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Effects of Increasing Levels of N Fertilization on Yields and Nutrient Content of Different Barley Varieties Grown under Arid Condition

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Abstract: The aim of this study was to evaluate the effects of N levels on chemical composition and energy content of different barley varieties grown under north Anatolian arid condition. Experiment was established as a split-plot design in a randomized complete block, with three replications. Five different winter type barley varieties (Bülbül 89, Tarm 92, Tokak 157/37, Yesevi 93 and Aday 1) were utilized. Five nitrogen levels (0, 45, 90, 135 and 180 kg ha^{-1}) were also applied to each variety. Barley were harvested by hand using a clipper and air-dried. Then, grains were separated from straw and yields were determined. Grains were analyzed for DM, OM, CP, CF, EE, and IVOMD. NFE, ME, NEL values were also calculated. N fertilization had significant effect on concentrations of CP, CF, EE, total and grain yields ($p<0.01$). The concentrations of DM, CP, CF, NFE and IVODM and total yields were significantly different among barley varieties ($p<0.05$). In conclusion, approximately 90 kg N/ha seemed to be most proper N levels in general Tokak 157/37, Tarm 92, and Bülbül 89 varieties seemed to be most consistent varieties for the region.

Key words: Barley, nitrogen fertilization, *in vitro* digestibility, energy content

INTRODUCTION

Barley is the second most commonly grown cereal grain following wheat in the world and Turkey among cool-season cereal grains. Even though barley have been used for human nutrition nowadays, it is commonly grown for mainly two reason; to fed animal and to produce beer in Turkey[1]. Barley is an excellent feed grain for most livestock species. Barley is the principle grain ingredient of feeds in the world where corn is not suitable for the production[2] .

Barley has a special importance for north Anatolia of Turkey, because major income of people in this region depends on farming, especially animal production. Unfortunately, average yield of barley (kg/hectare, ha) grown in Van region is almost half of Turkey average[3]. Climate, problems associated with sowing, type of barley planted and fertilization are some of the factors causing low yield in the region[4].

There is no special barley type or variety adapted for the region. Barley is generally planted in spring. However, barley yield is very low when planted in spring because rainfall is short and not well distributed during spring and summer[5]. Yilmaz *et al.*,[6] reported that yields of different barley varieties were 695.0-1355.0 g kg^{-1} when planted in spring and fall respectively in Van. These differences among barley yields clearly show the effect of planting time and variety.

The influence of amount and availability of mineral nutrients on plant production and quality has been reviewed by Minson[7]. Of all the nutrients, N has the greatest impact on plant growth[8]. In deed, many researches have reported that application of N up to certain levels increased barley yield (9,10, 11 and 12).

Fertilizer nutrients are applied to crops to increase yield by correcting deficiencies in the soil. Application of fertilizer can have both direct and indirect effects on animals by inducing chemical, morphological, or physiological changes in plants. Main chemical change in plant is usually to raise the crude protein concentration of non-legume plants[8]. Therefore, the objective of this study was to evaluate the effects of N levels on chemical composition and energy content of different barley varieties grown under north Anatolian arid condition.

MATERIALS AND METHODS

This experiment were carried out in Van, where is at border of Turkey-Iran and 1725 m above sea level. Van receives approximately 378 mm precipitation per year (mainly as snow in winter). It receives approximately 30 d snow-fall and snow stay 81 d on ground[5]. Soil

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Table 1: Temperature and precipitation values of Van in 2001-3 year(*)

	Average Temperature (°C)			Average Precipitation (mm)		
Months	Average	2001-2	2002-3	Average	2001-2	2002-3
September	17.0	18.1	17.0	6.78	6.4	16.4
October	10.5	12.8	13.0	48.80	58.8	23.6
November	4.2	5.3	4..5	56.28	49.8	59.6
December	1.1	-2.6	N/A	32.82	72.9	N/A
January	-3.8	-3.3	-1.4	39.45	30.8	26.1
February	-3.2	-0.8	-1.4	33.14	7.7	54.5
March	0.6	3.4	0.1	51.01	3.4	83.4
April	6.9	6.9	8.4	42.41	107.4	78.8
May	12.8	12.3	14.5	60.63	54.8	6.4
June	17.8	17.9	18.2	19.41	20.4	50.2
July	21.9	22.6	23.1	3.88	3.1	-
August	21.7	22.2	22.8	8.07	-	15.7
Total average	9.0	9.6	10.8	402.7	415.5	414.7

* Van Meteorology data, Anonymous, (2001-2003)

experiment has slightly alkaline, organic matter concentration is low, but phosphorous level is moderate. It is a sandy-clay type soil.

Experiment was established as a split-plot design in a randomized complete block, with three replications. Five different winter type barley varieties (Bülbül 89, Tarm 92, Tokak 157/37, Yesevi 93 and Aday 1) were selected and are assigned to subplots within each main plot. Five nitrogen levels (0, 45, 90, 135, and 180 g kg^{-1}) were also applied and nitrogen were supplied as ammonium nitrate at given levels to main plots.

Each plot was 5.0 m long and 1.6 m wide, a total of 8 m^2 and included 8 rows with 20 cm inter row spacing[13]. The barley plots were planted on 21 September 2001 and each variety was randomly assigned to three replications. The barley was seeded at 400 seed per m2[13]. All of the barley plots were fertilized with 40 kg P_2O_5 per hectare (ha) at planting.

To eliminate side effect, all of barley plant from each side (50 cm) of each plot were excluded and then, remaining barley plants were sampled for determination of yield and other analysis. Barley was harvested by hand using a clipper on 25 June 2002 and 2-3 d air-dried. Then, grains were separated from straw and yields were determined. Dry matter (DM) of samples were determined by oven drying of triplicate sub-samples at 65°C for 72-h, after an air-drying[14].

Dried samples were ground to pass through a 1 mm screen before analysis. Ash concentrations of samples were determined in a muffle furnace at 550°C for 8 h. All samples were analyzed for crude protein (CP) by Kjeldahl procedure, ether extract (EE) and crude fiber (CF; 14). Concentrations of organic matter (OM) and nitrogen free extract (NFE) were calculated. *in vitro* organic matter digestibility (IVOMD) of samples were determined by the procedure of Tilley and Terry[15], as modified by Marten and Barnes[16]. Ruminal ingesta from an alfalfa-fed ruminally fistulated ram was hand-collected and strained through four layers of cheesecloth to provide the innocula for IVOMD determination. Metabolizable energy (ME, Mcal/kg) and net energy for lactation (NEL, Mcal/kg) values were calculated using following equations.

$$ME, (Mcal\ kg^{-1}) = Digestible\ energy \times 0.82, (17)$$

$$NEL, (Mcal\ kg^{-1}) = 0.00245 \times digestible\ energy,\ kg - 0.12, (18)$$

Statistical analysis: All data were subjected to analysis of variance for completely randomized design using the GLM procedure of SAS[19].

RESULTS

Temperature and precipitation values of region are presented in Table 1. Both temperature value and amount of precipitation from March to June were higher for second year compared with first year[20].

Chemical composition, total plant and grain yields, IVOMD and energy values of barley varieties are presented in Table 2, 3 and 4 for year 1, year 2 and average of two years, respectively. Concentrations of DM were significantly differed among barley varieties in both years ($p<0.01$) and were approximately 90 %. Average OM and EE concentrations were similar among varieties and not affected by N levels ($P>0.05$). Crude fiber concentrations were different among barley varieties and affected by N level in first year and average ($p<0.05$), but not in second year. Both concentrations of CP and NFE were significantly different among barley varieties ($p<0.05$). While concentration of CP linearly decreased, concentration of NFE linearly increased with increasing N level.

Total plant (straw + grain) yields were significantly different among barley varieties. Total plant yields were affected by both N level and year ($p<0.01$). Grain yields

Table 2: Effects of increasing levels of N fertilization on nutrient contents and yields of different winter type barley varieties harvested first year (2001-2002)

Variety	N Level	DM	Ash	OM	CP	CF	EE	NFE	IVOMD, % OM	ME, Mcal /Kg	NEL Mcal /Kg	Total Yield	Grain Yield	CP Yield	IVOMD Yield	Cal/Kg Yield	ME NEL Yield
Tokak	No	90,91	2,07	97,93	8,68	4,91	2,02	82,33	85,27	3,08	1,97	756,93	306,27	26,62	261,20	944,34	603,19
157/37	N1	90,94	1,97	98,03	10,37	4,83	2,01	81,26	87,20	3,15	2,02	1324,97	340,77	35,42	297,12	1074,18	687,04
	N2	91,18	1,98	98,02	10,37	4,57	2,05	81,14	84,75	3,64	1,95	1416,67	543,97	56,16	461,40	1668,15	1065,17
	N3	91,27	2,14	97,86	12,25	4,70	2,08	78,84	86,23	3,12	1,99	1415,23	462,60	56,65	399,54	1444,49	923,36
	N4	91,13	1,84	98,16	13,50	5,16	2,23	77,26	86,64	3,13	2,00	1209,70	393,70	52,92	340,92	1232,56	788,07
Tarm	No	92,37	2,41	97,59	7,28	4,38	2,08	83,85	87,30	3,15	2,02	895,83	284,57	20,92	248,17	897,25	573,88
92	N1	92,07	2,46	97,54	7,78	3,76	2,23	83,75	87,90	3,18	2,03	1472,93	597,77	46,45	525,14	1898,59	1214,87
	N2	92,08	2,40	97,60	10,6	94,18	2,02	80,71	86,92	3,14	2,01	1277,77	490,30	51,87	428,04	1547,52	989,86
	N3	92,08	2,25	97,75	10,9	14,42	20,1	78,82	86,44	3,13	2,00	1133,33	323,00	35,26	279,15	1009,25	645,17
	N4	92,02	2,19	97,81	12,47	4,96	2,05	78,33	88,92	3,22	2,06	1323,63	427,43	53,43	379,79	1373,10	409,45
Bülbül	No	91,02	2,43	97,5	77,75	5,00	2,02	82,81	88,9	63,15	2,01	973,603	50,03	27,13	304,68	1101,54	704,44
89	N1	91,03	2,56	97,44	9,03	4,57	2,01	81,83	87,97	3,18	2,03	1311,10	447,03	40,37	393,50	1422,64	910,43
	N2	91,48	2,01	97,99	10,0	44,94	2,05	80,96	89,17	3,22	2,06	1437,50	506,60	50,98	452,06	1634,37	1046,75
	N3	91,15	1,81	98,19	10,4	55,08	2,08	80,58	88,04	3,18	2,04	1447,20	523,43	54,79	460,68	1665,55	1065,86
	N4	91,01	2,47	97,53	13,70	6,10	2,23	75,50	87,84	3,17	2,03	1404,17	475,53	65,28	417,73	1510,26	966,38
Yesevi	No	90,62	2,00	98,00	7,70	4,09	2,02	84,19	85,13	3,08	1,96	1031,93	393,03	30,27	334,35	1208,81	771,99
93	N1	90,52	2,00	98,00	8,82	3,75	2,01	84,42	86,42	3,05	1,95	1419,43	521,57	11,64	439,89	352,19	225,14
	N2	90,61	1,75	98,25	10,44	3,90	2,08	81,42	84,35	3,18	2,04	1466,70	490,07	46,02	430,74	1590,37	1015,14
	N3	91,30	1,67	98,33	11,14	4,92	2,23	80,04	84,38	3,05	1,95	1238,90	437,47	48,59	369,29	2335,11	582,25
	N4	91,05	2,35	97,64	15,00	4,13	2,02	76,50	85,16	3,08	1,97	1298,63	367,20	55,07	312,91	1131,28	722,56
Aday 1	No	90,27	2,11	97,89	8,17	4,00	2,01	83,71	86,03	3,11	1,99	1055,57	434,03	35,47	373,36	1349,85	862,65
	N1	90,95	2,33	97,67	9,33	4,17	2,05	82,12	87,56	3,17	2,03	1361,10	522,37	48,65	457,33	1653,42	1057,77
	N2	90,72	2,26	96,74	10,01	4,29	2,02	80,42	81,79	2,96	1,88	1180,53	351,23	35,01	286,43	1035,54	659,59
	N3	90,67	1,81	98,19	11,42	3,91	2,01	80,85	87,12	3,15	2,01	1027,80	517,13	58,85	450,53	1628,84	1041,74
	N4	90,44	1,91	98,09	13,83	4,87	2,05	77,72	85,49	30,9	1,98	1326,40	339,47	46,93	290,25	1049,35	670,36
Average																	
Significance																	
Variety		0,01	0,20	0,20	0,01	0,01	0,79	0,06	0,04	0,04	0,04	0,14	0,01	0,02	0,01	0,01	0,01
N Leve		l0,6	0,44	0,44	0,01	0,02	0,41	0,01	0,87	0,87	0,87	0,01	0,01	0,01	0,01	0,01	0,01
VxL		0,5	0,37	0,37	0,3	0,83	0,31	0,47	0,52	0,52	0,52	0,04	0,01	0,01	0,01	0,01	0,01

were significantly different each year ($p<0.01$), but average gain yields were similar among barley varieties ($p>0.05$). Similarly, grain yields were affected by both N levels and year ($p<0.01$). While effect of N level was quadratic in first year, it was linear in second year for both total plant and grain yields.

in vitro OM digestibilities, ME, Mcal/kg and NEL, Mcal kg^{-1} concentrations were significantly different among barley varieties and were generally greater in first year compared with second year ($p<0.01$).

While average CP yields (g kg^{-1}) differed ($p<0.01$), yields of IVDMD, ME, and NEL were similar among varieties ($p>0.05$; Table 3). All of these parameters were significantly affected by N level and year ($p<0.01$).

DISCUSSION

The major goal of this work was to determine the optimal N level and proper barley variety/ies grown under north Anatolia condition based on grain yield and nutrient content of barley varieties.

Dry matter concentrations of barley varieties were significantly different ($p<0.05$) in each year and average. Average DM percentages of all barley varieties were over 90%, indicating full maturity. Average OM and EE concentrations were similar ($p>0.05$) among barley varieties and were not affected by N levels. Average OM and EE concentrations ranged from 97.23 to 98.26 % and from 2.00 to 2.23 %, respectively, which are in agreement with the values reported in the literature (2, 21). Average crude fiber concentrations of Yesevi 93 and Aday 1 were significantly lower compared with other three varieties. The highest CF concentrations were observed at the highest N level. As N fertilization increases, a number of tiller increase. Thus, number of empty grain per seed increase with increasing levels of N, resulting in higher concentration of CF (22, 23). Crude protein concentrations significantly differed among barley varieties and linearly increased with increasing levels of N fertilization ($p<0.05$). It is well known that there are big differences in chemical composition of same plant varieties[24]. One of the major effects of N fertilization is to increase CP concentration of plant. Nitrogen is primarily absorbed as nitrate, but it can also be absorbed as ammonium. Nitrogen is rapidly taken up by plant roots. Most of absorbed N is used in the synthesis of protein in a process involving reduction of nitrate to ammonium before incorporation into amino acids. The major portion of non-protein N, about 10 to 30% of the total N, is comprised of amino acids. Normally, nitrate concentration is low in plants, but can cause accumulation of toxic levels of nitrate for livestock due to bad environmental conditions that restrict growth of

Table 3: Effects of increasing levels of N fertilization on nutrient contents and yields of different winter type barley varieties harvested second year (2002-2003).

Variety	N Level	DM	Ash	OM	CP	CF	EE	NFE	IVOMD, % OM	ME, Mcal /Kg	NEL Mcal /Kg	Total Yield	Grain Yield	CP Yield	IVODM Yield	ME Yield	NEL Yield
Tokak 157/37																	
	No	92,20	2,32	97,68	9,47	4,47	2,07	81,87	83,56	3,08	1,93	610,00	122,00	11,52	101,96	368,63	235,16
	N1	92,09	2,06	97,94	10,95	4,86	2,12	80,00	85,96	3,11	1,97	856,67	171,33	18,79	147,38	532,84	340,52
	N2	92,20	1,84	98,16	12,59	3,90	1,98	79,69	84,73	3,06	1,97	926,67	185,33	23,44	156,96	567,47	362,31
	N3	92,21	2,11	97,87	14,52	5,16	2,06	76,14	87,43	3,16	2,02	846,67	169,33	21,68	148,02	535,15	342,33
	N4	92,19	2,21	97,79	13,65	4,85	2,02	77,27	83,88	3,03	1,94	1203,33	240,67	32,89	201,93	730,04	465,84
Tarm 92	No	91,24	2,20	97,80	9,25	4,78	2,04	81,73	87,42	3,16	2,02	503,33	100,67	9,29	87,97	318,05	92203,45
	N1	90,96	20,5	97,95	9,76	4,57	2,12	81,49	89,30	3,22	2,07	723,33	144,67	14,13	129,18	467,04	299,13
	N2	91,41	202	97,98	11,65	4,00	2,19	80,13	86,79	3,14	2,01	723,33	144,67	16,82	125,53	453,82	290,18
	N3	90,50	1,84	98,16	12,80	4,50	2,04	78,82	87,43	3,16	2,02	846,67	169,33	21,68	148,02	535,15	342,33
	N4	90,94	1,83	98,16	13,73	4,39	2,12	77,92	89,91	3,25	2,08	983,33	196,67	27,00	176,76	639,04	409,45
Bülbül 89	No	90,97	2,14	97,86	8,82	4,57	2,02	82,63	84,26	3,04	1,94	466,67	93,33	8,28	78,72	284,61	181,67
	N1	91,06	2,00	98,00	11,99	4,34	2,01	79,66	83,88	3,03	1,74	573,30	114,67	13,74	96,28	348,10	222,14
	N2	90,81	2,09	97,91	13,25	4,39	2,05	78,22	86,11	3,11	1,99	766,67	153,33	20,30	132,00	477,26	305,02
	N3	90,49	1,93	98,07	11,99	3,95	2,08	80,04	83,66	3,03	1,93	833,33	166,67	20,00	139,35	503,79	321,40
	N4	90,84	1,94	98,06	12,65	4,80	2,23	78,37	86,87	3,14	2,01	990,00	198,00	24,95	172,24	622,72	398,23
Yesevi 93	No	91,25	2,08	97,92	9,32	4,41	1,99	82,19	84,21	3,04	1,94	516,67	103,33	9,62	86,99	314,51	200,73
	N1	91,45	2,06	97,94	10,31	4,16	2,02	81,44	86,42	3,12	2,00	563,33	112,67	11,64	97,41	352,19	225,14
	N2	90,70	1,82	98,18	13,51	4,79	2,00	77,89	82,66	3,99	1,91	676,67	135,33	18,27	111,87	404,46	257,85
	N3	91,75	1,81	98,19	14,07	4,35	2,06	77,72	83,96	3,03	1,94	706,67	141,33	19,88	118,65	428,98	273,74
	N4	90,63	1,94	98,05	13,02	4,06	2,02	78,95	85,74	3,09	1,98	723,33	144,67	18,82	124,01	448,36	286,47
Aday 1	No	90,14	2,36	97,64	9,91	3,91	2,04	81,78	84,83	3,07	1,96	473,33	94,67	9,35	80,38	290,60	185,56
	N1	89,53	2,19	97,81	11,65	3,81	2,02	80,33	85,93	3,11	1,96	540,00	108,00	12,61	80,37	335,04	214,09
	N2	90,3	2,28	97,72	12,80	3,77	2,00	79,14	81,98	2,96	1,89	610,00	122,00	15,63	92,67	341,46	230,31
	N3	90,31	2,29	97,71	13,55	4,14	2,06	77,98	83,91	3,03	1,94	646,67	129,33	17,49	99,98	392,05	250,15
	N4	89,70	1,80	98,20	12,64	4,57	2,02	78,97	83,24	3,01	1,92	710,00	144,00	18,47	108,44	433,47	276,46
Signifigance																	
	Variety	0,01	0,15	0,15	0,41	0,13	0,21	0,37	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01
	N Level	0,48	0,12	0,12	0,01	0,53	0,77	0,01	0,28	0,28	0,28	0,01	0,01	0,01	0,01	0,01	0,01
	V x L	0,48	0,38	0,38	0,38	0,32	0,56	0,20	0,76	0,78	0,78	0,01	0,01	0,01	0,01	0,01	0,01

plant, such as drought[8]. The concentrations of NFE were significantly affected by N fertilization. As N level increased, NFE concentration decreased in a linear fashion. This decrease mainly resulted from increases in CP concentration of barley with increasing levels of N fertilization.

in vitro OM digestibilities, and consequently ME and NEL values calculated based on IVOMD were differed among varieties, affected by year ($p<0.05$) but not affected by N levels. It is known that digestibility and energy value differ among varieties[24]. Digestibility and energy values were in range of values reported in the literature[2, 25].

Total plant and grain yields of different barley varieties significantly differed in first and second year ($p<0.05$), but not in average. Total plant and grain yields ranged from 7569 and 2846 to 14729 and 5978 g kg^{-1} in first year, and from 4667 and 933 to 12033 and 2407 g kg^{-1} in second year, respectively. However, average total plant and grain yields ranged from 6835 and 1926 to 12293 and 3712 g kg^{-1}, respectively. Both total plant and grain yields were significantly affected by N levels and year ($p<0.05$). While the effect of N level on total plant and grain yields were quadratic in first year, it was linear in second year ($p<0.05$). Both total plant and grain yields were significantly greater in first year compared with second year ($p<0.05$), but grain yields were generally 2 folds or more higher in first year than in second year. There were variety x N level and variety x year interaction. Tarm 92 and Tokak 157/37, and Bülbül 89 varieties had the highest response to N fertilization and were affected less compared with other varieties by year ($p<0.05$). Yilmaz *et al.*,[6] have reported that average total plant and grain yields ranged from 4739 and 1198 to 8284 and 3361 g kg^{-1}, respectively for winter type barley varieties grown in same region, which was somewhat less than the values obtained in this study. One of the major factors affecting total plant and grain yields of barley is rainfall during growth, heading and heading-maturity time[6,25]. As seen at Table 1, total rainfalls from January 25, 2006March to June were 111.3 and 186 mm in first and second year, respectively. One would expect to see a greater yields in second year compared with first year. In contrast, yields were greater in first year than in second year in this study. Low yields in second year mainly resulted from frost killing in this study. A significant reduction in yields of winter type barley due to frost killing have been reported previously for this region[26]. While the highest grain yields were observed from 40 to 80 kg N/ha[12,27] under dry conditions, the highest grain yields were obtained between 130 and 160 kg N/ha[12,27] under irrigation[11,12,27,28,29]. Similarly, grain yields were generally

the greatest at 90 kg N/ha in first

Table 4: Effects of increasing levels of N fertilization on nutrient contents and yields of different winter type barley varieties (Average of two years)

Variety	N Level	DM	Ash	OM	CP	CF	EE	NFE	IVOMD, % OM	ME, Mcal /Kg	NEL Mcal /Kg	Total Yield	Grain Yield	CP Yield	IVODM Yield	ME Cal/Kg Yield	NEL Yield
Tokak 157/37																	
	No	91,55	2,20	97,80	9,07	4,59	2,05	82,10	84,42	3,05	1,95	683,47	215,15	18,93	183,08	661,91	422,73
	N1	91,51	2,02	97,98	10,66	4,62	2,07	80,63	86,58	3,13	2,00	1090,82	256,05	27,10	222,25	803,51	513,78
	N2	91,69	1,91	98,09	11,48	4,18	2,02	80,41	84,74	3,06	1,96	1171,67	364,65	39,80	309,18	1117,81	713,74
	N3	91,74	2,13	97,88	13,38	4,92	2,07	77,49	86,08	3,11	1,99	1229,30	335,63	43,48	289,44	1046,44	668,85
	N4	91,66	2,03	97,98	13,58	5,01	2,13	77,27	85,26	3,08	1,97	1206,52	316,93	42,91	271,42	981,30	626,95
Tarm	No	91,81	2,30	97,70	8,27	4,58	2,06	82,79	87,36	3,16	2,02	699,58	192,62	15,10	168,07	607,65	388,67
92	N1	91,51	2,26	97,74	8,77	4,17	2,18	82,62	88,60	3,20	2,05	1098,13	371,22	30,29	327,16	1182,82	757,00
	N2	91,69	1,91	98,09	11,48	4,18	2,02	80,41	84,74	3,06	1,96	1171,67	364,65	39,80	309,18	567,47	362,31
	N3	91,29	2,04	97,97	11,86	4,46	2,02	79,62	86,93	3,14	2,01	990,00	246,17	28,47	213,59	772,20	493,75
	N4	91,57	2,01	97,99	13,10	4,68	2,09	78,13	89,42	3,23	2,07	1153,48	312,05	40,21	278,28	1006,07	644,33
Bülbül	No	91,10	2,28	97,72	8,28	4,78	2,02	82,63	85,62	3,10	1,98	720,13	221,78	17,71	191,70	693,07	443,06
89	N1	91,16	2,28	97,72	10,51	4,46	2,01	80,74	85,90	3,11	1,98	942,22	280,85	27,06	244,89	885,37	566,28
	N2	91,15	2,05	97,95	11,65	4,67	2,05	79,59	87,64	3,17	2,03	1102,08	329,97	35,64	292,03	1055,82	675,89
	N3	90,82	1,87	98,13	11,22	4,52	2,08	80,31	85,85	3,10	1,98	1140,27	345,05	37,40	300,01	1084,67	693,63
	N4	90,92	2,21	97,80	13,18	5,45	2,23	76,94	87,36	3,16	2,02	1197,08	336,77	45,11	294,99	1066,49	682,31
Yesevi	No	90,93	2,04	97,96	8,51	4,25	2,00	84,20	84,67	3,06	1,95	774,30	248,18	19,94	210,67	761,66	486,37
93	N1	90,98	2,03	97,97	9,57	3,96	2,12	82,43	85,39	3,09	1,97	991,38	317,12	28,83	268,65	971,28	620,14
	N2	90,66	1,79	98,22	11,89	4,35	2,04	79,86	85,36	3,09	1,97	1071,68	312,70	34,72	271,31	980,88	627,18
	N3	91,52	1,74	98,26	12,60	4,64	2,15	78,88	84,17	3,04	1,94	972,78	289,40	34,24	243,97	882,04	563,00
	N4	90,84	2,15	97,85	14,01	4,09	2,02	77,72	85,45	3,09	1,97	1010,98	255,93	36,94	218,46	789,82	504,52
Aday 1	No	90,21	2,24	97,77	9,04	3,96	2,03	82,75	85,42	3,09	1,97	764,45	265,34	22,41	226,87	820,22	524,11
	N1	90,24	2,26	97,74	10,49	3,99	2,04	81,23	86,75	3,14	2,01	950,55	315,18	30,63	275,00	994,23	635,93
	N2	90,38	2,77	97,23	11,40	4,03	2,01	79,79	81,88	2,96	1,89	895,27	236,61	25,32	192,69	696,65	443,70
	N3	90,49	2,05	97,95	12,48	4,02	2,03	79,42	85,52	3,03	1,94	837,23	323,23	38,17	279,48	1010,45	645,95
	N4	90,09	1,86	98,15	13,24	4,53	2,04	78,34	84,36	3,05	1,95	1018,20	241,73	32,60	205,07	741,41	473,41
Signifigance																	
	Variety	0,01	0,10	0,10	0,03	0,01	0,25	0,05	0,01	0,01	0,01	0,01	0,32	0,01	0,16	0,16	0,15
	N Level	0,7	0,15	0,15	0,01	0,01	0,21	0,01	0,2	0,2	0,2	0,01	0,01	0,01	0,01	0,01	0,01
	Year	0,3	0,08	0,08	0,01	0,19	0,55	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01
	Var*N	0,11	0,16	0,16	0,5	0,55	0,16	0,34	0,33	0,33	0,32	0,01	0,01	0,01	0,01	0,01	0,01
	Var*Year	0,01	0,22	0,22	0,97	0,05	0,75	0,77	0,09	0,09	0,09	0,01	0,01	0,01	0,01	0,01	0,01
	SEM	0,2	1,73	0,58	0,72	0,36	0,07	0,88	1,48	0,05	0,03	75,46	30,65	3,24	27,43	99,13	63,57

year in which rainfall was lacking, but yields were linear in second year up to 180 kg N ha^{-1} in which rainfall was greater and number of plants per m^2 were less due to frost killing compared with first year in this study. These factors may explain the differences in responses of barley to N levels and yields in first and second year.

As expected, IVOMD, ME, and NEL yields were significantly differed among varieties in both years, but were similar in average similar to grain yields. However, IVOMD, ME, and NEL yields were significantly affected by N fertilization and year. The greatest effect of N fertilization was observed in CP yields. Both yields and CP concentrations of barley increased with N fertilization, resulted in big differences in CP yields. The differences between the lowest and the highest CP yields were approximately 2 folds in Tokak 157/37, Tarm 92, and Bülbül 89, but were less than 2 folds in Yesevi 93 and Aday 1 varieties.

In conclusion, approximately 90 kg N/ha seemed to be most proper N levels in general, but if greater rainfall is expected, N levels over 90 g kg^{-1} can be applied. Tokak 157/37, Tarm 92, and Bülbül 89 varieties seemed to be most consistent varieties for the region.

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