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INFLUENCE OF NITROGEN FERTILIZATION LEVELS ON GRAIN YIELD AND ITS COMPONENTS IN BARLEY (*Hordeum vulgare* L.)

SUMMARY

Grain yield and its components are very important and complicated in barley and highly have been influenced by agronomic applications and environmental factors. On the other hand; this is depend on combination varied plant traits (agronomic and quality). For this season, the study was designed to evaluate the effects of different nitrogen fertilization levels (0, 10, 20, 30 and 40 kg ha^{-1} of N) on the agronomic performance of five barley cultivars in two growing seasons. Split plot layout within randomized complete block design with 3 replications was used in both years. The response to fertilization levels were evaluated through GGE (Genotype main effects and Genotype x Environment interaction) biplot graphic methodologies and regression. Combined analysis of variance of nitrogen applications of five cultivars showed highly significant ($p<0.01$) difference between the cultivars, nitrogen applications and interaction. There were genetic variability among cultivars on grain yield and yield components in response to nitrogen fertilization. The results showed that biggest increases on yield and yield components were observed under 40 kg/ha^{-1} nitrogen fertilization level, while thousand grain weight was the biggest under without nitrogen application. The higher performance of yield and yield components was associated with higher nitrogen fertilization in regression analysis. The results of the this study has been recommended that it should be use and study higher nitrogen application levels than 40 kg ha^{-1} of N in the next barley studied.

Keywords: Nitrogen application, yield components, Barley, GGE biplot; regression

INTRODUCTION

Barley (*Hordeum vulgare* L.) is the major cereal in many dry areas of the world and is vital for the livelihoods of many farmers (Alazmani, 2015). It is the second important cereal crop of Turkey and accounts for about 25% of the total cereal production. In East Anatolia, barley has been cultivated for many years and has a significant role for livelihoods of majority farms. It is also grown mainly on rainfall conditions, but some application restricts the progress of yield improvement under rain fed and unpredictable climatic conditions during growing seasons (Kilic 2014). Therefore, experimental research needs to be

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carried out over multiple environment trials with different applications in order to identify and analyses the major factors that are responsible for genotype yields (Kendal et al., 2016). Nitrogen is needed for early tiller development of barley to set up the crop for a high yield potential. On the other hand; nitrogen fertilization has an important effect on the final harvest, thus if this element is not take from plant, yield is decreases (Mareno et al., 2003). The amount of nitrogen, barley crop needs to reach maximize yield and quality, will depend on the seasonal conditions, soil type, and rotational history of the soil as well as the potential yield of the cultivars (Alazmani, 2015).

Nitrogen is the key nutrient input for achieving higher yield of barley. Barley is very sensitive to insufficient nitrogen and very responsive to nitrogen fertilization. On the other hand, excessive use of nitrogen in barley causes lush succulent growth, more lodging, low thousand grain weight, low spike, delayed maturity and greater susceptibility to diseases and pests (Alam, 2007). Nitrogen application at proper dose is the most important for increasing crop production. The farmers have not enough information about use nitrogen fertilizers and adequate information concerning actual soil requirements. Therefore, the study of use N dozes in barley cultivars is necessary to recommend optimum nitrogen doses for high yield and quality in different environment conditions.

The yield of each variety in any environment is a sum of environment (E) main effect, genotype (G) main effect and genotype by environment interaction (GE or GEI) (Yan et al., 2000; Farshadfar et al 2013; Sayar et al., 2013). On the other hand; farmers need varieties that show high performance in terms of yield and other essential agronomic Traits by use nitrogen fertilizer. Modern barley breeding is largely directed towards the development of genotypes characterized with increased yield potential, wide adaptation and high responses to agronomic inputs (Przuli et al 2014). Some agronomic and technological traits such as lodging (LOG), plant height (PH), thousand-kernel weight (TKW), hectoliter mass (HM) and grain protein content (GPC) have significant influence on barley grain yield and quality.

Different statistical analysis, such as correlation, path coefficient and principal component analysis (PCA) can be used to reveal associations between yield and other agronomic traits. The impact of GGE Biplot methods and regression analysis has been clearly showed by different researchers using relationship among factors. This methods; provide the correlative size and interaction (Asfaw et al 2009; Sayar and Han, 2015; Kendal and Sayar 2016). So it is very important to identify the use of nitrogen fertilization doses to cultivars for high yield and best quality. The major objective of study reveal effect of nitrogen fertilization doses using GGE Biplot and regression analysis to recommend doses for application in farm areas.

MATERIAL AND METHODS

The experiment was conducted in the research field of the Department Faculty of Agricultural, University of 100. Van, Turkey. The experiment was conducted on the basis of split plot layout with completely randomized block design with 3 replications. Main plot was different level of nitrogen fertilizer (0, 10, 20, 30 and 40 kg ha^{-1} of N and sub plot was different five barley cultivars (Table 1).

Table 1. The information's about cultivars, used in experiment.

Number	Cultivar name	Spike type
1	Tokak 157/37	2 rows
2	Tarm-92	6 rows
3	Çetin-2000	6 rows
4	H-47	2 rows
5	Bülbül-89	2 rows

This research was conducted in 2001-2002 and 2002-2003 growing seasons. The seeding rates were 500 seeds m^{-2}. Plot size was 7.2 m^{-2} (1.2 × 6 m) consisting of 6 rows spaced 20 cm apart. Sowings were made by using an experimental drill. The fertilization rates for all plots were different N ha^{-1} doses and 60 kg P ha^{-1} with sowing time and different N ha-1 doses was applied to plots in double ridge stage. Harvests were made using Hege 140 harvester in 6 m^{2}. Other normal agronomic practices for barley production were followed. During both of growing seasons, heading time (date), spike per square(m^{2}), plant height(cm), length of spike (cm) , number of grains per spike, thousand grain weight(g), harvest index (%), biological yield(kg/ha^{-1}) and grain yield (kg/ha^{-1}) were examined(Kendal, 2016). The Soil analysis results was shown in Table 2 and the climate data of growing seasons were shown in Fig. 1 and Fig. 2 (Van Regional Directorate of Meteorology).

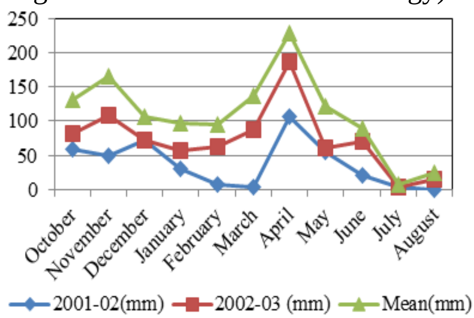

Fig. 1. The precipitation of 2001-02, 2002-03and mean of years(mm).

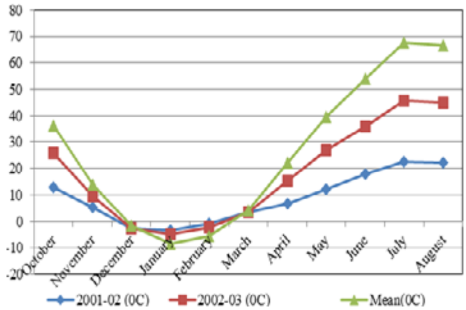

Fig. 2.The temperature of 2001-02, 2002-03 and mean of years(^{o}C).

Table 2. The main soil analysis results were

Depth (cm)	Texturing	pH	Lime (%)	Phosphorus (ppm)	Total N (me/100g)	Organic Subs. (%)	Total Salt (%)
0-20	Sandy clayey	7.75	18.7	336.2	0.076	1.41	0.091
20-40	Sandy clayey	7.60	19.2	375.4	0.072	1.21	0.080

The data obtained from the study related the investigated grain yield and yield components were analyzed respectively for each year and combined with nitrogen doses by using the JMP 5.0.1 statistical software package (SAS Institute, 2002), and the differences between means were compared using a least significant difference (LSD) test at the 0.05 probability level (Steel and Torrie, 1980). Also regression analysis was done by this program. On the other hand; GT biplot analyses were used to determine the differences among application nitrogen doses and crop characteristics and cultivar crop characteristics in two growing seasons (Dogan et al. 2016; Kilic, 2016). GGE biplot analysis also allows comparison amongst nitrogen doses in terms of their discriminating ability and representativeness. These values can be assessed using the discriminating power of the doses' biplot screen of the GGE biplot (Yan and Thinker, 2006). In a multi-application trial (MAT) for barley, biplot figures were constructed by plotting the first two principal components (PC1 and PC2) derived from subjecting nitrogen and cultivar-centered yield, and yield components data (yield variation due to GGE) to singular value separation (Yan et al., 2000). Also, with the GT biplot analysis graphs in the study: It was aimed at revealing relation among nitrogen doses and examined yield components for growing seasons means (Figs. 3A, 3B, 3C, 3D), and separately.

RESULTS

The combined ANOVA revealed highly significant differences among the years, cultivars and interaction of them for all components ($P < 0.01, 0.05$), the differences among nitrogen doses was highly significant ($P < 0.01, 0.05$) for all components without HI(harvest index), as shown in Table 3.

Table 3 The variance of analysis on grain yield and yield components of barley

Sources	DF	HT (date)	SS (m^2)	PH (cm)	SL (cm)	NGS	TGW (g)	HI (%)	BY (kg/ha^{-1})	GY (kg/ha^{-1})
Year	1	0.01**	129042**	1459.13**	34.92**	414.41**	66.84**	39.14**	2412**	25777.5**
Error 1	20	0.16	154.39	8.68667	0.009	0.867	1.04	0.64352	325.51	60.73
Cultivar	4	658.82**	389663**	492.55**	17.20**	1234.47**	194.54**	51.89**	109335**	206732**
Year* Cult.	4	34.28**	25460.4**	42.58*	0.80**	22.80**	4.29*	72.00**	20778.4**	2176.43**
Nitr. Doses	4	1.89**	10826**	392.88**	0.40**	18.61**	16.36**	1.29ns	93102.6**	15708.8**
Year*N.Dos.	4	0.35ns	92.57ns	8.6314ns	0.05**	1.49ns	0.43ns	0.92ns	973.26ns	40.88ns
Cul.*N.Dos	16	0.25ns	261.48ns	9.13ns	0.09**	1.40*	4.81**	6.70**	2474.81**	248.53**
Y*C*ND	16	0.18*	373.34*	8.70ns	0.01ns	0.36ns	2.75*	2.78**	1776.61**	69.09ns
Error 2	79	0.08	190.3	7.87	0.008	0.7678	1.06	0.52	491.2	76.6
C. Total	148									
CV(%)		20.8	3.32	4.12	1.32	3.33	2.56	1.82	2.93	2.92

HT:Heading Time, SS:Spike of per Square, PH:Plant Height, LS:Length of Spike, NGS:Number of grains per Spike, TGW:Thousand Grain Weight, HI:Harvest Index, BY:Biological Yield, GY: Grain Yield.

Moreover, the nitrogen doses × year's interaction (NYI) was only found to be highly significant ($P < 0.01$) for LS(length of spike), the nitrogen doses × cultivar's interaction were found to be highly significant($P < 0.01$) for LS, TGW, HI, BY and GY, while it was found significant ($P < 0.05$) for NGS. On the other hand, the nitrogen doses, years and cultivar's interaction were found to be highly significant ($P < 0.01$) for HI, BY and GY, while it was found significant ($P < 0.05$) for HT and SS. Generally, breeders interested in the genotypes with high genotypic main effect (average over years and nitrogen doses) and with low fluctuation in yield or yield components (stable). The results combined analysis of regression showed that the values of grain yield and yield component were high (positive) depend on application nitrogen doses, while it was low in TGW. The best results were obtained from the highest nitrogen dosing (N4-40 kg/ha-1) for all components, except TGW (Figs.-3A-3L).

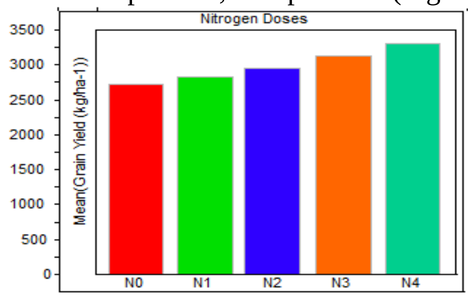

Fig. 3A. Regression analysis nitrogen doses of grain yield

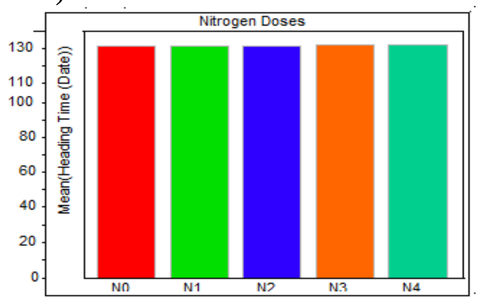

Fig. 3B. Regression analysis nitrogen doses of heading time

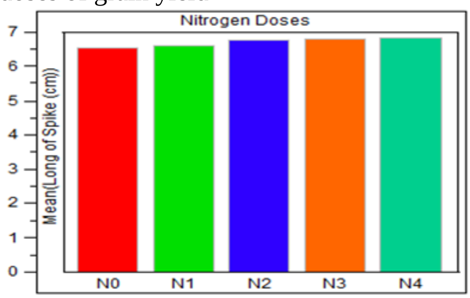

Fig. 3C. Regression analysis nitrogen doses of spike lenght

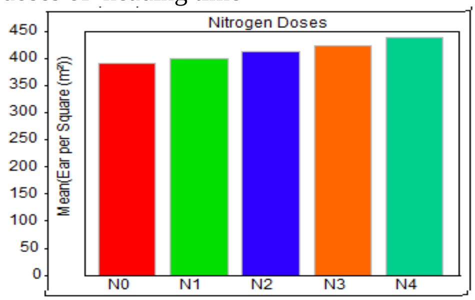

Fig. 3D. Regression analysis nitrogen doses of spike per squar

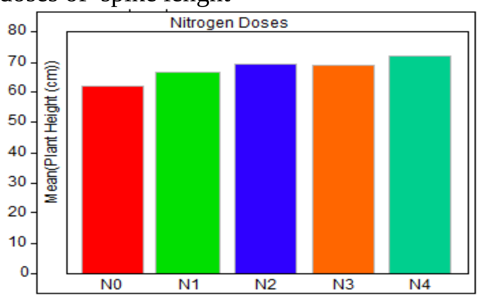

Fig. 3E. Regression analysis nitrogen doses of plant height

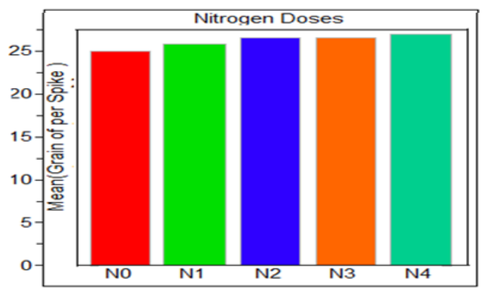

Fig. 3F. Regression analysis nitrogen doses of grain of per spike

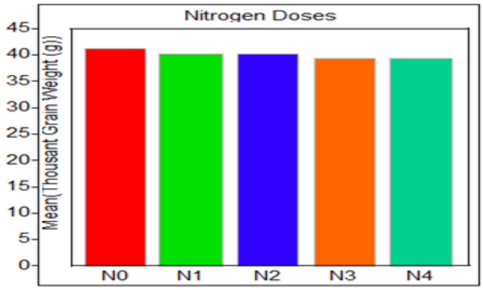

Fig. 3G. Regression analysis nitrogen doses of thausand grain weight

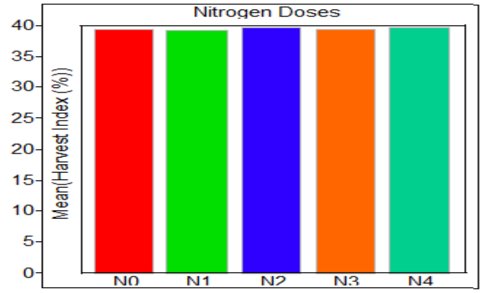

Fig. 3K. Regression analysis nitrogen doses of harvest index

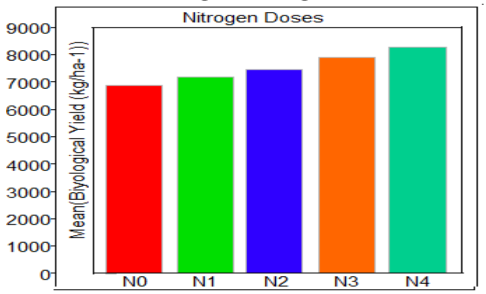

Fig. 3L. Regression analysis nitrogen doses of biological yield.

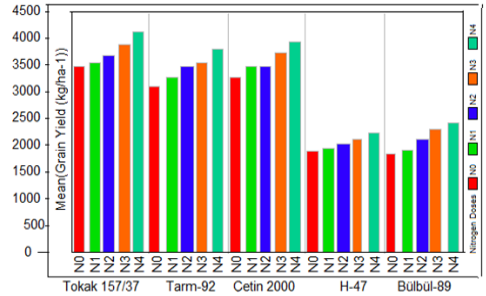

Fig.3M. Regression analysis of cultivar and nitrogen doses

The results of the data reviewed

The mean yield of 2001/02 growing season (3127 kg ha^{-1}) was high than 2002/03(2864 kg ha^{-1}), the mean yield of growing seasons was changed from 1953 kg ha^{-1} to 3952 kg ha^{-1}, and the best yield was obtained from Tokak 157/37 (3557 kg ha^{-1}(Table 4). The mean grain yield of both years was ranged from 2050 kg ha^{-1} to 3754 kg ha^{-1}, and the best yield was obtained from Tokak 157/37 (3557 kg ha-1), while the low yield from H-47(2050 kg ha^{-1}). The yield of application nitrogen doses were ranged from 2726 kg ha^{-1}(N0) - 3310 kg ha^{-1}(N4)(Table 5). The yield of cultivar and nitrogen interaction were changed from 1855 kg ha^{-1} to 4120 kg ha^{-1} and the best yield was obtained by N4 nitrogen doses Tokak 157/37, while the low yield obtained from N0 (without nitrogen) doses and Bülbül-89 variety. The results of grain yield showed that first growing season had high yield than the second and the Tokak-157/37 variety was the best yielding during two grooving seasons. On the other hand; the grain yield was high in N4 nitrogen doses for all varieties and the yield increased in parallel with the dose increase for all varieties (Table 4 and Table 5).

The mean heading time of both growing season was the same (132 date), the mean heading time cultivars of both years was changed from 125 to 138 date, and the long duration was obtained from Tokak 157/37 (138 date) in Table 4. The mean heading time cultivar and year interaction of both years was ranged from 125 to 138 date, and the long duration of heading time was obtained from Tokak 157/37 (138 date) in 2001/02 season, while the low duration of heading time obtained from H-47 (125 date) variety. The heading time of application nitrogen doses were ranged from 132 date (N0) - 133 date (N4) in Table 5. The heading time of cultivar and nitrogen interaction of both year means were changed from 126 to 138 dates and the long duration was obtained by N4 nitrogen doses from Tokak 157/37, while the low duration obtained from N1 and N2 doses by Bülbül-89 variety. The results of heading time indicated that first growing season had long duration than the second as statistical analysis and the Tokak-157/37 variety had long duration during two grooving seasons. On the other hand; the duration was long in N4 nitrogen doses for all varieties and the heading time increased in parallel with the dose increase for all varieties (Table 4 and Table 5).

The mean ear per square of 2001/02 growing season (444 m^2) was high than 2002/03(383 m^2), the mean ear per square of cultivars of both years was changed from 250 to 591 m^2, and the high ears were obtained from Tokak 157/37(591 m^2) and 2001/02 season in Table 4. The application nitrogen doses of ear per square were ranged from 391 date (N0) - 440 date (N4) in Table 5. The ear per square of cultivar and nitrogen interaction of both year means were changed from 286 to 518 m^2.The study results revealed that first growing season had high values of ear per square than the second years as statistical analysis and the Tokak-157/37 variety had haigh ear per square during two grooving seasons. On the other hand; ear per square was high in N4 nitrogen doses for all varieties and the ear per square increased in parallel with the dose increase for all varieties (Table 4 and Table 5).

The mean plant height of 2001/02 growing season (71.2 cm) was high than 2002/03(64.9 cm), the mean plant height of cultivars of both years was changed from 61.1 to 76.7 cm, and the high plant height were obtained from Tokak 157/37 (76.7 cm) and 2001/02 season in Table 4. The application nitrogen doses of plant height were ranged from 62.4 cm (N0) to72.1 cm (N4) in Table 5. The plant height of cultivar of both year means were changed from 62.7 to 74.2 cm.The study results revealed that first growing season had high plant height than the second years as statistical analysis and the Tokak-157/37 variety had haigh plant height during two grooving seasons. On the other hand; plant height was high in N4 nitrogen doses for all varieties and the plant height increased in parallel with the dose increase for all varieties (Table 4 and Table 5).

The mean long ear of 2001/02 growing season (8.9 cm) was high than 2002/03(7.2 cm), the mean long ear of cultivars of both years was changed from 5.5 to 8.3 cm, and the high long ear was obtained from Tokak 157/37 (8.3 cm) and 2001/02 season in Table 4. The long of ears of application nitrogen doses and years interaction were ranged from 6.2 to 7.4 cm, and the best long of ear obtained from N4(7.4 cm) doses in 2001/02 season. The application nitrogen doses of long of ears were ranged from 6.6 cm (N0) to 6.9 cm (N4) in Table 5. The long ear of nitrogen doses and cultivar interaction of both year means were changed from (7.2 to 8.4 cm. The best long ear was obtained from Tokak 157/37 cultivar with (N4) doses. The study results revealed that first growing season had high long ear than the second years as statistical analysis and the Tokak-157/37 variety had haigh long ear during two grooving seasons. On the other hand; long ear was high in N4 nitrogen doses for all varieties and the long of ear increased in parallel with the dose increase for all varieties (Table 4 and Table 5).

The mean number of grain per spike of 2001/02 growing season (27.9) was high than 2002/03(24.6), the mean number of grain per spike of cultivars of both years was changed from 21.3 to 40.4, and the high number of grain per spike was obtained from Çetin-2000 (40.4) and 2001/02 season in Table 4. The application nitrogen doses of number of grain per spike were ranged from 25.0 (N0) to 27.0 (N4) in Table 5. The number of grain per spike of nitrogen doses and cultivar interaction of both year means were changed from 21.3 to 38.7. The number of grain per spike was obtained from Çetin-2000 cultivar with (N4) doses. Also, the number of grain per spike of among cultivars was ranged from 21.9 to 37.4 and the best grain of spike was obtained from Çetin-2000 cultivar. The study results revealed that first growing season had high number of grain per spike than the second years as statistical analysis and the Çetin-2000 variety had high number of grain per spike during two grooving seasons. On the other hand; number of grain per spike was high in N4 nitrogen doses for all varieties and the number of grain per spike increased in parallel with the dose increase for all varieties (Table 4 and Table 5).

The mean thousand grain weight (TGW) of 2001/02 growing season (40.8 g) was high than 2002/03(39.5 g), the mean thousand grain weight of cultivars of both years was changed from 36.7 g to 45.5 g, and the high thousand grain weight was obtained from Tokak 157/37 (45.5 g) during 2001/02 season in Table 4. The application nitrogen doses of thousand grain weight were ranged from 39.3 g (N4) to 41.2 g (N0) in Table 5. The number of thousand grain weight of nitrogen doses and cultivar interaction of both year means were changed from 36.8 g to 45.3 g, and the thousand grain weight was obtained from Tokak 157737 cultivar with N0 application doses. Also, the thousand grain weight of among cultivars was ranged from 38.8 g to 44.4 g, and the best thousand grain weights were obtained from Tokak 157/37 cultivar. The study results revealed that first growing season had high number of thousand grain weight than the second years as statistical analysis, and the Tokak 157/37 variety had haigh thousand grain weights during two grooving seasons. On the other hand; thousand grain weights was high in N0 nitrogen doses for all varieties, and the thousand grain weight decreased in parallel with the dose increase for all varieties (Table 4 and Table 5). The mean harvest index (HI) of 2001/02 growing season (40.0 %) was high than 2002/03(39.0 %), the mean harvest index of cultivars of both years was changed from 38.9 g to 43.1 g, and the high harvest index was obtained from Çetin-2000 (43.1 g) during 2001/02 season in Table 4. The application nitrogen doses, years and cultivar interaction was changed 38.1%-44.6%, and the best high harvest index was obtained from 2001/02 season in Çetin 2000 variety with N4 nitrogen application doses, while low harvest index from 2002/03 in same variety with N2 application nitrogen doses.

Table 4. Influence of different nitrogen levels on yield and yield components of barley cultivars.

Cultivars	Years											
	2001-2002						2002-2003					
	N0	N1	N2	N3	N4	Mean	N0	N1	N2	N3	N4	Mean
Heading Time (date)												
Tokak 157/37	138^{a}	138^{a}	138^{a}	138^{a}	138^{a}	138^{A}	136^{c}	136^{c}	136^{c}	136^{c}	137^{b}	136^{B}
Tarm-92	133^{g}	133^{g}	133^{g}	134^{f}	134^{f}	134^{E}	135de	136^{c}	136^{c}	136^{c}	13^{6c}	136^{C}
Çetin 2000	135^{d}	135^{d}	135^{d}	135^{d}	135^{d}	135^{D}	134^{ef}	135^{d}	135^{d}	135^{d}	136^{c}	135^{D}
H-47	127^{i}	127^{kl}	128^{jk}	128^{j}	128^{jk}	128^{G}	125^{n}	125^{n}	125^{n}	126^{m}	125^{mn}	125^{I}
Bülbül-89	127^{l}	127^{l}	127^{l}	127^{l}	127^{l}	127^{H}	129^{i}	12^{9i}	129^{i}	129^{i}	130^{h}	129^{F}
Mean of Doses	132^{EF}	132DE	132^{CE}	132^{B}	132^{BC}	132^{A}	132^{F}	132DE	132^{CE}	132^{BD}	133^{A}	132^{B}
Spike per Square (m^2)												
Tokak 157/37	551^{bd}	406o	572^{b}	419no	604^{a}	591^{A}	427mo	604^{a}	447^{lm}	625^{a}	470^{ik}	434^{E}
Tarm-92	510^{fg}	484^{hi}	530^{df}	504g^{h}	542de	540^{B}	529^{df}	552^{bd}	525^{eg}	565^{bc}	545^{ce}	518^{C}
Çetin 2000	437^{ln}	419no	454^{jl}	420no	45^{1kl}	459^{D}	428mo	477^{i}	433^{ln}	475^{ij}	448^{lm}	430^{C}
H-47	291^{tu}	247^{wx}	308^{it}	243^{vw}	330^{pr}	321^{F}	239^{x}	332^{pg}	259^{yx}	346^{p}	262^{vw}	250^{I}
Bülbül-89	305st	263^{vw}	296^{t}	271^{uv}	311^{qt}	310^{G}	294^{t}	307st	319^{qs}	333^{pq}	333^{pq}	296^{H}
Mean of Doses	419	432.2	448	454.1	469	444^{A}	364	371	384	396	412	385^{B}
Plant Height (cm)												
Tokak 157/37	69.3	71.7	80.7	79.7	82.0	76.7^{A}	62.1	74.0	73.3	73.0	76.0	71.7^{BC}
Tarm-92	63.7	68.0	72.3	71.7	73.7	69.9^{C}	59.7	62.0	63.3	65.0	70.0	64.0^{D}
Çetin 2000	68.3	74.3	74.0	73.7	76.3	73.3^{B}	60.0	62.3	65.3	64.7	68.0	64.1^{D}
H-47	59.7	64.7	65.7	64.3	67.3	64.3^{D}	56.0	61.0	62.0	62.7	63.7	61.1^{E}
Bülbül-89	66.3	68.0	75.3	73.7	75.3	71.7^{BC}	59.3	60.7	63.7	66.0	69.0	63.7^{D}
Mean of Doses	65.5	69.3	73.6	72.6	74.9	71.2^{A}	59.4	64.0	65.5	66.3	69.3	64.9^{B}
Spike Lenght (cm)												
Tokak 157/37	8.3	8.4	8.2	8.4	8.4	8.3^{A}	7.2	7.2	7.2	7.2	7.2	7.2^{C}
Tarm-92	6.6	6.7	6.9	6.9	7.1	6.8^{D}	6.0	6.1	6.2	6.2	6.2	6.2^{F}
Çetin 2000	7.7	7.7	8.0	8.0	8.1	7.9^{B}	6.5	6.5	6.5	6.6	6.6	6.5^{E}
H-47	6.0	6.1	6.2	6.1	6.1	6.1^{F}	5.5	5.5	5.6	5.5	5.5	5.5^{H}
Bülbül-89	6.5	6.6	7.0	7.1	7.1	6.9^{D}	5.5	5.5	5.7	6.0	6.2	5.8^{G}
Mean of Doses	7.0^{C}	7.1^{C}	7.3^{B}	7.3^{AB}	7.4^{A}	7.3^{A}	7.2^{F}	6.2^{EF}	6.2^{E}	6.3^{D}	6.3^{D}	6.3^{B}
Number of Grains per Spike												
Tokak 157/37	25.7	26.3	27.0	27.3	27.0	26.7^{C}	23.7	24.3	25.0	25.3	24.7	24.6DE
Tarm-92	24.3	24.7	24.7	26.0	26.0	25.1^{D}	21.3	22.7	23.0	22.7	24.0	22.7^{G}
Çetin 2000	38.0	40.0	41.3	41.3	41.3	40.4^{A}	32.0	34.0	35.3	34.7	36.0	34.4^{B}
H-47	22.0	23.3	23.3	24.0	24.0	23.3^{FG}	20.0	21.3	22.0	20.7	22.7	21.3^{H}
Bülbül-89	24.0	23.7	24.0	24.3	24.0	24.0^{EF}	18.7	19.3	20.0	20.0	20.7	19.7^{I}
Mean of Doses	26.8	27.6	28.1	28.6	28.5	27.9^{A}	23.1	24.3	25.1	24.7	25.6	24.6^{B}
Thousand Grain Weight (g)												
Tokak 157/37	45.7	46.3	46.7	45.0	44.0	45.5^{A}	44.8	44.3	42.7	42.7	42.3	43.4^{B}
Tarm-92	44.0	42.0	41.3	39.7	38.3	41.1^{C}	42.3	37.7	40.7	38.0	39.0	39.5^{D}
Çetin 2000	40.0	40.0	38.7	38.0	39.3	39.2^{DE}	38.3	40.0	39.0	37.7	37.0	38.4^{F}
H-47	38.7	39.3	38.0	38.0	38.7	38.5^{EF}	37.0	36.7	37.0	35.7	37.0	36.7^{G}
Bülbül-89	41.3	38.0	40.3	40.7	38.7	39.8^{D}	40.0	39.3	39.0	40.0	39.0	39.5^{D}
Mean of Doses	41.9	41.1	41.0	40.3	39.8	40.8^{A}	40.5	39.6	39.7	38.8	38.9	39.5^{B}
Harvest Index (%)												
Tokak 157/37	39.9^{gj}	39.03^{io}	38.9^{jp}	39.27^{io}	39^{io}	39.2^{DE}	43.9^{ab}	43.4^{ac}	43^{bc}	39.6^{hn}	39.3^{io}	41.8^{B}
Tarm-92	37.4^{gr}	39.03^{io}	39^{io}	39.53^{in}	39.6^{hn}	38.9^{DE}	39.3^{in}	39.2^{io}	39.7^{gl}	39.8^{gk}	41.1^{ef}	39.9^{C}
Çetin 2000	42.9^{bc}	42.4^{de}	42.7^{bd}	43.07^{bc}	44.6^{a}	43.1^{A}	39.7^{gm}	38.7^{kp}	38.1^{oq}	38.6^{lp}	39.5^{in}	38.9^{E}
H-47	37.8^{pg}	35.87^{s}	35.5st	34.53^{t}	35.3st	35.8^{G}	39.0^{jo}	39.9^{gj}	39.4^{in}	39.1^{io}	40.2^{fi}	39.5^{CD}
Bülbül-89	36.2^{rs}	36.37^{rs}	39.7^{gm}	39.2^{io}	38.5^{nq}	38.0^{F}	38.5^{mq}	38.8^{jp}	40.8^{eg}	41.5^{de}	40.8^{eh}	40.1^{C}
Mean of Doses	38.8	38.54	39.2	39.12	39.4	40.0^{A}	40.1	40	40.2	39.7	40.2	39.0^{B}

Biyological Yield (kg/ha^{-1})												
Tokak 157/37	9305^{ef}	9715^{cd}	10029^{c}	10406^{b}	10096^{a}	10088^{A}	7480^{m}	7722^{m}	8116^{kl}	9365^{df}	10060^{bc}	8549^{D}
Tarm-92	8788^{hj}	8651^{ij}	9248^{ef}	9372^{f}	9808^{c}	9173^{B}	7439^{m}	8180^{k}	8474^{ik}	8555^{ij}	9030^{fh}	8336^{E}
Çetin 2000	8174^{k}	$8809g^{i}$	8697^{ij}	9275^{ef}	9398^{de}	8871^{C}	7760^{lm}	$8377^{j}k$	8613^{ij}	9086^{fg}	9415^{de}	8650^{D}
H-47	5222^{st}	5739^{pr}	6197^{no}	6403^{p}	6506^{n}	6013^{F}	4647^{y}	4622^{v}	4768^{uv}	5257^{st}	5435^{rs}	4946^{I}
Bülbül-89	5246^{st}	5205^{st}	5358^{st}	5904^{op}	6434^{n}	5629^{G}	4673^{uy}	5022^{tu}	5210^{st}	5541^{qs}	5850^{oq}	5259^{H}
Mean of Doses	7347^{E}	7624^{D}	7906^{C}	8272^{B}	8626^{A}	7955^{A}	6400^{H}	6785^{G}	7036^{F}	7561^{D}	7958^{C}	7148^{B}
Grain Yield(kg/ha^{-1})												
Tokak 157/37	3710	3773	3903	4083	4290	3952^{A}	3278	3350	3493	3713	3950	3557^{C}
Tarm-92	3283	3377	3607	3723	3880	3574^{C}	2923	3210	3367	3410	3733	3329^{D}
Çetin 2000	3500	3733	3707	3990	4190	3824^{B}	3077	3237	3283	3510	3717	3365^{D}
H-47	1970	2057	2193	2210	2300	2146^{E}	1810	1843	1877	2053	2183	1953^{F}
Bülbül-89	1900	1893	2123	2313	2473	2141^{E}	1810	1953	2127	2297	2383	2114^{E}
Mean of Doses	2873	2967	3107	3264	3427	3127^{A}	2580	2719	2829	2997	3193	2864^{B}

The harvest index of nitrogen doses and cultivar interaction of both year means were changed from 36.8 % to 42.0 g, and the best harvest index were obtained from Çetin-2000 cultivar with N4 application doses, while the low harvest index obtained from H-47 variety with N2 application doses (Table 5). Also, the harvest index of among cultivars was ranged from 37.7% to 44.4 %, and the best harvest index was obtained from Tokak 157/37 cultivar. The study results revealed that first growing season had high harvest index than the second years as statistical analysis and the Tokak 157/37 variety had haigh harvest index of mean two grooving seasons. On the other hand; the high harvest index was changed depend on nitrogen doses and cultivar for and the harvest index showed fluctuate depend on dose increase for all varieties (Table 4 and Table 5).

The mean biological yield (BY) of 2001/02 growing season (7955 kg ha^{-1}) was high than 2002/03(7148 kg ha^{-1}), the mean biological yield of cultivars of both years was changed from 4946 to 10088 kg ha^{-1}, and the high biological yield was obtained from Tokak 157/37 (10088kg ha^{-1}g) during 2001/02 season in Table 4. The application nitrogen doses, years and cultivar interaction was changed 4647-10406 kg ha^{-1}, and the best biological yield was obtained from 2001/02 season in Tokak 157/37 variety with N3 nitrogen application doses, while low biological yield from 2002/03 in Çetin-2000 variety with N0 application nitrogen doses. The biological yield of nitrogen doses of both year means were changed from 6870 to 8292 kg ha^{-1}, and the best biological yield were obtained from N4 application doses, while the low biological yield obtained from N0 application doses (Table 5). Also, the biological yield of among cultivars was ranged from 5444 to 9318 kg ha^{-1}, and the best biological yield was obtained from Tokak 157/37 cultivar. The study results revealed that first growing season had high biological yield than the second years as statistical analysis, and the Tokak 157/37 variety had high biological yield of mean two grooving seasons. On the other hand; the high biological yield was high in N4 application doses for all cultivars, and the biological yield increased in parallel with dose increase for all varieties (Table 4 and Table 5).

Table 5. The data effect interaction of nitrogen levels and barley cultivars.

Cultivars	Heading Time(date)						Number of Grains per Spike					
	N0	N1	N2	N3	N4	Mean	N0	N1	N2	N3	N4	Mean
Tokak 157/37	137^{b}	137^{b}	137^{b}	137^{b}	138^{a}	137^{A}	26.3^{d}	26.0^{de}	24.7^{fg}	25.3^{df}	25.8^{de}	25.6^{B}
Tarm-92	134^{f}	135^{e}	135^{e}	135^{d}	135^{d}	135^{B}	24.3^{fh}	23.8^{gi}	22.8^{il}	23.7^{gj}	25.0^{ef}	23.9^{C}
Çetin 2000	135^{e}	135^{d}	135^{d}	135^{d}	136^{c}	135^{C}	35.0^{c}	37.0^{b}	38.3^{a}	38.0^{ab}	38.7^{a}	37.4^{A}
H-47	127^{l}	126^{jk}	126^{kl}	127^{i}	127^{j}	128^{D}	22.3^{km}	22.7^{jl}	21.0^{n}	22.3^{km}	23.3^{hk}	22.3^{D}
Bülbül-89	128^{h}	128^{h}	128^{h}	128^{h}	128^{g}	126^{E}	21.3^{mn}	21.5^{mn}	22.0^{ln}	22.2^{lm}	22.3^{km}	21.9^{D}
Mean of Doses	132^{D}	132^{C}	132^{C}	132^{B}	133^{A}		25.0	26.0^{C}	26.6^{B}	26.6^{AB}	27.0^{A}	
	Spike per Square(m^2)						Thousand Grain Weight(g)					
Tokak 157/37	497	517	536	538	555	513^{B}	45.2^{a}	45.3^{a}	44.7^{ab}	43.8^{bc}	43.2^{c}	44.4^{A}
Tarm-92	479	496	516	525	548	529^{A}	43.2^{c}	39.8^{dh}	41.0^{d}	38.8^{gj}	38.7^{hk}	40.3^{B}
Çetin 2000	428	437	440	455	462	444^{C}	39.2^{fi}	40.0^{dg}	38.8^{gj}	37.8^{jl}	38.2^{ik}	38.8^{D}
H-47	269	276	285	295	304	286^{E}	37.8^{jl}	38.0^{il}	37.5^{kl}	36.8^{l}	37.8^{jl}	37.6^{E}
Bülbül-89	284	283	303	313	333	303^{D}	40.7^{de}	38.7^{hk}	39.7^{eh}	40.3^{df}	38.8^{gj}	39.6^{C}
Mean of Doses	391^{E}	402^{D}	416^{C}	425^{B}	440^{A}		41.2^{A}	40.4^{B}	40.3^{B}	39.5^{C}	39.3^{C}	
	Plant Haigh (cm)						Harvest Index(%)					
Tokak 157/37	62.8	64.3	69.5	69.8	72.2	74.2^{A}	41.9^{a}	41.2ab	41bc	39.4ef	39.2fg	41.0^{A}
Tarm-92	64.2	68.3	69.7	69.2	72.2	66.9^{C}	38.3^{gh}	39.1fg	39.4f	39.7df	40.4cd	40.5^{B}
Çetin 2000	57.8	62.8	63.8	63.5	65.5	68.7^{B}	41.3ab	40.5^{bc}	40.4^{cd}	40.8^{bc}	42^{a}	39.4^{C}
H-47	61.7	65.0	67.8	68.3	71.8	62.7^{D}	38.4^{gh}	37.9^{hi}	37.5^{ij}	36.8^{j}	37.8^{hi}	37.7^{D}
Bülbül-89	65.7	72.8	77.0	76.3	79.0	67.7^{BC}	37.4^{ij}	37.6^{hj}	40.3^{ce}	40.4^{cd}	39.6^{df}	39.0^{C}
Mean of Doses	62.4^{D}	66.7^{C}	69.6^{B}	69.4^{B}	72.1^{A}		39.5	39.3	39.7	39.4	39.8	
	Spike Lenght (cm)						Biyological Yield(kg/ha^{-1})					
Tokak 157/37	7.7^{ab}	7.8^{ab}	7.7^{b}	7.8^{ab}	7.8^{a}	7.8^{A}	8393	8719	9073	9886	10523	9318^{A}
Tarm-92	6.3^{g}	6.4^{g}	6.6^{ef}	6.5^{f}	6.7^{e}	6.5^{C}	8114	8416	8861	8964	9419	8755^{B}
Çetin 2000	7.1^{d}	7.1^{d}	7.3^{c}	7.3^{c}	7.3^{c}	7.2^{B}	7967	8593	8655	9181	9407	8761^{B}
H-47	5.8^{k}	5.8^{jk}	5.9^{ij}	5.8^{jk}	5.8^{jk}	5.8^{E}	4935	5181	5482	5830	5970	5480^{C}
Bülbül-89	6.0^{hi}	6.1^{h}	6.4^{g}	6.6^{ef}	6.7^{e}	6.^{3D}	4959	5114	5284	5723	6142	5444^{C}
Mean of Doses	6.6^{D}	6.6^{D}	6.8^{B}	6.8^{C}	6.9^{A}		6870^{E}	7204^{D}	7471^{C}	7916^{B}	8292^{A}	
							Grain Yield(kg/ha^{-1})					
Tokak 157/37							3494^{f}	3562^{f}	3698^{e}	3898^{bc}	4120^{a}	3754^{A}
Tarm-92							3103^{h}	3293^{g}	3487^{f}	3567^{f}	3807^{cd}	3451^{C}
Çetin 2000							3288^{g}	3485^{f}	3495^{f}	3750de	3953^{b}	3594^{B}
H-47							1890^{m}	1950^{lm}	2035^{kl}	2132^{k}	2242^{j}	2050^{E}
Bülbül-89							1855^{m}	1923^{m}	2125^{k}	2305^{j}	2428^{i}	2127^{D}
Mean of Doses							2726^{E}	2843^{D}	2968^{C}	3130^{B}	3310^{A}	

GGE Biplot Analysis

Analysis of variance for nitrogen doses (ND) x component (C), and the cultivar(C) × component (C) interaction showed significant ($P < 0.01$) effect, and the total sum of squares explained for 97.56%, with PC1 and PC2 accounting 90.03% and 7.53% for nitrogen doses (ND) component (C) (Figs. 4A–4D), it was explained for 91.87%, with PC1 and PC2 accounting 77.48% and 14.39% for cultivar(C) × component (C) interaction (Figs. 5A–5D), respectively.

GGE biplot analysis of the means over years for nitrogen doses relationships among yield components (Figs. 4), the relationship between doses-components and components groups (Figs. 4A-4B), ranking of doses on components means (Fig. 4C), and comparison of components means of doses

(Fig. 4D) accounted for 97.56% (90.03% and 7.53%, for principal components [PCs] 1 and 2, respectively) of the total variation.

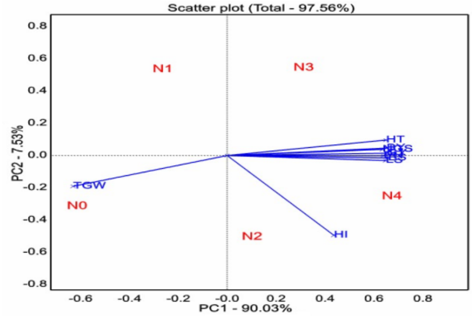

Fig. 4A. Relation among N doses and mean of components

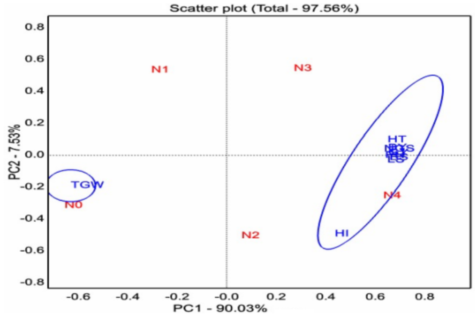

Fig. 4B. The grouping of components over doses

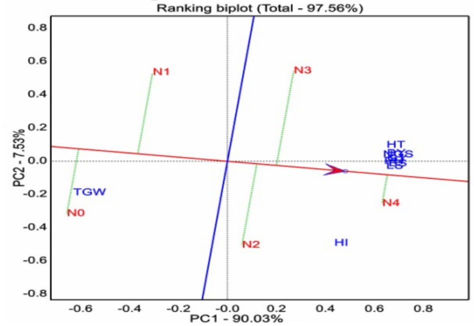

Fig.4C. Ranking of N doses on means of components

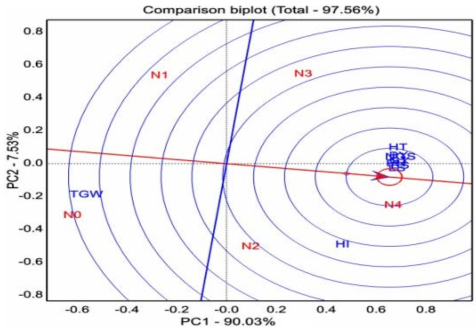

Fig. 4D. Comparison of N doses on means of components

The biplot analysis of the means over years for genotypes relationships among yield components (Figs. 5), the relationship between genotypes-components and components groups (Figs. 5A-5B), ranking of genotypes on components means (Fig. 5C), and comparison of components means of genotypes (Fig. 5D) accounted for 91.87% (77.48% and 14.39%, for principal components [PCs] 1 and 2, respectively) of the total variation.

The relationship between application N doses-components and grouping of components with doses: The nitrogen doses-components vectors and groups illustrate the specific interactions of each dose with each component (Figs. 4A, 4B, 4C, 4D). The biplot showed two groups that were highly correlated in terms of components means (Figs. 4A, 4B). Positive correlations were found among components without TGW, all components took places in(Group 1) and indicated by the acute angles (vector angles < 90°) of their respective vectors, while TGW in (Group 2) by the acute angles (vector angles > 90°). The relationships among doses, with regard to components, were observed. The biplot showed that majority of components means related with N4 application doses, while just N0 application doses related with doses (Figs. 4A, 4B) Thus, the biplot showed excellent discriminating ability in selecting specific component with particular doses and in recommending best application dose for each component.

Ranking and comparison of application nitrogen doses–components: The application dose with both high mean for components over years is called an ideal dose, and should have both high mean performances for all components (Figs. 4C, 4D). The application doses that are closer to the average axis (AEA) and are considered ideal application dose are more desirable than other dose. The ranking and comparison of application doses, based on t means of components over 2 years (Figs. 4C, 4D), showed that N4 was an ideal application dose. Some doses (N2, N3) performed favorably, as they were above the x-axis. On the other hand, some doses (N0, N1) were not desirable, as they were below the x-axis. The ranking and comparison of application doses based on component means of seasons (Figs. 4C, 4D) showed that N4 was ideal application for all components without TGW. The figure of biplot showed the best wives of to see the best application nitrogen doses for all components or each component.

The relationship between genotypes-components and grouping of components with genotypes: The genotypes-components vectors and groups illustrate the specific interactions of each genotype with each component over doses (Figs. 5A, 5B). The biplot showed two groups that were highly correlated in terms of components means (Figs. 5A, 5B). Positive correlations were found among components without NGS, all components took places in (Group 1) and indicated by the acute angles (vector angles < 90°) of their respective vectors, while NGS in (Group 2) by the acute angles (vector angles > 90°). The relationships among genotypes, with regard to components, were observed. The biplot showed that majority of components means related with Tokak 157/37 variety, while just Çetin-2000 related with NGS (Figs. 5A, 5B) Thus, the biplot showed excellent discriminating ability in selecting specific genotype with particular component and in recommending best genotype for all components or each component.

Ranking and comparison of genotypes–components over all doses: The genotype with both high mean for components over years is called an ideal genotype, and should have both high mean performances for all components (Figs. 5C, 5D). The genotypes that are closer to the average axis (AEA) and are considered ideal genotypes are more desirable than other genotype. The ranking and comparison of genotypes, based on means of components over 2 years (Figs. 5C, 5D), showed that Tokak 157/37 was an ideal genotype.

Two genotypes (Tarm 92, Çetin -2000) performed favorably, as they were above the x-axis. On the other hand, two genotypes (H-47 and Bülbül 89) were not desirable, as they were below the x-axis. The ranking and comparison of genotypes based on component means of seasons (Figs. 5C, 4D) showed that Tokak 157/37 was ideal application for all components without NGS. The figure of biplot showed the best wives of to see the best genotype for all components or each component.

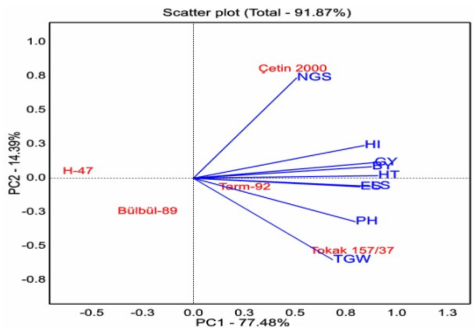

Fig. 5A. Relation among cultivars and mean of components

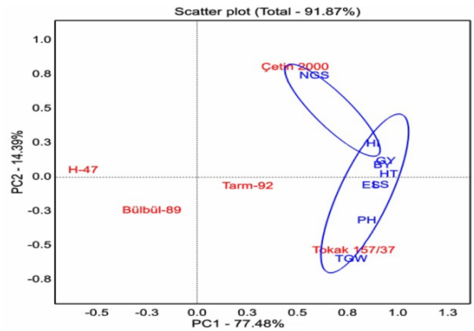

Fig. 5B. The grouping of components over cultivars

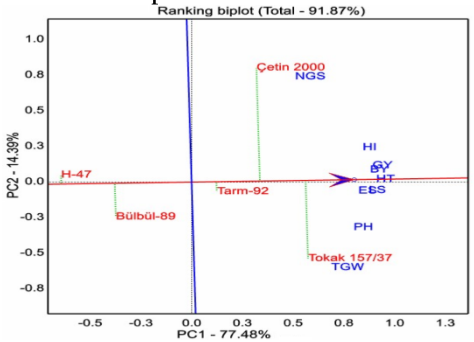

Fig. 5C. The ranking of cultivars over components

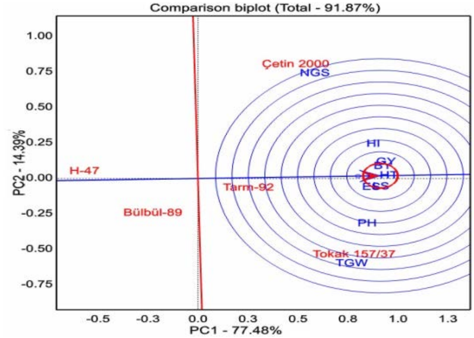

Fig. 5D. The comparison of cultivars over components

The regression analysis of component-application doses over years

The regression analysis showed positive or negative effect of nitrogen doses to genotypes or components in Figs. 3. For this purpose, the regression figures were obtained by analysis. In Fig. 3A-3M, the regression analysis nitrogen doses of grain yield and yield components showed that there was increasing linear performance for grain yield and all yield components in all cultivar as a function of the increase in the N doses. However, thousand grain weights were influenced negatively by application nitrogen doses as a function of decrease in the N doses (Fig. 3G).

DISCUSSION

The significant differences ($P<0.001$, $P<0.005$) found of the yield and yield components of the different years indicated the high influence of the year factor(Table 3), therefore the climatic conditions give a lead to high variable outputs in yield and it's all components every year. This results are accepted by Moreno at al. (2003), who proceed that the response of the barley to N fertilizer highly depend on growing seasons variations conditioned by environmental factors (Figs. 1 and 2). Climatic data of both growing season were indicated that the season of 2001/02 had more favorable climate conditions for barley growth, without more cold in winter and good rainfall in planting time (October, November) for early germination and for grain filling time occurs (April, May). On the other hand, the high temperature of grain filling time of 2002/03 season had negative affect to grain yield and it is components. The bad environmental conditions of grain filling occurs time is cause to reduce the grain yield and it's components. This is supported by Wallvork et al. (1998), who point that high temperatures have a strong effect on the structure of the mature barley grain and reducing its final weight.

According the results of the study, the application of nitrogen doses had positive effect on yield and yield components. The results increased in parallel with dose increase in all cultivars for all characters without TGW. The optimum N fertilizer doses to maximize barley yield and yield components are agreement with different studies (Moreno at al. 2003, Fallahi at al., 2008). There have been different studies described the positive effect of nitrogen doses on yield and yield components (Moselhy and Zahran, 2002; Alazmani, 2015). Nitrogen application had positive influence on all the yield components (Fallahi et al. 2008).

Heading time (HT) was affected by different N levels, years, cultivars and interactions. In the present study, the HT increased by increasing nitrogen doses and different climatic data of both years and all cultivars (Table 3, 4 and 5). The high rainfal and low temperature of HT of 2001/02 season, attributed to increasing HT, and so it was attributed positive effect on yield indirect, so the yield of N4 application doses was high than N0 doses. It was stated by Hadi et al. (2012), increase in number of time to spike by increasing N rate and it might be attributed to the increase in long time filling grain (Gürsoy, 2011;Shafi et al., 2011). Among the cultivars, Tokak 157/37 produced the latest HT, followed by Tarm 92. It can say that the HT of cultivars is more depend on genetic of cultivars.

Spike per square m^{-2} (SS) revealed that this component is significant affected by different N levels, years, cultivars and interactions. The study results showed that SS increased with parallel by increasing nitrogen doses and different climatic data of both years and genetic of cultivars (Table 3, 4 and 5). The high rainfal and low temperature of spike occurs period time in 2001/02 season, attributed to increasing ES, so the SS of N4 application doses was high than N0 doses. On the other hand, SS of 2001/02 was higher than 2002/03 depend on different climatic conditions. It was stated by Hadi et al. (2012), increase SS m^{-2} by increasing N rate and it might be attributed to increase the time of number spike. Among the cultivars, Tarm-92 produced the best SS followed by Tokak 157/37. It can say that the SS of cultivars is more depend on genetic of cultivars. So the six rows cultivars had high ES that of two rows (Table1)

Plant height (PH) was an important morphological character directly linked with the productive potential of plant in terms of grain yield. In the present investigation, PH increased by increasing nitrogen doses, different climatic conditions of both year and cultivars (Table 3, 4 and 5). The high rainfall of growing season of 2001/02 contributed positive effect PH, so the plant high of 2001/02 growing season was high than 2002/03. Similar results were reported in barley by Alazmani (2015) and Podsiadlo et al. (1999), in wheat. As stated by Hadi et al. (2012), increase in PH by increasing N rate might be attributed to the increase in vegetative of plant. Among the cultivars, Tokak 157/37 produced the tallest plant followed by Çetin 2000. The results of a study showed that increase in PH by increasing N rate might be attributed to the increase in internodes length and vegetative of plant since the number of internodes is greatly influenced by the genetic makeup of the plant (Subhan et al. 2004).

Spike length (SL) was affected by different N levels, years, cultivars and N x C interactions. In the present study, the LE increased by increasing nitrogen doses and different climatic data of both years and all cultivars (Table 3, 4 and 5). The high rainfall and low temperature of 2001/02 season, attributed to increasing SL, and so it was attributed positive effect on yield direct, so the yield of N4 application doses was high than N0 doses. The results of SL showed that increase in SL by increasing N rate and available environmental condition of growing season. Similar results were reported in barley by Gürsoy (2011) and Shafi et al. (2011), in wheat On the other hand; among the cultivars, Tokak 157/37 produced the longest SL, followed by Çetin-2000. It can say that the SL of cultivars is more depend on genetic of cultivars.

Number of grains per spike (NGS) indicated that this component is significant affected by different N levels, years, cultivars and N x C interactions. The study results showed that NGS increased with parallel by increasing nitrogen doses and different climatic data of both years and genetic of cultivars (Table 3, 4 and 5). The high rainfal and low temperature of grains occurs period time of 2001/02 season, contributed to increasing NGS, so the NGS of N4 application doses was high than control and other application doses. On the other hand, NGS of 2001/02 was haigh than 2002/03 depend on different climatic conditions (Figs.1 and 2). It was stated by Subhan et al. (2004) and Shafi et al. (2011), increase NGS by increasing N rate and it might be attributed to increase the time grain occurs. The results showed that among the cultivars, Çetin-2000 produced the best NGS followed by Tokak 157/37. It can say that the NGS of cultivars is more depend on genetic of cultivars. So, the six rows cultivars had high NGS that of two rows (Table1).

Thousand grain weight (TGW) showed that this quality parameter is significant affected by different N levels, years, cultivars and N x C interactions. The results of study showed that TGW decreased with parallel by increasing nitrogen doses and different climatic data of both years and genetic of cultivars (Table 3, 4 and 5). The high rainfall and low temperature of grain filling period of 2001/02 season, contributed to decreasing TGW, so the TGW of N0 control doses was high than N application doses. On the other hand, TGW of 2002/03 was higher than 2001/02 depend on different climatic conditions (Figs.1 and 2). It was stated by Hadi et al. (2012) and Yesmin at al. (2014), increasing N rate and it might be attributed to increase the grains per spike, this is decreasing TGW. The results showed that among the cultivars, Tokak 157/37 produced the best TGW followed by Tarm 92. It can say that the TGW of cultivars is more depend on genetic of cultivars, and similar comments stated by different studies (Gürsoy, 2011;Kizilgeci at al., 2016).

Harvest index (HI) demonstrated that this parameter is significant affected by years, cultivars and N x C interaction and Y x N x C triple interactions. The results of study showed that HI decreased with different climatic data of both years and genetic of cultivars (Table 3, 4 and 5). The high rainfal and low temperature of period of 2001/02 season, contributed to increasing HI, so the HI of 2001/02 season was high than 2002/03(Figs.1 and 2). HI of 2002/03 was haigh than 2001/02 depends on different climatic conditions. It was stated by Alam et al. (2007) and Yesmin et al. (2014), increasing N rate and it might be attributed to increase the biological and grain yield, and this is increasing or decreasing HI in different growing season. On the other hand, The results showed that Çetin-2000 produced the best HI followed by Tokak 157/37. It can say that the HI of cultivars is more depend on genetic of cultivars and different of climatic condition. So, the six rows cultivar had high HI in 2001/02, while two rows barley variety had high HI in 2002/03 (Table1, 4, 5).

Biological yield (BY) indicated that this component is significant affected by N application doses, years, cultivars and Y x N x C triple interactions. The results of study showed that BY increased with N application doses in parallel and different climatic data of both years and genetic of cultivars (Table 3, 4 and 5). The high rainfal and low temperature of period of 2001/02 season, contributed to increasing BY, so the BY of 2001/02 season was high than 2002/03(Figs.1 and 2). Moreover, BY of N4 application doses was haigh than control (N0) and other application doses. It was stated by Gürsoy (2011) and Hadi et al. (2012), increasing N rate and it might be attributed to increase the grains per spike and plant height, and this is increasing the BY. On the other hand, The results showed that Tokak 157/37 produced the best BY followed by Çetin-2000 and Tarm-92 cultivars. It can say that the BY of cultivars is more depend on genetic of cultivars and different of climatic condition. So, the two rows cultivar had high BY in 2001/02, while six rows barley variety had high BY in 2002/03 (Table1, 4, 5).

Grain yield (GY) demonstrated that it is significant affected by N application doses, years, cultivars and N x C interaction. The results of study showed that GY increased with N application doses in parallel and different climatic data of both years and genetic of cultivars (Table 3, 4 and 5). The high rainfall and low temperature of period of grain occurs time in 2001/02 season, contributed to increasing GY, so the GY of 2001/02 season was high than 2002/03(Figs.1 and 2). Moreover, GY of N4 application doses was haigh than control (N0) and other application doses. It was stated by Subhan et al. (2004), Fallahi et al. (2008), Yesmin et al. (2014) and Alazmani (2015), Yildirim et al. (2016), increasing N rate and it might be attributed to increase the grains per spike, and this is increasing GY. On the other hand, The results showed that Tokak 157/37 produced the best GY followed by Çetin-2000 and Tarm-92 cultivars in 2001/02. It can say that the GY of cultivars is more depend on genetic of cultivars. So, the two rows cultivar had high GY both of season (Table1, 4, 5).

GGE Biplot Analysis

The GGE biplot method has been widely used to analyze the stability and performance of the genotypes for yield and other components (Yan and Rajcan, 2002; Goyal et al., 2011; Sabaghnia and Janmohammadi, 2014). The GGE biplot mainly allows the visualization of any crossover GE interaction, which is very important for the breeding program (Güngör and Akgöl, 2015; Sayar and Han, 2015; Kendal et al., 2016;). The GGE biplot method provides considerable flexibility, allowing plant breeders to simultaneously select for yield and stability (Rubio et al., 2004; Kilic et al., 2016). Moreover, GEI and yield stability analyses are important for their consideration of both varietal stability and suitability for cultivation across seasons and ecological circumstances (Adjabi et al., 2014). The GT (genotype-trait) biplot provides an excellent tool for visualizing genotype × trait data (Adjabi et al., 2014).

The GGE biplot could be used to interpret the relationships among nitrogen doses, components, and groups of component (Figs. 4). An understanding of the relationship between doses and components can aid in better understanding doses objectives and in identifying components that are positively or negatively correlated with nitrogen doses. This understanding can also aid in identifying components that can be indirectly selected by selecting for correlated components. It also helps to visualize the strengths and weaknesses of nitrogen doses, which is important for application in barley. If the angle of the vector was less than 90°, there was a positive correlation two observation factors. If the angle was equal to 90°, they were not correlated. There was a negative correlation if the angle was less than 90° (Yan and Thinker, 2006; Sabaghnia, 2015). The results of study showed that there is high positive correlation among large components and N application doses; while negative correlation with TGW in barley (Fig. 4A and Fig. 4B).The results of component was increase depend on application N nitrogen doses, while TGW was decrease (Table 5).Therefore, all components took place in a first group, except TGW in second. There is high correlation which is took places in same group (Kendal et al., 2016).On the other hand; the GGE biplot was accurate in interpreting the ranking and comparing genotypes and traits (Fig. 4C and Fig. 4D). The doses with both high mean performance and high stability for all of the components were called an ideal dose. The center of the concentric circles (i.e., ideal dose) was the AEA in the positive direction. Doses located closer to the ideal dose were more desirable than others (Yan &Tinker, 2006; Dogan et al., 2016). The result demonstrated that N4 was ideal application dose in the both season, as it was in the center circle for the ideal doses and on the AEA (Fig. 4C). N4 dose was the ideal dose for means over the two seasons, as it was closer to the ideal dose center on the AEA (Fig. 4D).

The GGE biplot could be used to interpret the relationships among cultivars, components, and groups of component (Figs. 4). An understanding of the relationship between cultivar and components can aid in better understanding cultivar objectives and in identifying components that are positively or negatively correlated with cultivars and each other. This understanding can also aid in identifying components that can be indirectly selected by selecting for correlated cultivars. It also helps to visualize the strengths and weaknesses of cultivars, which is important for selection in different environmental seasons. If the angle of the vector was less than 90°, there was a positive correlation two observation factors. If the angle was equal to 90°, they were not correlated. There was a negative correlation if the angle was less than 90° (Yan & Thinker, 2006). The results of study showed that there is high positive correlation among large components and large variation among cultivars (Fig. 5A and Fig. 5B).The results of cultivars was varied depend on genetic factor (Table 5). Therefore, all components took place in a first group with Tokak 157/37, Çetin-2000 with NGS in second. There is high correlation among components and cultivars which are took places in same group (Kendal et al., 2016).On the other hand; the GGE biplot was accurate in interpreting the ranking and comparing genotypes and traits (Fig. 5C and Fig. 5D). The doses with both high mean performance and high stability for all of the components were called an ideal cultivar. The center of the concentric circles (i.e., ideal cultivar) was the AEA in the positive direction. Cultivars located closer to the ideal cultivar were more desirable than others (Yan et al., 2000; Dogan et al., 2016). The result demonstrated that Tokak 157/37 was ideal cultivar in the both season for more components, as it was in the center circle for the ideal cultivar and on the AEA (Fig. 5C). Tokak 157737 was the ideal cultivar for means over the two seasons, as it was closer to the ideal cultivar center on the AEA (Fig. 5D).

CONCLUSIONS

The nitrogen application doses had positive effect on grain yield and yield components except thousand grain weight. Therefore, the values of component and grain yield increased in parallel with application nitrogen doses, while decreased in thousand grain weight. The nitrogen dose of N4 (40 kg ha^{-1}) are responsible for the maximum productivity of barley crop in Van environmental conditions. Tokak157/37 showed that it is best cultivar for more components and grain yield except TGW. On the other hand; GGE biplot analysis revealed that this analysis provided useful results and high image quality to show the correlation among doses, cultivars and components. The results of study recommended that the N application of doses in barley should be increased in next dose application studies to see the quadratic results of doses.

REFERENCES

Adjabi, A., Bouzerzour, A and Benmah, A. (2014). Stability analysis of durum wheat (Triticum durum desf.) grain yield. J. of Agr., 13(3):131-139.

Alam, M. Z., Haider, S.A and Paul, N. K. (2007).Yield and yield components of barley (Hordeum vulgare L.) cultivars in relation to nitrogen fertilizer. Journal of Applied Sciences Research, 3(10): 1022-1026, 2007.

Alazmani, A.(2015). Evaluation of yield and yield components of barley varieties to nitrogen. International Journal of Agriculture and Crop Sciences. IJACS/2015/8-1/52-54.

Anonymous. (2002). SAS, Institute. JMP Statistics. Cary, NC, USA: SAS Institute, Inc., 707 p.

Asfaw, A., Alemayehu, F, Gurum, F and Atnaf, M. (2009). AMMI and SREG GGE biplot analysis for matching varieties onto soybean production environments in Ethiopia, Scientific Res. and Essay Vol. 4(11) pp. 1322-1330, 2009.

Dogan, Y., Kendal, E and Oral, E. (2016). Identifying of relationship between traits and grain yield in spring Barley by GGE biplot analysis. The Journal "Agriculture and Forestry", 62(4), 239-252.

Fallahi, H.A., Nasseri, A and Siadat, A. (2008). Wheat yield components are positively influenced by nitrogen application under moisture deficit environments, Int. J. Agri. Biol., Vol. 10, No. 6, 2008.

Farshadfar, E., Rashidi, M., Jowkar, M.M and Zali, H. (2013). GGE Biplot analysis of genotype × environment interaction in chickpea genotypes. European J. of Exper. Biology, 3(1): 417-423.

Filho, M.C.M.T, Buzetti, S., Andreotti, M and Arf, O. (2011). Eustáquio de Sá M.. Application times, sources and doses of nitrogen on wheat cultivars under no till in the Cerrado region. Santa Maria, 41(8), p: 1375-1382.

Goyal, A., Beres, B.L., Randhawa, H.S., Navabi, A., Salmon, D.F and Eudes, F. (2011). Yield stability analysis of broadly adaptive triticale germplasm in southern and central Alberta. Canadian J. Plant Sci., 91: 125-135.

Gungor, H and Akgol, B. (2015). Evaluation of yield and quality traits of durum wheat genotypes by biplot analysis method under kirklareli ecological conditions, Turkish J. of Agr. and Nat. Sci., Vol 2(3): 56–267.

Gursoy, M. (2011). Effects of different nitrogen doses on yield and quality components in some two-rowed barley (Hordeum vulgare L.) lines and cultivars. Journal of New World Sciences, Vol: 6 (4): 114-123.

Hadi, F., Arif, M and Hussain, F. (2012). Response of dual purpose barley to rates and methods of nitrogen application. ARPN Journal of Agricultural and Biological Science, Vol. 7 (7):533-539.

Kendal, E and Sayar, M.S. (2016). The stability of some spring triticale genotypes using biplot analysis, The Journal of Animal & Plant Sciences, 26(3): 2016, Page:754-765 ISSN: 1018-7081

Kendal, E., Sayar, M.S., Tekdal, S., Aktas, H and Karaman, M. (2016). Assessment of the impact of ecological factors on yield and quality parameters in triticale using GGE biplot and AMMI analysis. Pak. J. Bot., 48(5): 1903-1913.

Kendal, E. (2016). GGE Biplot analysis of multi-environment yield trials in barley (Hordeum vulgare L) cultivars, Ekin J. of Crop Breeding and Genetics, (2016) 2-3:90-99.

Kilic H, Aktas H, Erdemci, I, Yazar S, Dönmez E, Kaya Y, Taner S, Akcura M, Oztürk I, Bolat N, Cakmak M, Yildirim M, Bayramoğlu H O.2016. Assessment of yield and some quality characters of winter bread wheat (Triticum aestivum L.) genotypes under Diyarbakir conditions, Turkish J. of Nat. and Sci., Vol. 5 (2), p:6-11.

Kilic, H. (2014). Additive main effect and multiplicative interactions (AMMI) Analysis of grain yield in barley genotypes across environments, J. Agr. Sc. 20,337-344.

Kizilgeci, F., Yildirim, M., Albayrak, O and Akinci, C. (2016). Investigation of yield and quality parameters of barley genotypes in Diyarbakir and Mardin conditions. Iğdir Univ. J. Inst. Sci. & Tech. 6(3): 161-169.

Mangel, K and Kirby, EA. (1979). Principles of plant nutrition. 2nd edition. International potash institute, Berne, Switzerland, pp: 295-296.

Moreno, A., Moreno MM, Ribas F and Cabello MC. (2003). Influence of nitrogen fertilizer on grain yield of barley (Hordeum vulgare L.) under irrigated conditions.

Moselhy, E.I, Zahran, M.A. (2002). Effect of bio and mineral nitrogen fertilization on barley crop grown on a sandy soil. Egypt. J. Agric. Res., 3: 921-936.

Podsiadlo, C., Koszanski, Z and Zbiec, I.I. (1999). Response of some spring barley cultivars to irrigation and mineral fertilization. Part II. Canopy architecture and yield structure. Folia Univ. Agril. Stetinensis, Agr., 73: 131-137.

Przuli, N., Momcilović, V., Simić, J and Mirosavljević, M. (2014). Effect of growing season and variety on quality of spring two-rowed barley. Genetika 46: 59-73.

Rubio, J., Cubero, J. I., Martin, L. M., Suso, M. J., & Flores, F. (2004). Biplot analysis of trait relations of white lupin in Spain. Euphytica, 135(2), 217-224.

Sabaghnia, N., & Janmohammadi, M. (2014). Interrelationships among some morphological traits of wheat (Triticum aestivum L.) cultivars using biplot. Botanica Lithuanica, 20(1), 19-26.

Sabaghnia, N. (2015). Investigation of some morphological traits in studied lentil (Lens culinaris Medik.) genotypes grown with foliar application of nanosized ferric oxide. Annales UMCS, Biologia, 69(2), 29-38.

Sayar, M.S, Anlarsa, A.E., Basbag, M. (2013). Genotype–environment interactions and stability analysis for dry-matter yield and seed yield in Hungarian vetch (Vicia pannonica CRANTZ.). Turkish J. of F. Crops, 18(2): 238-246.

Sayar, M.S and Han, Y. (2015). Determination of seed yield and yield components of grasspea (Lathyrus sativus L.) lines and evaluations using GGE biplot analysis method, Tarim Bilimleri Der- J. of Agric. Sci., 21(1): 78-92.

Shafi, M., Bakht, J., Jalal, F., Aman Khan, M and Gul Khattak, S. (2011). Effect of nitrogen application on yield and yield components of barley (Hordeum vulgare L.) Pak. J. Bot., 43(3): 1471-1475.

Steel, G.D and Torrie, J.H. (1980). Principles and Procedures of Statistics: A Biometrical Approach. 2. ed. New York: McGraw-Hill Publ. Company

Subhan, W., Anwar, M., Ahmad, N., Gulzar, A., Siddig, M., Rahman, S., Ahmad, I., Rauf, A. (2004). Effect of gamma raiadtion on growt and yield of barley under different nitrogen levels.Pakistan Journal of Biologicial Sci. 7(6):981-983.

Yan, W.L., Hunt, A., Sheng, Q and Szlavnics, Z. (2000). Cultivar evaluation and mega-environment investigation based on the GGE biplot, Crop Sci. 40: 597-605.

Yan, W and Tinker, N.A. (2006). Biplot analysis of multi-environment trial data; Principles and applications, Canadian Journal of Plant Science 86, 623-645.

Wallwork, M.A.B., Logue, S.L., McLeod, L.C., Jenner, C.F.(1998). Effect of the high temperature during grain filling on the grain growth characteristics and malting quality of three Australian malting barleys. Aust. J.Agric. Res. 49(8), 1287-1296.

Yildirim, M., Ykut, Z., Akinci, C., Kurt, F and Kizilgeci, F. (2016). Nitrogen rate and timing implementation on durum wheat in a bed planting system, Sains Malaysiana, 45(2)(2016): 221–228.

Yan, W., & Rajcan, I. (2002). Biplot analysis of test sites and trait relations of soybean in Ontario. Crop Science, 42(1), 11-20.