.59a	0.96d	1.27a
Yüreğir-89	3.36	1.66	1.49	0.85	1.14	0.58	0.64	0.35	1.66a	0.86d	1.26a
Fuatbey-2000	3.61	1.62	1.42	0.83	1.07	0.54	0.61	0.34	1.68a	0.83d	1.26a
Amanos-97	2.82	2.04	1.30	1.05	0.86	0.70	0.50	0.43	1.37abc	1.05bcd	1.21ab
Panda	3.18	1.69	1.33	0.87	1.00	0.58	0.55	0.35	1.52a	0.87d	1.19ab
Genç-99	3.03	1.83	1.11	0.94	0.97	0.63	0.62	0.38	1.43ab	0.95d	1.18ab
Doğankent-I	3.07	1.48	1.37	0.76	0.93	0.51	0.61	0.31	1.49a	0.77d	1.13ab
Gediz-75	3.01	1.46	1.25	0.75	0.95	0.51	0.51	0.31	1.43ab	0.76d	1.09b
Seyhan-95	2.64	1.55	1.28	0.80	0.95	0.54	0.55	0.33	1.36abc	0.80d	1.08b
Average	3.08a	1.71b	1.34c	0.88d	1.02d	0.59e	0.59e	0.36e	1.51A	0.88B	

Year. P<0.01 LSD=0.068; Dose. P<0.01 LSD=0.085; Year x Dose. P<0.01, LSD=0.231; Cultivar. P<0.01 LSD=0,153; Year x Cultivar. P<0.01, LSD= 0.365; CV: 20.26

Previous researches indicated yield level as the most significant factor affecting the N response of wheat and also indicated precipitation and soil available nitrogen contents as the other significant environmental factors. Nitrogen-use efficiencies of cultivars were found to be more related with yield potentials (Clarke *et al*., 1990). Beside climate and soil-like environmental factors and cultural techniques, genotypes also have significant impacts on physical, chemical and technological characteristics of wheat (Otteson *et al*., 2008).

3.2. Nitrogen - Utilization Efficiency (NUtE)

Nitrogen-utilization efficiency (NUtE) is a parameter expressing how much of the up taken nitrogen (grain N + shoot N) is converted by plant into grain yield and cumulative results are briefly described in Table 3. NUtE value of less precipitated (346.7 mm) year was higher than much precipitated (737.4 mm) year (37.9% vs 36.1%) (Table 3). In the first year, the bread wheat cultivars Adana-99, Yüreğir-89 and Ceyhan-99 and durum wheat cultivars Fuatbey-2000 and Amanos-97 had higher NUtE values than the year average. In the second year, Adana-99 and Doğankent-1 had higher NUtE values above the average. These cultivars were followed by Ceyhan 99, Gediz-75 and Panda. These cultivars with high NUtE values also had high harvest index values (results are not presented).

Durum wheat cultivars had lower NUtE values in the second year compared to first year. Higher precipitation resulted in decreased NUtE values and increased shoot and biological yields. With regard to NUtE values, Year, Dose, Cultivar, Year x Dose and Year x Cultivar interactions were found to be significant ($P<0.01$) (Table 3). Excessive precipitation had negative impacts on nitrogen conversion into grain yield and NUtE values at different nitrogen doses were generally lower in the second year compared with the first year. Distribution of precipitation within a year has also significant effects on development, yield and yield parameters of wheat.

Climate data for experimental years are provided in Table 1. Compared to long-term averages, annual distribution of precipitations were unfavorable during the wheat growing seasons of both years. Number of spike per unit area, shoot yield and biological yield values of the second year were higher than the first year. On the other hand, harvest index values of the first year were higher than the second year. It was comprehended that nitrogen up taken by the plant was spent to tillering rather than grain yield because of excessive precipitation. Increasing nitrogen contents were reported to increase vegetative growth and decrease harvest index (Yunusa and Sedgley 1992; Sezal *et al*., 2007). Increasing biological yields were also reported with increasing nitrogen doses (Serrano *et al*., 2000). In a similar study in Mexico, researchers tested breeding material under low N (zero dose), medium N (15 kg N da^{-1}) and high N (30 kg N da^{-1}) conditions and reported unchanged HI values and indicated that entire factors effective on yield were observed because of variations in biological yields.

Researchers also reported that NUpE was more related to yield and biological yield development than NUtE at all nitrogen doses and the yield under optimum conditions were related to higher biological yields, higher NUpE values and lower shoot nitrogen contents. It was also pointed out that high yields of lines under low nitrogen conditions were because of higher harvest index and NUpE values of these lines (Ginkel *et al*., 2000). In another study, increased vegetative development, increased number of tillers but decreased spiked tiller and yields of wheat were reported with increased nitrogen doses (Akkaya 1994). With regard to NUtE values, the cultivars Adana-99 and Ceyhan-99 were identified as the most stable cultivars.

3.3. Nitrogen- Use Efficiency (NUE)

Nitrogen-use efficiency (NUE) is a parameter expressing how much of the nitrogen supplied to plant (soil + fertilizer) is used for grain yield and cumulative results are provided in Table 4. The average nitrogen use efficiency of cultivars was 33.6% for much precipitated in the second year, while it was 58.2% in first year for less precipitated. In the first year, there was 3.6 kg nitrogen in soil and NUE value was 119.8%; Average NUE value of ten wheat cultivar was 55.0, 38.2 and 19.6%, at doses of 5, 10 and 20 kg da^{-1} soil applied nitrogen in the first year. In the second year, 5.3 kg da^{-1} nitrogen was recorded in soil and NUE values of 68.7, 34.3, 20.9 and 10.4% were observed at same nitrogen doses (Table 4). Nitrogen uptake is closely related to soil moisture levels. Together existence of nitrogen in soils together with water results in optimum yields. Plant died because plant sap is used by the fertilizer through osmotic pressure, when nitrogen is applied to soils with insufficient moisture levels. On the other hand, in case of excessive irrigation, applied nitrogen is leached out of the root zone (Martin *et al.*, 1982). Excessive precipitations of the second year decreased the availability of nitrogen in clay loam soils in the present study. Since soil texture designates the water movement in soil, it also effects nitrogen leaching. When the soil is saturated, water with dissolved elements moves downward with the action of gravity. Nitrogen transport is less in fine textured soil as it has lower permeability than coarse textured soils. Besides, fine textured soils (clay soils) are more prone to nitrogen loss through denitrification (IPNI, 2014). Nitrogen uptake also decreases in heavy-textured soils through high denitrification because of limited aeration capacity (Karaşahin 2014). Excessive grazing and heavy machinery also result in soil compaction and consequently reduced soil porosity and infiltration capacity. Low porosity increase denitrification and low infiltration capacity results in nitrogen leaching and water resources pollution through runoff (Karaşahin 2014).

Increasing N doses decreased availability levels of nitrogen and ultimately NUE values decreased down to 10% levels (Table 4). Decreased nitrogen uptake levels were also reported in previous studies with increasing nitrogen doses (Staley and Perry 1995; Keklikçi *et al.*, 2001; Presterl *et al.*, 2003). In excessive N treatments, the extra amount left after maximum saturation levels is leached below the root zone and thus such excessive amounts do not increase yields (Jokela and Randall 1997; Lambert *et al.*, 2000). Plant N uptake also decreases over the optimum doses and thus it was reported in excessive treatments that nitrogen losses increase through leaching of nitrate nitrogen and plant benefit ratios from the nitrogen decreases (Karam *et al.*, 2002).

In second year of experiments, measurements revealed increased shoot and biological yields but decreased harvest indexes. The cultivars with high harvest index values exhibited the highest NUE values both in dry and wet year. In combined analysis of variance, Year, Dose, Cultivar, Year x Dose and Year x Cultivar interactions were found to be significant (Table 4). Plants benefited from 10.40% of 20 kg nitrogen in the second year with higher precipitation, they benefited from 19.64% in less precipitated first year (Table 4). Rather than applying additional nitrogen, agronomic measures should be taken to improve nitrogen use efficiencies. Bread wheat cultivars of Adana-99 and Ceyhan-99 had the highest NUE values in both years (Table 4).

Table 3. Effects of nitrogen doses (0, 5, 10 and 20 kg da^{-1}) on nitrogen utilization efficiency (NUtE, %) of bread and durum wheat cultivars.

Çizelge 3. Dekara 0, 5, 10 ve 20 kg azot uygulamalarının, ekmeklik ve makarnalık buğday çeşitlerinin azot- değerlendirme etkinliği (NUtE -%) değeri üzerine etkisi.

	NUtE (%)										
	Nitrogen doses (kg da^{-1})										
	0		5		10		20		Average		General
Cultivars	**Y-1**	**Y-2**	**Y-1**	**Y-2**	**Y-1**	**Y-2**	**Y-1**	**Y-2**	**Y-1**	**Y-2**	**average**
Ceyhan-99	41.7	41.1	43.9	41.9	40.1	40.0	35.8	30.2	40.4ab	38.3ab	39.3a
Adana-99	39.5	44.6	44.1	44.5	40.2	41.8	33.9	27.3	39.4ab	39.6ab	39.5a
Yüreğir-89	41.2	37.3	42.5	33.9	38.4	32.1	36.0	24.6	39.5ab	32.0b	35.7cd
Fuatbey-2000	38.1	41.3	41.5	36.8	37.0	31.9	32.6	29.2	37.3ab	34.8ab	36.1bcd
Amanos-97	45.7	36.5	43.7	39.2	41.2	37.2	35.5	29.0	41.5a	35.5ab	38.5abc
Panda	37.0	43.6	37.9	40.8	32.7	34.7	29.4	27.4	34.2ab	36.6ab	35.4cd
Genç-99	33.2	39.9	42.1	37.5	33.3	33.1	30.9	25.5	34.9ab	34.0ab	34.4d
Doğankent-I	40.1	44.2	39.7	42.2	41.7	36.1	33.4	34.5	38.7ab	39.2ab	39.0ab
Gediz-75	41.4	41.2	42.2	40.0	34.7	33.0	32.0	34.7	37.6ab	37.0ab	37.2ad
Seyhan-95	37.6	42.5	35.8	35.4	37.9	31.0	33.4	30.4	36.1ab	34.8ab	35.5cd
Average	39.5ab	41.2a	41.3a	39.1ab	37.7abc	35.1bc	33.3cd	29.3d	37.9A	36.1B	

Year. P<0.01 LSD=1.24; Dose. P<0.01 LSD=1.91; Year x Dose. P<0.01 LSD=4.899; Cultivar. P<0.01 LSD=2.76; Year x Cultivar. P<0.01 LSD=7.74; CV: 13.88

Kalaycı *et al.* (1996), investigated nitrogen use efficiencies of bread and durum wheat cultivars at different nitrogenous fertilizer levels and reported higher efficiency values of bread wheat than durum wheat at low nitrogen levels and indicated that efficiency at high doses was related to yield potentials of the cultivars in addition to the initial efficiency values. NUE values were higher in bread wheat cultivars of Adana-99 and Ceyhan-99 than durum wheat cultivars at low nitrogen doses of the second year. Different nutrient uptake and use efficiency values were reported for different cultivars and even for different genotypes of the same cultivar (Gill *et al.*, 1994; Yaseen *et al.*, 1998).

Table 4. Effects of nitrogen doses (0, 5, 10 and 20 kg da^{-1}) on nitrogen use efficiency (NUE, %) of bread and durum wheat cultivars.

Çizelge 4. Dekara 0, 5, 10 ve 20 kg azot uygulamalarının, ekmeklik ve makarnalık buğday çeşitlerinin azot- kullanım etkinliği (NUE-%) değeri üzerine etkisi.

	NUE (%)										
	Nitrogen Doses (kg da^{-1})										
	0		5		10		20		Average		General
Cultivars	**Y-1**	**Y-2**	**Y-1**	**Y-2**	**Y-1**	**Y-2**	**Y-1**	**Y-2**	**Y-1**	**Y-2**	**average**
Ceyhan-99	126.0	76.7	64.8	41.2	46.4	26.5	23.2	12.4	65.1a	39.2ef	52.1a
Adana-99	118.3	79.8	60.2	43.2	46.7	27.0	22.6	10.5	61.9ab	40.1e	51.0a
Yüreğir-89	134.2	62.1	63.1	28.9	43.9	18.5	23.0	8.5	66.1a	29.5gh	47. 8ab
Fuatbey-2000	138.8	66.9	59.3	31.0	39.5	17.8	19.8	9.9	64.3a	31.4fgh	47.9ab
Amanos-97	127.0	71.1	56.9	41.0	35.3	26.0	17.6	12.3	59.2abc	37.6efg	48.4ab
Panda	113.8	72.9	50.5	35.4	31.9	20.2	16.2	9.6	53.1cd	34.5e-h	43.8bcd
Genç-99	100.0	71.0	45.6	35.2	32.1	21.4	18.8	9.7	49.1d	34.3e-h	41.7cd
Doğankent-I	121.3	64.2	53.6	31.8	38.1	18.6	20.3	10.6	58.3abc	31.3fgh	45.0bc
Gediz-75	120.0	58.9	51.2	28.4	32.7	16.6	16.4	10.6	55.1bcd	28.6h	41.9cd
Seyhan-95	98.1	63.8	45.0	27.5	35.8	16.7	18.5	9.8	49.3d	29.5gh	39.4d
Average	119.8 a	68.7 b	55.0 c	34.3 d	38.2 d	20.9 e	19.6 e	10.4 f	58.2A	33.6B	

Year. P<0.01 LSD=2.31; Dose. P<0.01 LSD=2.80; Year x Dose. P<0.01 LSD=7.609; Cultivar. P<0.01 LSD=5.17; Year x Cultivar. P<0.01 LSD= 8.50; CV: 17.42

4. CONCLUSION

In conclusion, about 40-55% of nitrogenous fertilizer provided in this region was benefited by wheat cultivars. It was comprehended that rather than using additional nitrogen doses, well-adapted cultivars should be selected and proper cultural practices should be implemented to improve nitrogen-use efficiencies. The cultivars Adana-99 and Ceyhan-99 with the highest nitrogen-use efficiencies were identified as the most suitable cultivars for the region. These cultivars were the ones that have been improved through long-term breeding works in the region. Recommendation of these cultivars for the region is a significant issue for benefiting nitrogenous fertilizers upmost level. Research is also recommended for nitrogen-use efficiency of new cultivars.

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