International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2020; 8(4): 2059-2062

Received: 22-05-2020
Accepted: 24-06-2020

Abha Parashar
Subject Matter Specialist, Krishi Vigyan Kendra, Sirohi, Rajasthan, India

Sudesh Sharma
Director, Rajasthan Agricultural Research Institute, Sri Karan Narendra Agriculture University, Jobner, Jaipur, Rajasthan, India

Prerna Dogra
Assistant Professor, Sri Karan Narendra Agriculture University, Jobner, Jaipur, Rajasthan, India

Kamini Parashar
Subject Matter Specialist, Krishi Vigyan Kendra, Sirohi, Rajasthan, India

BS Tyagi
(1). Assistant Professor, Sri Karan Narendra Agriculture University, Jobner, Jaipur, Rajasthan, India
(2). Assistant Professor, Jagganath Univrersity, Chaksu, Jaipur, Rajasthan

Corresponding Author:
Abha Parashar
Subject Matter Specialist, Krishi Vigyan Kendra, Sirohi, Rajasthan, India

Response of malt barley (*Hordeum vulgare* L.) varieties to different levels of nitrogen and sulphur application under agro-climatic zone IIIa (Semi-arid eastern plain zone) of Rajasthan

Abha Parashar, Sudesh Sharma, Prerna Dogra, Kamini Parashar and BS Tyagi

DOI: https://doi.org/10.22271/chemi.2020.v8.i4v.9932

Abstract
Field studies were carried out to investigate the effect of different nitrogen and sulphur applications on growth parameters, yield and quality parameters of two row malt barley varieties conducted at research farm, Rajasthan Agricultural Research Institute, Durgapura for two consecutive rabi seasons 2015-16 and 2016-17 on loamy sand soil. The twenty seven treatment combinations consisting of 3 varieties (RD 2849, DWRUB 52 and RD 2668), 3 nitrogen levels (60 kg, 90 kg and 120 kg) and 3 sulphur levels (0 kg, 10 kg and 20 kg) were tested in factorial randomized block design with three replications. The results indicated that variety RD 2849 proved significantly superior to DWRUB 52 and RD 2668 with respect to yield (grain and straw yield (q ha^{-1})) and quality parameters (Starch content (%). In case of nitrogen and sulphur applications grain and straw yield (q ha^{-1}), Crude protein content (%) and Starch content (%) of barley were improved. The highest grain and straw yield (q ha^{-1}), Crude protein content (%) and Starch content (%) of barley obtained with 120 kg N ha^{-1} and 20 kg S ha^{-1} and it was found statically at par with 90 kg N ha^{-1} and 10 kg S ha^{-1} application.

Keywords: *Hordeum vulgare* L., nitrogen, sulphur, agro-climatic

Introduction

Barley (*Hordeum vulgare* L.) is an ancient cereal crop, which is used as food grain to a feed and malting grain (Baik and Ullrich 2008; Pourkheirandish and Komatsuda 2007) [4, 9]. It is considered fourth largest grown cereal crop in the world with a share of 7% of the global cereal production (Pal *et al*., 2012) [7]. Barley is also used as animal fodder, as a source of beverages and as a constituent of various health foods. The barley grains products such as "Sattu" (in summers because of its cooling effects on human body) and Missi Roti have been traditionally used in India (Verma *et al*. 2011) [12].

Barley ranks next to wheat both in area and production among rabi cereals in India. It is because of its less water requirement and fairly tolerance to salinity, alkalinity, frost and drought situations. Barley is generally grown on marginal and sub-marginal land farmers because of its low inputs. In Rajasthan, it is mostly grown on light texture soils that having low nitrogen and organic matter content with poor moisture retentive capacity.

Adequate mineral fertilization is considered to be one of the most important requirements for better yield. The major production constraints in barley growing areas are their low fertility status in general and deficiency of nitrogen in particular. Nitrogen is one of the essential nutrient that is universally deficient in most of the Indian soils particularly in the loamy sand soils of semi-arid regions of Rajasthan (Chhonkar and Rattan 2000) [3]. It is the most important growth limiting factor in non-legumes (Zebarth *et al*. 2009) [13].

Sulphur is also an essential nutrient for plants that helps in formation of important enzymes and assists in the formation of plant proteins. Enhanced removal of sulphur due to exploitation agriculture seems to be principal cause for occurrence of progressive incidence of sulphur deficiency. The interaction of nitrogen and sulphur is generally positive and occasionally additive. It has been established that for every 15 parts of nitrogen in proteins, there is one part of sulphur which implies that N-S ratio is fixed within narrow 15:1 range.

Therefore, deficiency of sulphur will decrease the amount of protein synthesized even if there is plenty of N available to the plant. The aim of this study was to investigate the effect of different levels of sulphur and nitrogen amounts on yield and some quality components of barley grown on loamy sand soil.

Materials and Methods

The experiment was conducted at Rajasthan Agricultural Research Institute, Durgapura, Jaipur (Rajasthan) during *Rabi* seasons of 2015-16 and 2016-17, geographic location of the place is $75^0$47' East longitude, $26^0$51' North latitude and altitude of 390 m above mean sea level. The climate of this place is semi-arid characterized by extremity of temperature both in summer (45.5 ˚C) and winter (4 ˚C) and aridity of the atmosphere. The rainfall of the region is between 500-700 mm per annum which is mostly received during July to September. The experimental soil (0.0-0.15 m depth) analysed using the standard methods had shown pH 8.1 and 7.8, EC 0.17 dS $m^{-1}$and 0.09 dS m^{-1}, organic carbon 0.19% and 0.24%, available N 134.2 and 139.2 kg ha^{-1}, available P_2O_5 36.5 and 42.5 kg ha^{-1}, available K_2O 180.7 and 186.8 kg ha^{-1}, available Sulphur 7.10 and 8.75 ppm during the year 2015-16 and 2016-17, respectively. The treatments were consisted of three varieties RD-2668 (V1), DWRUB-52 (V2) , RD-2849 (V3), three nitrogen levels 60 (N1), 90 (N2) and 120 kg ha^{-1} (N3) and three sulphur levels 0 Control (S1), 10 (S2) and 20 kg ha^{-1} (S3).The experiments were laid out in Factorial Randomized Block Design (RBD) with three replications. The treatments were randomly allotted to different plots using random number table of Fisher and Yates (1963) [4]. As per treatment, fertilizers were applied through urea, DAP and gypsum. Full dose of phosphorus and sulphur with half dose of nitrogen were applied as basal, while remaining nitrogen was top dressed according to treatments. The barley varieties viz. RD 2668, DWRUB-52 and RD 2849 were sown on 15^{th} and 19^{th} November during 2015 and 2016 as per treatments. A uniform seed rate of 100 kg ha^{-1} was used at inter row spacing of 20 cm. In order to obtain uniform plant stand, seeds were weighed for each plot separately in small packets before sowing. Sowing was done manually in furrows, followed by irrigation. Five plants were randomly selected from each plot and tagged for required measurements. After harvesting, these samples were dried in sunlight for 2-3 days and finally dried in oven at 70 ˚C till constant weight was obtained. Thereafter, the samples were weighed for estimating total dry matter accumulation (g) at the above mentioned growth stages. After threshing and winnowing, grain yield per plot was weighed and expressed in terms of q ha^{-1}. Straw yield was obtained by subtracting the grain yield per plot from the respectively biological yield $plot^{-1}$ and expressed in terms of q ha^{-1}.

For recording crude protein and starch content in percentage samples of grain were taken replication wise and predicted using FOSS NIR system and expressed on dry weight basis. To record the husk content in percent, sodium hypochlorite method (dry basis) as per EBC method was used to determine the husk content in barley grain. To test the significance of variation in experimental data of various treatment effects, the data were statistically analyzed as described by Panse and Sukhatme (1985) [8].

Results and Discussion

Barley Yield

Barley varieties differ significantly in the grain and straw yield during both the year of experiment and on pooled data (Table 1). On the basis of pooled data, RD 2849 increased the grain yield by 9.21 and 12.91% as compared to varieties DWRUB 52 and RD 2668 respectively. Similarly, variety RD 2849 also recorded the highest straw yield (58.67 q ha-1) and showed significant increase of 7.29 and 8.18%, respectively, over varieties DWRUB 52 and RD 2668 based on pooled analysis. Chakravarty and Kushwah (2007) [2] also reported the highest grain yield of variety RD 2552 among three varieties i.e. RD 2552, K 560 and DL 88. Nitrogen application of 120 kg N ha^{-1} also brought significantly higher grain yield compare to control and but was found at par with 90 kg N ha^{-1}(Table 1). Application of 120 kg and 90 kg N ha-1 increased the grain yield of barley by 23.07 and 18.15% as compared to control, respectively, in pooled data. Similarly, application of 120 kg N ha-1 recorded the highest straw yield and proved superior to control and was found at par with 90 kg N ha-1 during both the years of experiment as well as in pooled analysis. Straw yield was recorded higher with increasing rates of N application might be due to improved biomass per plant at successive growth stages and increase in various morphological parameters like plant height, number of tillers etc. it has been also reported by Katiyar and Uttam (2007) [6] in barley and Jat *et al.* (2014) [5] in wheat. Sharma and Verma (2010) [11] also documented the significant positive influence of nitrogen on yield of barley. Sulphur significantly increased grain and straw yield during both the years of experiment as well as on pooled analysis. Among sulphur levels, application of 20 kg and 10 kg S ha^{-1} increased the grain yield by 11.00 and 8.53% as compared to control, while the treatment 20 kg S ha-1 was found at par with treatment 10 kg S ha^{-1}. As grain yield is primarily a function of cumulative effect of growth parameters and yield attributing characters, the higher values of these attributes because of sulphur and nitrogen application can be assigned as the most probable reason for significantly higher grain yield. Application of 20 kg S ha^{-1} recorded the highest straw yield and proved superior to control and was found at par with 10 kg S ha^{-1} during both the years of experiment as well as in pooled analysis. On the basis of pooled data, application of 20 kg and 10 kg S ha^{-1} increased the straw yield by 8.82 and 6.64% as compare to control.

Quality parameters

Crude protein (%)

Varieties did not cause any significant variation in crude protein content during both the years of experimentation and in pooled analysis (Table 2). Nitrogen bought significant variation in crude protein during both the years of experimentation as well as in pooled analysis. Application of 120 kg N ha^{-1} recorded the highest crude protein and proved significantly superior to control and was found at par with 90 kg N ha^{-1} during both the years of experimentation as well as in pooled analysis. Application of 120 kg and 90 kg N ha^{-1} increase the crude protein of barley by 12.80 and 11.08 per cent as compared to control, respectively, in pooled data. Similarly, application of 20 kg S ha^{-1} recorded the highest crude protein and proved significantly superior to control and was found at par with 10 kg S ha^{-1} during both the years of experimentation as well as in pooled analysis. Application of 20 kg and 10 kg S ha^{-1} increased the crude protein of barley by 7.50 and 6.25 per cent as compared to control, respectively, in pooled analysis. Fathi *et al*. (1997) also reported an increase in the grain protein content upto highest rate of added N (0 to 105 kg N ha^{-1}).

Starch content (%)

Barley varieties responded significantly in the starch content during both the year of experimentation and on pooled basis. Variety RD 2849 proved significantly superior as compared to other varieties during both the years of experimentation. On the basis of pooled data, RD 2849 increased the starch content by 2.85 and 5.14 per cent, respectively as compared to variety DWRUB 52 and RD 2668. Nitrogen application significantly increased the starch content during both the years and in pooled analysis over control (Table 2). Among of nitrogen levels, application of 120 kg N ha^{-1} recorded the highest starch content and proved significantly superior to control and was found at par with 90 kg N ha^{-1} during both the years of experimentation as well as in pooled analysis. Application of 120 kg and 90 kg N ha^{-1} increased the starch content of barley by 6.18 and 5.71 per cent as compared to control, respectively, in pooled data. Sulphur levels significantly increased starch content during both the years and in pooled analysis. Among of sulphur levels, application of 20 kg S ha^{-1} recorded the highest starch content and proved significantly superior to control and was found at par with 10 kg S ha^{-1} during both the years of experimentation as well as in pooled analysis. Application of 20 kg and 10 kg S ha^{-1} increased the starch content of barley by 9.47 and 8.10 per cent as compared to control, respectively, in pooled analysis (Table 2). Varieties, nitrogen levels and sulphur levels did not cause any significant variation in husk content during both the years of experimentation and pooled data.

Correlation and regression

Simple correlation and regression were worked out between grain yield and dry matter at physiological maturity, effective tillers, length of spike, number of grains per spike, test weight, malt yield, malt friability, malt homogeneity, hot water extract and hectoliter weight. The correlation coefficients and corresponding regression equations have been given in table 3.

Correlation coefficient study revealed that the yield was significantly and positively correlated with dry matter at physiological maturity, effective tillers, length of spike, number of grains per spike, test weight, malt yield, malt friability, malt homogeneity, hot water extract and hectoliter weight. The corresponding values for correlation coefficients were 0.98, 0.89, 0.93, 0.90, 0.98, 0.92, 0.96, 0.94, 0.85 & 0.97 during 2015-16 and 0.98, 0.85, 0.93, 0.92, 0.98, 0.90, 0.97, 0.94, 0.86 & 0.96 during 2015-16 and in pooled and 0.98, 0.87, 0.93, 0.91, 0.98, 0.91, 0.97, 0.94, 0.85 & 0.97 This indicates that yield attributes and malt quality parameters are directly correlated with the grain yield.

The regression equations show that with the increase in one unit in dry matter at physiological maturity, effective tillers, length of spike, number of grains per spike, test weight, malt yield, malt friability, malt homogeneity, hot water extract and hectoliter weight, the corresponding grain yield increased by 0.192, 0.417, 3.57, 1.65, 1.47, 1.00,1.10, 1.15, 3.09 & 1.16 during 2015-16 and 0.173, 0.308, 3.60, 1.56, 1.25, 0.886, 1.05, 1.04, 2.82 & 1.04 during 2016-17 and in pooled 0.182, 0.359, 3.61, 1.60, 1.36, 0.94, 1.08, 1.10, 2.95 & 1.10 respectively.

Table 1: Response of malt barley varieties to nitrogen and sulphur on grain, straw yield and harvest index

Treatments	Grain yield (q ha^{-1})			Straw yield (q ha^{-1})		
	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled
Varieties						
RD 2668	39.48	40.73	40.11	53.61	54.85	54.23
DWRUB 52	40.87	42.07	41.47	54.36	55.00	54.68
RD 2849	44.80	45.77	45.29	57.66	59.68	58.67
SEm±	0.90	0.96	0.66	1.01	1.09	0.74
CD (P=0.05)	2.56	2.73	1.85	2.87	3.10	2.09
Nitrogen levels (kg/ha)						
60	36.43	37.92	37.18	50.03	50.53	50.28
90	43.40	44.45	43.93	56.76	58.48	57.62
120	45.32	46.20	45.76	58.84	60.52	59.68
SEm±	0.90	0.96	0.66	1.01	1.09	0.74
CD (P=0.05)	2.56	2.73	1.85	2.87	3.10	2.09
Sulphur levels (kg/ha)						
0	38.90	40.50	39.70	52.25	53.99	53.12
10	42.63	43.55	43.09	56.11	57.19	56.65
20	43.62	44.52	44.07	57.27	58.35	57.81
SEm±	0.90	0.96	0.66	1.01	1.09	0.74
CD (P=0.05)	2.56	2.73	1.85	2.87	3.10	2.09

NS = Non significant

Table 2: Response of malt barley varieties to nitrogen and sulphur on crude protein, starch content and husk content

Treatments	Crude protein content (%)			Starch content (%)			Husk (%)		
	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled
Varieties									
RD 2668	9.85	9.95	9.90	60.29	60.12	60.20	8.88	8.91	8.89
DWRUB 52	9.98	10.15	10.07	61.43	61.66	61.54	8.95	8.98	8.97
RD 2849	10.05	10.22	10.13	63.14	63.45	63.30	9.07	9.09	9.08
SEm±	0.08	0.09	0.06	0.48	0.52	0.36	0.07	0.08	0.05
CD (P=0.05)	NS	NS	NS	1.37	1.49	1.00	NS	NS	NS
Nitrogen levels (kg/ha)									
60	9.27	9.32	9.29	59.36	59.30	59.33	8.88	8.92	8.90
90	10.21	10.44	10.32	62.60	62.84	62.72	8.99	9.00	9.00
120	10.40	10.56	10.48	62.91	63.10	63.00	9.04	9.05	9.05

SEm±	0.08	0.09	0.06	0.48	0.52	0.36	0.07	0.08	0.05
CD (P=0.05)	0.23	0.26	0.17	1.37	1.49	1.00	NS	NS	NS
Sulphur levels (kg/ha)									
0	9.50	9.69	9.59	58.15	58.39	58.27	8.88	8.91	8.90
10	10.13	10.25	10.19	62.92	63.05	62.99	8.99	9.01	9.00
20	10.25	10.38	10.31	63.79	63.79	63.79	9.03	9.06	9.05
SEm±	0.08	0.09	0.06	0.48	0.52	0.36	0.07	0.08	0.05
CD (P=0.05)	0.23	0.26	0.17	1.37	1.49	1.00	NS	NS	NS

NS = Non significant

Table 3: correlation coefficients (r) and regression equations for the relationship between grain yield (Y) (q ha^{-1}) and growth, yield attributing characters and quality parameters of crop (X)

S. No.	Treatments	2015-16		2016-17		Pooled	
		Correlation coefficient (r)	**Regression equation $Y = a + b_y x .X$**	**Correlation coefficient (r)**	**Regression equation $Y = a + b_y x .X$**	**Correlation coefficient (r)**	**Regression equation $Y = a + b_y x .X$**
1.	Dry matter at harvest	0.981**	$Y = -4.840+0.192 X_1$	0.983**	$Y = 0.136 + 0.173 X_1$	0.982**	$Y = -2.368 + 0.182 X_1$
2.	Effective tillers/plant	0.890**	$Y = -92.429 + 0.417 X_1$	0.852**	$Y = -61.717 + 0.308 X_2$	0.872**	$Y = -76.281 + 0.359 X_2$
3.	Number of grains/spike	0.931**	$Y = -49.981 + 3.575 X_3$	0.938**	$Y = -56.314 + 3.605 X_3$	0.938**	$Y = -53.825 + 3.616 X_3$
4	Spike length (cm)	0.909**	$Y = 23.432 + 1.657 X_4$	0.921**	$Y = 25.389 + 1.561 X_4$	0.915**	$Y = 24.399 + 1.609 X_4$
5	Test weight (g)	0.982**	$Y = -28.419 + 1.474 X_4$	0.985**	$Y = -21.420 + 1.257 X_5$	0.986**	$Y = -25.164 + 1.367 X_5$
6	Malt yield	0.925**	$Y = -43.956 + 1.005 X_6$	0.903**	$Y = -33.149 + 0.886 X_6$	0.915**	$Y = -38.654 + 0.946 X_6$
7.	Malt friability	0.965**	$Y = -9.856 + 1.102 X_7$	0.975**	$Y = -6.331 + 1.057 X_7$	0.971**	$Y = -8.156 + 1.081 X_7$
8.	Malt homogeneity	0.949**	$Y = -46.900 + 1.159 X_8$	0.940**	$Y = -37.404 + 1.046 X_8$	0.945**	$Y = -42.168 + 1.103 X_8$
9	Hot water extract	0.853**	$Y = -206.531 + 3.091X_9$	0.860**	$Y = -184.053 +2.823X_9$	0.857**	$Y = -195.318 + 2.958 X_9$
10	Hectoliter weight	0.970**	$Y = -27.813 + 1.162 X_{10}$	0.968**	$Y = -20.809+ 1.046X_{10}$	0.970**	$Y = -24.415 + 1.105 X_{10}$

** Significant at 1 per cent level of significance

4. References

1. Baik BK, Ullrich SE. Barley for food: Characteristics, improvement, and renewed interest. Journal of Cereal Science. 2008; 48:233-42.
2. Chakrawarty VK, Kushwaha KP. Performance of barley (*Hordeum vulgare*) varieties under sowing dates and nitrogen levels in Bundelkhand. Progressive Research. 2007; 2:163-64.
3. Chhonkar PK, Rattan RK. Soil Fertility Management for Sustainable Agriculture. Indian Farming. 2000; 49(11):26-31.
4. Fisher RA, Yates F. Statistical tables. Oliver and Boyd, Edinburgh, London, 1963.
5. Jat SL, Nepalia V, Choudhary J, Singh D. Effect of nitrogen and weed management on productivity and quality of durum wheat (*Triticum durum*). Indian Journal of Agronomy. 2014; 59(2):281-285.
6. Katiyar AK, Uttam SK. Effect of fertility levels and weed control measures on growth, yield attributes and yield of barley (*Hordeum vulgare* L.) under rainfed condition. Bhartiya Krishi Anusandhan Patrika. 2007; 22:324-326.
7. Pal D, Kumar S, Verma RPS. Pusa Losar (BHS 380) – the first dual- purpose barley variety for northern hills of India. Indian Journal of Agricultural Sciences. 2012; 82:164 -165.
8. Panse VG, Sukhatme PV. Statistical Methods for Agricultural Workers. Indian Council of Agricultural Research. New Delhi, 1985.
9. Pourkheirandish M, Komatsuda T. The importance of barley genetics and demonstration in a global perspectives. Annals of Botany. 2007; 100:999-1008.
10. Sestak Z, Catsky J, Jarvis PG. Plant photosynthetic production: Manual of methods. Dr. W.junk N.V. Publishers, Den Haag, 1971.
11. Sharma RK, Verma RPS. Effect of irrigation, nitrogen and varieties on the productivity and grain malting quality in barley. Cereals Research Communication. 2010; 38:419-28.
12. Verma RPS, Kharub AS, Kumar D, Sarkar B, Selvakumar R, Singh R *et al*. Fifty years of coordinated barley research in India. Directorate of Wheat Research, Karnal-132001. Research Bulletin No. 2011; 27:46.
13. Zebarth BJ, Arsenault WJ, Moorehead S, Tapani Kunelius H, Sharifi M. Effect of fertilizer nitrogen management and plough-sown date for Italian ryegrass on soil nitrogen supply to a subsequent potato crop. Agronomy Journal. 2009 101:1573-1580.