Black Sea Journal of Agriculture
doi: 10.47115/bsagriculture.878459

Open Access Journal
e-ISSN: 2618 – 6578

Research Article
Volume 4 - Issue 2: 71-78 / April 2021

THE IMPACT OF ORGANIC LIQUID NITROGEN FERTILIZER APPLICATION ON GROWTH AND PRODUCTIVITY OF BARLEY (*HORDEUM VULGARE* L.) VARIETIES

Arzu MUTLU[1], Timucin TAS[2]*

[1]Harran University, Akcakale Vocational High School, Organic Cereal Department, 63100, Sanliurfa, Turkey
[2]Republic of Turkey Ministry of Agriculture and Forestry, GAP Agricultural Research Institute, Cereal Agronomy and Breeding Department, 63040 Sanliurfa, Turkey

Abstract: Barley is a cereal used extensively in animal nutrition in the world. Nowadays, Organic practices have an important place in healthy nutrition of people and animals and protection of agricultural lands. This study was conducted to determine the effect of organic applications such as organic liquid nitrogen and barn manure on yield and quality values of barley during 2018-2019 and 2019-2020 growing seasons according to the randomized complete block design with split plot arrangements. This two-year study inferred the impact of organic liquid nitrogen fertilizer application at different growth stages on growth and productivity of barley. Organic liquid nitrogen fertilizer was applied at different phenological periods (control, tillering, beginning of booting, end of booting and heading) of spring barley varieties, Akhisar and Samyeli. Parameters such as Plant height (cm), number of heading (number m^{-2}), hectoliter weight (kg hl^{-1}), 1000 grain weight (g), grain yield (kg ha^{-1}), chlorophyll content (SPAD values) and protein ratio (%) were determined in the study. All parameters investigated were significantly different (P≤0.01) between the years. Compared to the first year, higher temperature and drier weather conditions during the second year increased protein ratio in seed, while decreased starch ratio; thus, yield and yield components were lower. Yield and yield parameters of barley varieties had a negative correlation between protein ratios, while had a positive correlation with chlorophyll content. The results concluded organic liquid nitrogen application at the end of booting phenological period of Akhisar variety resulted in higher yield and improved the related traits. It has been concluded that the organic liquid fertilizer to be applied in this phenological period will increase both yield and quality in barley plants. Another result of this study was that as a result of organic applications, the yield and quality levels obtained from barley was close to conventional agriculture.

Keywords: Barley, Spad, Organic liquid nitrogen, Protein ratio, Grain yield

***Corresponding author:** Republic of Turkey Ministry of Agriculture and Forestry, GAP Agricultural Research Institute, Cereal Agronomy and Breeding Department, 63040 Sanliurfa, Turkey
E mail: ttas_4@hotmail.com (T. TAS)
Arzu MUTLU https://orcid.org/0000-0001-8992-8371
Timucin TAS https://orcid.org/0000-0002-2144-9064

Received: February 11, 2021
Accepted: March 09, 2021
Published: April 01, 2021

Cite as: Mutlu A, Tas T. 2021. The impact of organic liquid nitrogen fertilizer application on growth and productivity of barley (*hordeum vulgare* L.) varieties. BSJ Agri, 4(2): 71-78.

1. Introduction

Barley (Hordeum *vulgare L.*) is one of oldest cultivated plants in the world. The existence of genetic sources and the first wild forms of barley have been reported in the Middle East. Barley which is extremely important for animal nutrition in the world and Turkey is used extensively as protein source in in animal production and feed rations, although not directly used in human nutrition. Barley is also consumed for human nutrition as flour and various products, although the share is too little. Barley matures earlier than wheat; therefore, preferred in areas where two crops are harvested in a year. Low yields are obtained in non-irrigated lands with irregular and insufficient rainfall (Dogan et al., 2014).

The latest FAO data showed that approximately 150 million tons of barley is produced in the world with 7.4 million tons produced in Turkey. Out of the total barley produced in Turkey, 10% is produced in the region where the study has been carried out (Anonymous, 2020). Majority (92%) of barley produced in Turkey is two-row barley varieties. The barley varieties used in this experiment are used for feed and widely cultivated in the country. The use of organic fertilizers instead of inorganic substances in agriculture will provide benefits for human and animal health. Studies revealed that grain yield of barley with manure and liquid nitrogen fertilizer applications was close to those obtained in conventional agriculture. In addition, the application of manure increased dry matter production, protein ratio and grain yield of cereals (Butler and Muir, 2006). Organic liquid fertilizers, which contain one or more nutrients required by plants, are applied by spraying on the leaves. Studies have reported that application of nutrients by spraying acts faster than soil application (Danisman and Belliturk, 2006).

Low soil fertility is reported as the reason for low barley yield; however, soil fertility increased with organic fertilization (Abera et al., 2018). Therefore, organic fertilizers are assumed to replace chemical fertilizers in crop production (Ahmadi et al., 2018). Alinezhad et al. (2013) reported that organic liquid nitrogen fertilizer applied during the final stage of barley growth improves grain quality and increases grain yield. Similarly, yield obtained for ten-year organic fertilizer application was equivalent to the yield obtained with chemical fertilizer application. Farm manure improved soil structure and increased water holding capacity (Edmeades, 2003). The positive effect of manure applications on cereal crops has been reported in numerous studies (Barzegar et al., 2002).

Livestock breeding and crop production should be integrated to adapt organic fertilizer application practices in a farm. Organic practices will conserve soils and provide a healthier food in the long run. This study was carried out to determine the effects of organic liquid nitrogen fertilizer applied at different phenological periods on grain yield, yield components and chlorophyll content of spring barley varieties.

2. Material and Methods

Sanliurfa province is located one of the hottest regions in Turkey. Climatic conditions of growing season in 2019-2020 were drier for plant growth compared to 2018-2019. Relative humidity in the second year of study was lower and temperature was higher than the first year. Total rainfall in the second year was lower than that occurred in the first year. The rainfall in both growing seasons was not equal distributed; therefore, supplemental irrigation was applied according to plant needs, especially during grain filling period (Table 1).

Table 1. Important climatic values of the trial location

	Mean temperatures (°C)		The highest temperatures (°C)		The lowest temperatures (°C)		Mean humidity (%)		Total precipitation (kg/m^{-2})	
	Years (2018, 2019, 2020)									
Months	18-19	19-20	18-19	19-20	18-19	19-20	18-19	19-20	18-19	19-20
October	28.4	30.7	34.2	37.0	5.6	7.3	54.3	50.6	28.8	12.8
November	18.1	22.6	28.0	28.1	3.3	0.5	81.0	47.2	177.6	2.6
December	12.8	13.5	18.1	19.6	-1.2	0.7	89.4	85.1	125.4	126.2
January	11.6	11.8	17.5	14.2	-3.8	-2.0	79.3	76.8	75.6	25.2
February	14.0	12.5	17.9	20.6	0.4	-7.8	79.3	71.5	79.6	3.0
March	16.4	19.8	21.3	26.9	0.5	1.9	75.5	70.5	115.6	83.6
April	20.6	24.2	26.7	29.2	4.5	4.2	73.1	64.1	104.8	18.4
May	32.2	31.0	40.0	38.8	9.5	10.1	42.3	45.9	10.2	0.2
June	37.9	36.5	44.2	41.6	17.4	13.2	34.4	33.9	0.8	0.0
Average	21.33	22.51	27.54	28.44	4.02	3.12	67.62	60.62	718.4	272.0

The study was conducted in the organic experimental field of Akçakale Vocational High School, Harran University during 2018-2019 and 2019-2020 growing seasons. 'Samyeli' and 'Akhisar' two-rowed spring barley varieties were used in the experiment. Certified barn manure and organic liquid fertilizer were applied in the experiment. The farm manure used in the experiment is a certified fertilizer of *Ecofarm*, and an organic liquid fertilizer is a certified fertilizer of *Merkez Anadolu Kimya*. Organic liquid fertilizer contains free nitrogen-nitrogen bonds, organic nitrogen and other microelements. The chemical content of both farmyard manure and organic liquid fertilizer are given in Table 2.

The experiment had four replications and laid out according to randomized complete block design with split-plot arrangement. Barley varieties were main plots, where phenological phases (control, tillering, beginning of booting, end of booting and heading) where organic liquid nitrogen was applied were subplots. Sowing was carried out in the third week of November during both years of the study. Seeds were manually planted in the opened lines. Each experimental unit was 5 m long and 1.2 m wide. To minimize mixing of experimental units, a buffer zone of 1 m and 3 m between the units was created. The plot area was 6 m² (5 m × 1.2 m). The interrow distance was 20 cm and each experimental unit had 6 rows. The seeds were placed 4 to 6 cm deep and seeding density was 475 plants m^{-2} (Akkaya, 1994). Inorganic fertilizers and herbicides were not applied in the experiment.

Table 2. Some chemical properties of the barnyard manure and organic liquid fertilizer

Chemical contents	Barnyard manure	Organic liquid fertilizer
Total organic matter (%)	40.12	20.34
Organic nitrogen (N, %)	1.00	1.23
Ph (%)	7.23	7.12
Humic-fulvic ratio (%)	28.23	
Potassium (K, %)	2.04	1.78
Phosphorus (P, %)	2.43	2.23
Mg (%)	1.13	1.12
Fe (%)	0.24	0.26
Zn (ppm)	129.08	121.67
Mn (ppm)	90.67	82.32
Free amino acids (%)		8.09

Farm manure at the rate of 20 tons' ha^{-1} was applied to all experimental units before sowing (Tan and Serin, 1995). After farm manure application, equal amounts of organic liquid nitrogen fertilizer were sprayed during tillering, beginning of booting, end of booting and heading stages. Organic liquid fertilizer was not applied in control treatment. The 100 *CC* of organic liquid nitrogen fertilizer and 1 kg of sugar were added into 20 liter of water, kept at room temperature overnight, and then applied to experimental units.

Plant height (cm), number of heading (number/m^{-2}), hectoliter weight (kg hl^{-1}), 1000-grain weight (g), grain yield (kg ha^{-1}), chlorophyll content (SPAD values) and protein ratio (%) of barley varieties were determined in study. Spike characteristics were examined from 10 spikes randomly selected from each experimental unit during harvest period and averaged (Kutlu et al., 2015). The plant heights of 10 plants were measured in each parcel and averaged. Protein ratios of grain samples taken from each plot were determined using Celdhl NIT (Near Infrared Transmittance) spectroscopy technique according to the ICC standard method (AACC Method 46-30) (Anonymous, 1990). The 1000-grain weight was determined according to the AACC 55-10 method (Koksel et al., 2000). The weight of hectoliters was measured with 4 replications using a Loyka brad instrument (1 L) and calculated in kg (Unal, 2002). The yield per hectare was calculated using the grains collected from the experimental unit after harvest. Chlorophyll contents were measured using a portable chlorophyll meter (Minolta SPAD-502, Osaka, Japan). Measurements were carried out in the open air during afternoon (14:$^{\underline{00}}$ and 16:$^{\underline{00}}$). The chlorophyll contents were measured from the flag leaf of ten randomly selected plants from each experimental unit, averaged and expressed as SPAD values (Yildirim et al., 2009).

The collected data were subjected to two-way analysis of variance using JMP 13.0 statistical program. LSD post-hoc test was used to compare the averages of the varieties and phenological stages. Correlation analysis was performed between all parameters examined (95%).

3. Results and Discussion

Statistical analysis of two years separately and combined was performed for all studied parameters. The combined year analysis indicated statistically significant differences (P≤0.01) in plant height between year, variety, periods and cultivar × period interaction. The highest plants (78.15 cm) were recorded in organic liquid fertilizer application during the end of boating period of Akhisar variety; while the shortest plant height (54.08 and 50.65 cm) was recorded for fertilizer application at tillering and control treatment in Samyeli variety, respectively (Table 3).

Table 3. Means and multiple comparison test results related to plant height (cm) in different varieties and phenological periods

Years	2018-19			2019-20			(2018-19)-(2019-20)		
Phenological Periods/Variety	Akhisar	Samyeli	Mean	Akhisar	Samyeli	Mean	Akhisar	Samyeli	Mean
C	57.93^{e}	65.97^{d}	61.95^{cd}	47.77	42.20	44.9^{e}	52.85^{e}	54.08^{e}	53.46^{d}
T	65.77^{d}	52.87^{e}	59.32^{d}	52.53	48.43	50.48^{d}	59.15^{d}	50.65^{e}	54.90^{d}
BB	73.53^{b}	57.63^{e}	65.58^{c}	58.50	59.90	59.2^{c}	66.01^{c}	58.76^{d}	63.39^{c}
BE	82.37^{a}	72.20^{bc}	77.28^{a}	73.93	67.93	70.9^{a}	78.15^{a}	70.96^{b}	74.10^{a}
H	75.87^{b}	67.90^{cd}	71.88^{b}	66.07	63.90	64.98^{b}	70.96^{b}	65.90^{c}	68.43^{b}
Mean	71.09^{a}	63.31^{b}	67.20^{A}	59.76^{a}	56.47^{b}	58.11^{B}	65.42^{a}	59.89^{b}	62.65
CV (%)	4.54			5.85			5.16		
LSD (0.05)	V(lsd): 2.36** PP (lsd): 3.73** VxPP:(lsd): 5.28**			V(lsd): 2.63** PP(lsd): 4.16** VxPP:(lsd): NS			Y(lsd): 1.70** V(lsd): 1.70** PP(lsd): 2.68** VxPP (lsd): 3.80**		

*,** significant at 0.05 and 0.01 levels of probability respectively, NS= not significiant, V= variety, PP= phenological periods, Y= year, C= control, T= tillering, BB= beginning of boating, BE= end of boating, H= heading.

The combined year analysis revealed statistically significant differences (P ≤ 0.01) in number of heading, hectoliter weight, 1000 grain weight, protein ratio, chlorophyll content and grain yield between years, varieties, and phenological periods, while the differences in variety × phenological stage interaction was not significant. The highest number of heading were obtained for Akhisar variety with fertilizer application at end of booting stage, while the lowest value was recorded for Samyeli variety with control treatment (Table 4). In the combined year analysis, the highest hectoliter weight (63.31 kg hl^{-1}) was measured for Akhisar variety with organic liquid fertilizer application at end of booting stage, while the lowest hectoliter weight (50.43 kg hl^{-1}) was obtained for Samyeli variety in control treatment (Table 5).

Table 4. Means and multiple comparison test results related to number of heading (number/m-2) in different varieties and phenological periods

Years	2018-19			2019-20			(2018-19)-(2019-20)		
Phenological Periods/Variety	Akhisar	Samyeli	Mean	Akhisar	Samyeli	Mean	Akhisar	Samyeli	Mean
C	339.10	334.50	336.80^{d}	340.20	319.80	330.00^{c}	339.65	327.15	333.40^{e}
T	353.33	346.67	350.00^{c}	348.73	330.37	339.55^{c}	351.03	338.52	344.78^{d}
BB	384.67	376.37	380.52^{b}	370.67	362.12	366.39^{b}	377.67	369.24	373.45^{c}
BE	410.60	405.20	407.90^{a}	404.10	389.10	396.60^{a}	407.35	397.15	402.25^{a}
H	401.33	399.93	400.63^{a}	396.70	375.75	386.23^{a}	399.02	387.84	393.43^{b}
Mean	377.81^{a}	372.53^{b}	375.17^{A}	372.08^{a}	355.43^{b}	363.75^{B}	374.94^{a}	363.98^{b}	369.46
CV (%)	1.63			2.59			2.15		
LSD (0.05)	V(lsd): 4.73* PP(lsd): 7.48** VxPP:(lsd): N.S			V(lsd): 7.29** PP(lsd):11.54** VxPP:(lsd): N.S			Y(lsd): 4.18** V(lsd): 4.18** PP(lsd): 6.61** VxPP(lsd): N.S		

*,** significant at 0.05 and 0.01 levels of probability respectively, NS= not significiant, V= variety, PP= phenological periods, Y= year, C= control, T= tillering, BB= beginning of boating, BE= end of boating, H= heading.

Table 5. Means and multiple comparison test results related to hectoliter weight (kg hl-1) in different varieties and phenological periods

Years	2018-19			2019-20			(2018-19)-(2019-20)		
Phenological Periods/Variety	Akhisar	Samyeli	Mean	Akhisar	Samyeli	Mean	Akhisar	Samyeli	Mean
C	59.00	51.17	55.08^{d}	51.80	49.70	50.75^{d}	55.40	50.43	52.92^{d}
T	60.67	54.10	57.38^{c}	54.17	52.87	53.52^{c}	57.42	53.48	55.45^{c}
BB	62.00	58.00	60.00^{b}	56.34	56.90	56.62^{b}	59.17	57.45	58.31^{b}
BE	65.33	61.24	63.29^{a}	61.28	60.07	60.67^{a}	63.31	60.66	61.98^{a}
H	62.83	58.10	60.47^{b}	57.03	57.33	57.18^{b}	59.93	57.72	58.82^{b}
Mean	61.97^{a}	56.52^{b}	59.24^{A}	56.12	55.37	55.75^{B}	59.05^{a}	55.95^{b}	57.50
CV (%)	2.53			2.87			2.69		
LSD (0.05)	V(lsd): 1.16** PP(lsd): 1.83** VxPP(lsd): N.S			V(lsd): N.S PP(lsd): 1.96** VxPP(lsd): N.S			Y(lsd): 0.81** V(lsd): 0.81** PP(lsd): 1.29** VxPP(lsd): N.S		

*,** significant at 0.05 and 0.01 levels of probability respectively, NS= not significiant, V= variety, PP= phenological periods, Y= year, C= control, T= tillering, BB= beginning of boating, BE= end of boating, H= heading.

Similar to the hectoliter weights, the highest value for 1000 grain weight (42.63 g) was obtained in the Akhisar variety at the end of booting phenological period, while the lowest value (32.23 g) was obtained with Samyeli variety in control treatment (Table 6). The lowest grain yield (3464.8 kg ha^{-1}) in two-year data was recorded for Samyeli variety in control treatment, while the highest grain yield (4187.1 kg ha^{-1}) was obtained for Akhisar variety with organic liquid fertilizer application at the end of booting phenological period (Table 7).

The lowest chlorophyll content (39.32 spad) which is an important physiological parameter was obtained for Samyeli variety in control treatment, while the highest value (49.46 spad) was recorded for Akhisar variety with organic liquid fertilizer application at the end of booting period (Table 8). In contrast to the other parameters, the highest protein ratio (15.23%) was obtained for Samyeli variety with organic liquid fertilizer application at the end of booting period, and the lowest protein ratio (9.71%) was obtained for Akhisar variety with control treatment (Table 9). The higher temperature and lower relative humidity in the second year caused a decrease in all parameters except protein ratio. In the second year of the experiment, high temperatures and dry weather suppressed the harvest of barley plants reduced starch ratio and increased protein ratio. In general, the highest values of all parameters were recorded for Akhisar variety with organic liquid fertilizer application at the end of booting phenological period, while the lowest values were recorded for Samyeli variety without any organic liquid nitrogen application.

Table 6. Means and multiple comparison test results related to 1000 grain weight (g) in different varieties and phenological periods

Years	2018-19			2019-20			(2018-19)-(2019-20)		
Phenological Periods/Variety	Akhisar	Samyeli	Mean	Akhisar	Samyeli	Mean	Akhisar	Samyeli	Mean
C	36.05	33.76	34.91^{d}	33.85	30.70	32.28^{d}	34.95	32.23	33.59^{e}
T	37.89	36.41	37.15^{c}	35.81	33.78	34.79^{c}	36.85	35.10	35.97^{d}
BB	40.32	38.71	39.51^{b}	38.99	35.69	37.34^{b}	39.65	37.20	38.43^{c}
BE	43.20	41.65	42.43^{a}	42.07	38.83	40.45^{a}	42.63	40.24	41.44^{a}
H	41.11	40.84	40.97^{ab}	40.18	36.53	38.36^{b}	40.64	38.69	39.67^{b}
Mean	39.71^{a}	38.27^{b}	38.99^{A}	38.18^{a}	35.11^{b}	36.64^{B}	38.95^{a}	36.69^{b}	37.82
CV (%)	3.74			3.77			3.76		
LSD (0.05)	V(lsd): 1.13** PP(lsd): 1.79** VxPP(lsd): N.S			V(lsd): 1.07** PP(lsd): 1.69** VxPP(lsd): N.S			Y(lsd): 0.75** V(lsd): 0.75** PP(lsd): 1.18** VxPP(lsd):N.S		

*,** significant at 0.05 and 0.01 levels of probability respectively, NS= not significiant, V= variety, PP= phenological periods, Y= year, C= control, T= tillering, BB= beginning of boating, BE= end of boating, H= heading.

Table 7. Means and multiple comparison test results related to grain yield (kg ha^{-1}) in different varieties and phenological periods

Years	2018-19			2019-20			(2018-19)-(2019-20)		
Phenological Periods/Variety	Akhisar	Samyeli	Mean	Akhisar	Samyeli	Mean	Akhisar	Samyeli	Mean
C	3883.5	3494.7	3689.1^{d}	3623.3	3435.0	3529.2^{d}	3753.4	3464.8	3609.1^{e}
T	4072.4	3690.3	3881.4^{c}	3772.0	3622.7	3697.3^{c}	3922.2	3656.5	3789.4^{d}
BB	4174.2	3773.0	3973.6^{bc}	3861.8	3693.7	3777.7^{b}	4018.0	3733.3	3875.7^{c}
BE	4330.8	3982.3	4156.6^{a}	4043.3	3914.3	3978.8^{a}	4187.1	3948.3	4067.7^{a}
H	4152.4	3895.7	4024.1^{b}	4009.6	3849.0	3929.3^{a}	4081.0	3872.3	3976.7^{b}
Mean	4122.7^{a}	3767.2^{b}	3944.9^{A}	3862.0^{a}	3702.9^{b}	3782.5^{B}	3992.3^{a}	3735.1^{b}	3863.7
CV (%)	2.35			1.55			2.01		
LSD (0.05)	V(lsd): 71.68** PP(lsd): 113.34** VxPP(lsd): N.S			V(lsd): 45.50** PP(lsd): 71.94** VxPP(lsd): N.S			Y(lsd): 40.79** V(lsd): 40.79** PP(lsd): 64.49** VxPP(lsd): N.S		

*,** significant at 0.05 and 0.01 levels of probability respectively, NS= not significiant, V= variety, PP= phenological periods, Y= year, C= control, T= tillering, BB= beginning of boating, BE= end of boating, H= heading.

Table 8. Means and multiple comparison test results related to chlorophyll content (spad values) in different varieties and phenological periods

Years	2018-19			2019-20			(2018-19)-(2019-20)		
Phenological Periods/Variety	Akhisar	Samyeli	Mean	Akhisar	Samyeli	Mean	Akhisar	Samyeli	Mean
C	45.19	40.68	42.94^{d}	42.62	37.96	40.29^{c}	43.91	39.32	41.61^{e}
T	47.05	43.00	45.03^{c}	44.37	38.67	41.52^{c}	45.71	40.84	43.27^{d}
BB	47.90	44.05	45.98^{b}	45.81	41.55	43.68^{b}	46.86	42.80	44.83^{c}
BE	50.35	46.57	48.46^{a}	48.56	44.92	46.74^{a}	49.46	45.75	47.60^{a}
H	48.19	44.28	46.24^{b}	48.96	45.18	47.07^{a}	48.58	44.73	46.65^{b}
Mean	47.74^{a}	43.72^{b}	45.73^{A}	46.06^{a}	41.66^{b}	43.86^{B}	46.90^{a}	42.69^{b}	44.79
CV (%)	1.59			3.13			2.45		
LSD (0.05)	V(lsd): 0.56** PP(lsd): 0.89** VxPP(lsd): N.S			V(lsd): 1.06** PP(lsd): 1.68** VxPP(lsd): N.S			Y(lsd): 0.58** V(lsd): 0.58** PP(lsd): 0.91** VxPP(lsd): N.S		

*,** significant at 0.05 and 0.01 levels of probability respectively, NS= not significiant, V= variety, PP= phenological periods, Y= year, C= control, T= tillering, BB= beginning of boating, BE= end of boating, H= heading.

Table 9. Means and multiple comparison test results related to protein ratio (%) in different varieties and phenological periods

Years	2018-19			2019-20			(2018-19)-(2019-20)		
Phenological Periods/Variety	Akhisar	Samyeli	Mean	Akhisar	Samyeli	Mean	Akhisar	Samyeli	Mean
C	9.16	10.97	10.07^{c}	10.26	12.36	11.31^{d}	9.71	11.67	10.69^{d}
T	9.77	12.06	10.92^{bc}	11.42	14.05	12.73^{c}	10.59	13.06	11.82^{c}
BB	10.67	13.04	11.86^{b}	12.44	15.19	13.82^{b}	11.56	14.11	12.84^{b}
BE	11.86	14.24	13.05^{a}	14.41	16.21	15.31^{a}	13.13	15.23	14.18^{a}
H	10.81	12.98	11.90^{b}	13.71	15.37	14.54^{ab}	12.26	14.17	13.22^{b}
Mean	10.45^{b}	12.66^{a}	11.56^{B}	12.45^{b}	14.63^{a}	13.54^{A}	11.45^{b}	13.65^{a}	12.55
CV (%)	7.69			5.72			6.64		
LSD (0.05)	V(lsd): 0.69** PP(lsd): 1.09** VxPP(lsd): N.S			V(lsd): 0.60** PP(lsd): 0.95** VxPP(lsd): N.S			Y(lsd): 0.44** V(lsd): 0.44** PP(lsd): 0.69** VxPP(lsd): N.S		

*,** significant at 0.05 and 0.01 levels of probability respectively, NS= not significiant, V= variety, PP= phenological periods, Y= year, C= control, T= tillering, BB= beginning of boating, BE= end of boating, H= heading.

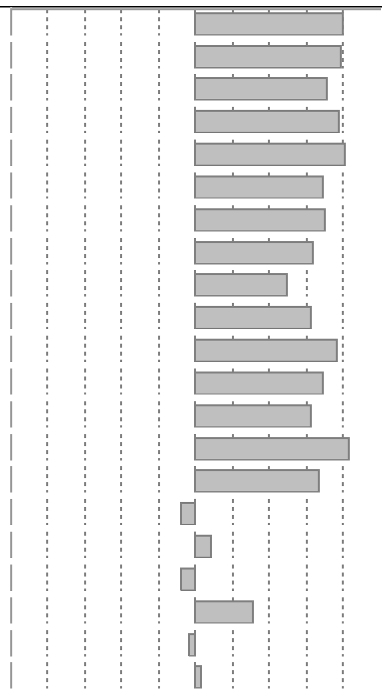
Many studies conducted in accordance with our findings stated that application of organic liquid nitrogen fertilizer increased yield, yield components and dry matter in grains (Ozcan and Brohi, 2000). Many researchers reported that liquid fertilizer application at different phenological periods (Kettlewell et al., 1998), distribution of precipitation during the year, temperature during growing period (Smith and Googing, 1999) and differences in variety affect yield and quality. The 1000 grain and hectoliter weight are defined as the important yield components affecting grain yield of cereals (Korkut et al, 1993). Similar to our findings, Poehlmen (1987) stated that grain weight was negatively affected by hot and dry weather conditions. Ofosu-Anim and Leitch, 2009 indicated a 1.5 to 4 fold higher grain yield in spring barley varieties with the increase in plant height, leaf chlorophyll content and dry matter accumulation due to the application of organic origin fertilizers.

3.1 Correlation Analysis

A combined data of two years was subjected to a correlation analysis to determine the relationships between investigated parameters (Table 10).

Table 10. Correlation coefficients and significance levels of yield components and grain yield and physiological parameter

Traits	Traits	Correlation coefficients	Count	The lowest coefficients	The highest coefficients	Significance levels	Correlation levels
PH	GY	0.800	60	0.686	0.876	<.0001**	
CC	GY	0.793	60	0.675	0.871	<.0001**	
CC	PH	0.709	60	0.556	0.817	<.0001**	
HN	GY	0.774	60	0.648	0.859	<.0001**	
HN	PH	0.812	60	0.703	0.884	<.0001**	
HN	CC	0.692	60	0.532	0.805	<.0001**	
HW	GY	0.704	60	0.548	0.812	<.0001**	
HW	PH	0.639	60	0.461	0.769	<.0001**	
HW	CC	0.499	60	0.281	0.669	<.0001**	
HW	HN	0.630	60	0.448	0.762	<.0001**	
GW	GY	0.769	60	0.639	0.856	<.0001**	
GW	PH	0.695	60	0.536	0.807	<.0001**	
GW	CC	0.628	60	0.445	0.761	<.0001**	
GW	HN	0.827	60	0.726	0.893	<.0001**	
GW	HW	0.673	60	0.505	0.791	<.0001**	
PR	GY	-0.076	60	-0.324	0.182	0.565NS	
PR	PH	0.084	60	-0.174	0.331	0.525NS	
PR	CC	-0.078	60	-0.326	0.179	0.552NS	
PR	HN	0.315	60	0.066	0.526	0.014*	
PR	HW	-0.029	60	-0.281	0.227	0.825NS	
PR	GW	0.028	60	-0.227	0.280	0.831NS	



GY= grain yield (t ha^{-1}); CC= chlorophyll content (spad); HN= number of heading (number/m-2); PH= plant height (cm); PR= protein ratio (%); GW= 1000 grain weight (g); H= hectoliter weight (kg hl^{-1})
*,** significant at 0.05 and 0.01 levels of probability respectively, NS= not significant

Negative and non-significant relationships were found between PR and GY, CC, HW, while positive and non-significant relationships were recorded between PR and GW. Positive and significant relationships were noted between PR and HN. Significant positive relationships were determined among different parameters except protein ratio. Positive and important relationships were obtained between chlorophyll content, which is one of the important physiological parameters, and yield and yield components. The increase in chlorophyll content increased photosynthesis; thus plants with increased photosynthesis produced more nutrient, and consequently increased the yield and yield components. In addition, the increase in yield components increased the grain yield. Jianren et al. (2000) reported that organic liquid fertilizer applied to barley leaves during late-ripening period promotes the transmission of organic matter from stem to the leaves and ears, accelerates grain filling in the spike, helps the formation of filled grains and increases grain weight.

4. Conclusions

The results recorded in this study concluded that higher temperatures and drier weather conditions experienced during the second year of the study caused a decrease in starch accumulation and an increase in protein accumulation. The decrease in starch accumulation reduced yield and yield components. In general, the organic liquid nitrogen fertilizer application at the end of booting phenological period had significant effects on all parameters except protein ratio of Akhisar barley variety. The highest values of all studied parameters except protein ratio were recorded for Akhisar variety with fertilizer application at the end of booting stage, whereas the lowest values were recorded for Samyeli variety with control treatment. The results revealed that application manure in large areas where barley is produced will increase the organic matter content of soils. In addition, organic liquid nitrogen can be applied easily and cheaply using a pulverizer at the end of booting period, and this practice will increase yield and quality of barley.

Author Contributions

All field study from sowing to harvest was carried out by AM. After the harvest, Parameters such as 1000 grain weight, hectoliter weight and protein ratio were analysed in grain laboratory by TT. In addition, TT have analysed statistically the data obtained. All authors read and approved the final manuscript.

Conflict of Interest

The authors declare that there is no conflict of interest.

Acknowledgements

This study was supported by Harran University. We thank to Harran University administrators for their valuable help.

References

Anonymous. 1990. Official methods of analysis of the AOAC. Association official analytical chemists, Fifteenth edition, Arlington.

Akkaya. A. 1994. Wheat growing. Kahramanmaras Sutcu Imam University, Faculty of Agriculture, publication no: 1, textbooks publication no: 1, Kahramanmaras, Turkey, pp. 225.

Alinezhad S, Sinaki JM, Zarei M, Baradan M, Abadi F. 2013. Effects of organic fertilizers and drought stress on physiological traits in barley. Inter J Agro Plant Prod, 4 (2): 300-306.

Abera T, Tufa T, Midega T, Kumbi H, Tola B. 2018. Effect of integrated inorganic and organic fertilizers on yield and yield components of barley in liben jawi district. Inter J Agron, 2(**7**): 1-11.

Ahmadi G, Jaafarinia M. 2018. Evaluating the effects of biofertilizers on growth and emergence of Barley (Hordeum *vulgare L.*). Asian J Agri Biol, 3(3): 110-116.

Anonymous 2020. Agri products development markets. Barley Januray, No: BU-01, https:// arastirma.tarimorman.gov.tr/tepge/Belgeler (accessed date: December 12, 2019).

Barzegar AR, Yousefi A, Daryashenas A. 2002. The effect of addition of different amounts and types of organic materials on soil physical properties and yield of wheat. J Plant Soil, 247 (3): 295–301.

Butler TJ, Muir JP. 2006. Dairy manure compost improves soil and increases tall wheatgrass yield. J Agron, 98(4):1090-1096.

Danısman F, Belliturk K. 2006. Foliar fertilizer. Harran Univ J Faculty Agri**,** 11(2):7-12 [In Turkey].

Dogan Y, Kendal E, Karahan T, Ciftci V. 2014. Determination of yield and some quality characteristics of some barley (Hordeum *vulgare L.*) genotypes in Diyarbakir conditions. JAFAG, 31(2), 31-40.

Edmeades DC. 2003. The long-term effects of manures and fertilizers on soil productivity and quality: A review. Nutrition Cycl Agroecosys, 66(3): 165-180.

Jianren G, Jianhai Y, Zaicheng Z, Yunfang G, Hubao G. 2000. Preliminary report on application of tianyuan maturation accelerating organic liquid fertilizer to barley and wheat. J Acta Agri Shanghai, 16(2): 86-88.

Korkut KZ, Saglam N, Baser I. 1993. Research on some traits affecting the yield of bread and durum wheat. Trakya Univ J Agri Fac, 2(2): 111-118.

Kettlewell PSI, Griffiths MWI, Hocking TJ, Wallington DJ. 1998. Dependence of wheat dough extensibility on flour sulphur and nitrogen concentrations and the influence of oliar applid sulphur and nitrogen fertilisers. J Cereal, 28(6): 15-23.

Koksel H, Sivri D, Ozboy O, Basman A, Karacan HD. 2000. Grain Laboratory Handbook. Hacettepe University, Engineering Faculty Publications, Ankara, Turkey, pp.47.

Kutlu I, Balkan A, Bilgin O. 2015. Analysis of heredity and population differences of some spike traits in bread wheat. Kahramanmaras Sutcu Imam University, J Natural Sci, 18(4): 40-47, [In Turkey].

Ozcan S, Brohi AR. 2000. The effect of various leaf fertilizers on growth and dry matter and N-P-K content of Bread Wheat (Triticum *aestivum L.)*. Gaziosmanpasa Univ J Agri Fac, 17(1): 133-136.

Ofosu-Anim J, Leitch M. 2009. Relative efficacy of organic manures in spring barley (Hordeum *vulgare L.*) production. Australian J Crop Sci, 3(1): 13-19.

Poehlmen JM. 1987. Breeding field crops. Van Nostrand Reinhold Conmpany Inc. 115, Fifth editions, Avenue, New York.

Smith GP, Googing MJ. 1999. Models of wheat grain quality considering climate, cultivar and nitrogen effects. Agri Forest Meteorol, 94(1): 86-93.

Tan M, Serin Y. 1995. Effects of rhizobium inoculation and various nitrogen fertilizer rates on hay, seed, straw and crude protein yields, crude protein percentage and nodule number of irrigated common vetch in Erzurum. Turk J Agric For, 19(3), 137- 144.

Unal. S. 2002. Importance of quality in wheat and methods used in its determination. In: Proceedings of the Cereal Products Technology Congress and Exhibition, 3-4 October, Turkey, pp. 25-37.

Yıldırım M, Akıcı C, Koc M. 2009. Barutcular C. Applıcability of canopy temperature depression and chlorophyl content in durum wheat breeding. Anatolian J Agri Sci, 24(3): 158-166.