YIELD, PROTEIN AND NITROGEN USE EFFICIENCY IN BREAD WHEAT GENOTYPES

Fatma GOKMEN YILMAZ [1], Mustafa HARMANKAYA[1], Sait GEZGIN[1]

e-mail: fgokmen@selcuk.edu.tr

Abstract

The effects of nitrogen fertilization on protein content, yield and nitrogen physiological efficiency (NUE), nitrogen uptake efficiency (NupE) and nitrogen agronomic efficiency (NutE) of grain for eight wheat (*Triticum aestivum* L.) genotypes (Gerek 79, Bezostaja 1, Altay 2000, Bayraktar 2000, Kate A-1, İzgi 2001, Sönmez 2001 and Karahan 99) were elavuated over a N application range of 0-8 kg N da^{-1}, on N-deficient soil in Central Anatolian Region during two growing periods (2007/08, 2008/09). N fertilization increased grain yield and grain protein concentration of all genotypes in two years. In both years of the study increasing levels of nitrogen applied in different bread wheat varieties effects on grain yield, protein content, NUE, NupE and NutE was found statistically significant. In the first year of experiment, average nitrogen use efficiency of bread wheat varieties are analyzed and determined the highest physiological efficiency of nitrogen is Kate A-1 (47.4) bread wheat variety, nitrogen agronomic efficiency and nitrogen uptake efficiency were identified highest in İzgi 2001 (14.7 and 0.33) bread wheat variety. In addition, ın the second year of experiment, on average nitrogen use efficiency of bread wheat varieties are analyzed, determined highest physiological efficiency of nitrogen is Bayraktar 2000 (50.5) bread wheat variety, nitrogen agronomic efficiency and nitrogen uptake efficiency were identified highest in Kate A–1 (15.9 and 0.33) bread wheat variety. During investigated growing years NUE was decreased with increasing nitrogen fertilization.

Key words: nitrogen use efficiency components, protein, yield, wheat.

Nitrogen is one of the key nutrients that limit crop growth of cereals in many production systems. Higher production costs, inefficient use of energy resources, possible environmental pollution by nitrates in water and gaseous emissions in the atmosphere are linked to the inefficient use of N. Nitrogen use efficiency has been defined as the grain yield produced per unit of n supply from soil and fertilizer (Sowers et al. 1994) and can be subdivided into components that identify soil and plant processes that contribute to the overall use of N (Moll et al. 1982).

Nitrogen use efficiency components can be defined as the product of physiological, uptake and agronomic efficiency. Nitrogen uptake increases with application of fertilizer N due to increases in crop yield, and to a lesser extent, increases in grain protein content (Fowler et al. 1990). NUE is generally greatest with low levels of applied N and decreases as amount of N applied increases. It is important to increase the efficiency of soil and fertilizer N by using nutrient efficient genotypes. Also, It is hypothesized that the NUE of the wheat can be optimized by stem and grain N content of wheat genotypes, which improves the efficiency of grain productions. The aim of investigation was to evaluate in yield, protein and nitrogen use efficiency components in bread wheat genotypes.

MATERIAL AND METHOD

Field experiments were conducted under rainfed conditions at the research from of Transitional Zone Agricultural Research Institute at Eskisehir and Bahri Dagdas International Winter Cereal Research Center at Konya, Turkey in the 2007/08 and 2008/09 growing seasons. In the 2007/08 growing season, while total precipitation of 304 mm to 400 mm in 2008/09. Some characterics of soils at the experimental sites at 0-30 cm depth respectively were as follows: soil texture clayey and sandy clay, $CaCO_3$ 31% and 16%, pH (H_2O):7.9 and 7.9, organic matter 1.8% and 1.3%. The concentrations of DTPA-extractable Zn,Fe,Mn and Cu, measured as described in Lindsay and Norvell (1978) were 0.33 and 0.38 Zn, 4.21 and 2.44 Fe, 6.24 and 6.13 Mn, 1.82 and 1.28 Cu in mg kg^{-1} soil. The levels of NH_4+NO_3-N determined with 2 M KCl (Kjeldahl method) was 19.0 mg kg^{-1} soil.

The experimental design was split split plots in randomized complete block design in with four replications comparing two N treatments (0 and 8 kg N da^{-1}) and eight bread wheat (*Triticum aestivum* L.) genotypes (Gerek 79, Bezostaja 1, Altay 2000, Bayraktar 2000,Kate A-1, İzgi 2001, Sonmez 2001

[1] Faculty of Agriculture, University of Selçuk, Konya-Turkey

and Karahan 99). The N fertilizer was divided into two doses: 4 kg N da^{-1} at sowing, 4 kg N da^{-1} at during tillering as a ammonium nitrate. In the trials N doses main plots and sub-plots of wheat genotypes formed. Planting was made the last week of October at a seeding rate of 450 grains m^{-2}. Each plot had eight rows, 12 m in length and 20 cm between rows. Agrochemicals were applied when necessary during the growth periods to keep the experiments free of pests and weeds. At physiological maturity, four rows of 10 m length in middle of the plots were harvested. Harvested was performed on 8/9 July. Grain from each plot was weighed and results expressed to kg da^{-1}. Nitrogen concentrations of samples were determined using auto LECO C/N/S analyzer. Protein concentrations were derived by multiplying grain N concentrations by 5.7. The components of N efficiency is in accordance with Delogu et al. (1998) and Lopez-Bellido and Lopez-Bellido (2001). The results were analysed separately for each experiment using of SAS.

RESULTS AND DISCUSSIONS

Genotype effects on NUE components were different in the two experimental years. Under unfertilized conditions grain yield was less than fertilized conditions. N fertilization increased grain yield, grain protein concentration of all genotypes in two years. In both years of the study increasing nitrogen applied in different wheat genotypes effect on grain yield, grain protein concentration, NUE, NupE and NutE was found statistically significant. The effect of genotype (G), nitrogen (N) and GxN interactions for yield and protein is presented in *table 1*. Also, the GxN interaction was significant for yield, protein content, NUE, NupE and NutE.

Table 1

Mean values of yield and protein contents of bread wheat genotypes[1]

Genotypes	2007/08	2008/09	2007/08	2008/09
	Yield (kg da^{-1})		Protein (%)	
Gerek 79	319 b	351 cd	12.3 cd	12.1 bc
Bezostaja 1	282 cd	324 e	12.8 abc	13.0 a
Altay 2000	299 bc	345 d	12.4 cd	12.1 bc
Sönmez 2001	299 bc	366 b	132.2 a	12.3 b
İzgi 2001	286 c	356 c	12.9 ab	11.9 bc
Kate A-1	279 cd	371 b	12.1 d	11.7 cd
Bayraktar 2000	348 a	393 a	12.5 bcd	11.4 d
Karahan 99	258 d	316 e	13.2 a	12.8 b

[1]Data represent mean values of two N levels. Mean values followed by different letters are different from each other at $p<0.05$ according to t-test comparisons.

In both years of study, average yield of bread wheat genotypes were analyzed and determined the highest yield Bayraktar 2000 genotype was respectively, 348 kg da^{-1} and 393 kg da^{-1}. In addition to, in the 2007/08 growing season, mentioned genotypes average yield increased linearly from 269 kg da^{-1} to 323 kg da^{-1} and from 323 kg da^{-1} to 374 kg da^{-1} in 2008/09 growing season (data not given). Also, significant N, G and GxN interactions were observed for the both experiment, therefore, protein content of genotypes are presented as averages across the N fertilization (table 1). Protein content of genotypes in first year and second year respectively, increasing order was: Kate A-1<Gerek 79<Altay 2000<Bayraktar 2000< Bezostaja 1<İzgi 2001<Sönmez 2001=Karahan 99 and Bayraktar 2000<Kate A-1<İzgi 2001<Gerek 79=Altay2000<Sönmez2001<Karahan99<Bezostaja1. In contrast, grain yields of Bayraktar 2000 and Gerek 79 were highest, while Karahan 99 and Kate A-1 were lowest in first year of study (Table 1). Protein content increased significantly, as the rate of increase of grain yield in response to N application declined, similar to the response observed for wheat protein by Fowler et al. (1990). NUE components of genotypes are presented in table 2. In the first year of experiment, average nitrogen use efficiency of bread wheat varieties are analyzed and determined the highest physiological efficiency of nitrogen is Kate A-1 (47.4) bread wheat variety, nitrogen agronomic efficiency and nitrogen uptake efficiency were identified highest in İzgi 2001 (14.7 and 0.33) bread wheat variety. In addition, ın the second year of experiment, on average nitrogen use efficiency of bread wheat varieties are analyzed, determined highest physiological efficiency of nitrogen is Bayraktar 2000 (50.5) bread wheat variety, nitrogen agronomic efficiency and nitrogen uptake efficiency were identified highest in Kate A–1 (15.9 and 0.33) bread wheat variety (*table 2*).

Under a high environment (year 1 and 2), grain yield of all genotypes increased with little change in grain protein content. Similar yield-protein relationships expressed under high and low yielding environments have been reported for other wheat producing areas (Benzian B. and Lane P.,1979).

Decreasing NUE reduces economic benefits of fertilization application at higher rates, as producers are paid basically according to grain yield, and not protein content per se, so that addition of fertilizer N, especially for all of genotypes, to increase protein content, would not be a desirable or useful practice.

Table 2

Mean values of nitrogen use efficiency components of bread wheat genotypes[1]

Genotypes	07/08	08/09	07/08	08/09	07/08	08/09
	NUE		NUpE		NUtE	
Gerek 79	47.1a	47.2bcd	0.25b	0.29cd	11.8c	13.9de
Bezostaja 1	44.6bc	44.1e	0.30a	0.28d	13.3abc	12.7f
Altay 2000	46.5ab	47.2bcd	0.28ab	0.32ab	13.5abc	15.1b
Sönmez 2001	43.2c	46.5cd	0.30a	0.29d	13.0bc	13.5ef
İzgi 2001	44.4bc	48.0bc	0.33a	0 31b	14.7a	14.8bc
Kate A-1	47.4a	48.7b	0.29a	0 33a	13.9ab	15.9a
Bayraktar 2000	46.3ab	50.5a	0.30a	0.31bc	13.8ab	15.5ab
Karahan 99	43.6c	46.1d	0.32a	0.31b	13.8ab	14.2cd

[1]Data represent mean values of two N levels. Mean values followed by different letters are different from each other at $p<0.05$ according to t-test comparisons.

CONCLUSIONS

Genotypes showed similar ranking for most the described components of nitrogen use efficiency in the field experiments. Bayraktar 2000 was superior as far as grain yield was concerned, while providing the highest yield has provided less protein content in both years. Of the tested genotypes, Bayraktar 2000 showed continued photosyntehic activity and good ability to take up N (fertilizer and soil). At the same time it was the most efficient genotype in the producing grain yield per unit N supply, but its concentration of grain protein content was lower that of Sönmez 2001. In both years of the study increasing levels of nitrogen applied in different bread wheat genotypes indicated that: 1. NUE, NupE and NutE were different of all genotypes. 2. NUE, NupE and NutE decreased with increasing N fertilization. The reasons for the different types of experiment results :- experiments of the physical and chemical properties (especially, 0-30 cm soil nitrogen content) of the soil can be different – to take place may be different rainfall – genotypes may be arise in genetic. In addition, very few studies on this subject in Turkey because of this study may shed light on future work.

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