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Research Article

EFFECT OF SOWING DATE AND NITROGEN LEVEL ON GROWTH AND YIELD OF BARLEY (*Hordeum vulgare* L.) UNDER IRRIGATED CONDITIONS OF PUNJAB REGION

SINGH SANDEEP*[1], LAL MOHINDER[1] AND KAUR JASHANJOT[2]
[1]PG Department of Agriculture, GSSDGS Khalsa College, Patiala, Punjab, 147001, India
[2]ICAR- Krishi Vigyan Kendra, Rauni, Patiala, 147001, Punjab Agricultural University, Ludhiana, 141004, Punjab, India
*Corresponding Author: Email - sandeeps1328@gmail.com

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Abstract- The field experiment was conducted during the *rabi* season of 2015-16 at Campus for Research and Advance Studies Dhablan, Patiala to evaluate the response of yield and yield attributes of barley (*Hordeum vulgare* L.) to date of sowing and nitrogen levels. A set of 12 treatment combinations including three dates of sowing *viz*., 20th October (D1), 16th November (D2) and 10th December (D3) in main plot, and nitrogen control, @ 30 kg ha^{-1}, 60 kg ha^{-1}, 90 kg ha^{-1} in sub plot were applied. The results showed that the crop sown on 20th October and 16th November attained statistically similar plant growth characters (in terms of plant height and dry matter accumulation). Crop sown on 20th October received significantly higher effective tiller (364.69 m^{-2}) then other date of sowing (16th November (358.61 m^{-2}) & 10th December (347.66 m-2)). Crop sown on 16th November resulted better yield attributes (Spike length, Number of grains per spikes and test weight) than the 20th October and 10th December. Different date of sowing significantly affects the yield and a yield attributes of barley. Grain yield found to be significant with crop sown on 16th November, however biological yield significant crop sown on 20th October. Application of 90 kg nitrogen per hectare resulted in improvement in most of the growth parameter. Application of 90 kg nitrogen per hectare resulted in improvement in most of yield attributes (Spike length, Number of grains per spikes and test weight). Grain and biological yield significant increase with each increasing in Nitrogen level up-to 90 kg ha^{-1}.

Keywords- *Date of sowing, Nitrogen, Plant Height, Dry Matter, Crop Growth Rate Spike length, Grain yield and biological yield*

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Introduction

Barley (*Hordeum vulgare* L.) is one of most important cereal crop consumed as a major food and feed. It is considered to be the fourth most -important crop in the world after wheat, maize and rice with a share of 7% of the global cereals production. In India, it is grown on an area of 6.95 lakh hectares with 1.74 million tonnes production with productivity 2.50 t ha^{-1} India [3]. Whereas, in Punjab it was grown on 15 thousand hectares with a production of 39 thousand tones and average yield of 35.80 ha^{-1} during 2014-15 [4]. Even though, barley can be grown under a wide range of soil and climatic conditions, but it is best adapted to fertile and well drained silt to clay loam soils and warm dry climates. The best sowing time is October to November and harvesting starts from end-March until mid- April in the northern India. Late harvesting of preceding crops, excessive soil moisture after rainy season and increasing cropping intensity have pushed a sizable barley area under moderately late to late sown condition. Late sown plants experience low temperature at the vegetative stage, which decreases rate of physiological processes particularly, root growth and nutrient and water uptake. On the contrary, reproductive stages of late sown plants experience high temperature, which reduces grain growth and ultimately crop productivity. Delayed planting may decrease yield and kernel plumpness though it could result in increased N content in the grain. Rate of nitrogen application is also an important cultural practice for realizing potential yield of any crop as requirement for nitrogen is the highest among all the essential plant nutrients. Keeping all these points in mind the present study was planned with an objective of studying effect of planting dates and nitrogen levels on growth and yield of barley.

Material and Methods

The experiment was conducted at research farm Dhablan, PG Department of Agriculture Khalsa College Patiala, during Rabi season 2015-16. The soil of the experimental field was clay loam in texture, soil pH 7.2, medium in organic carbon (0.6), medium in available nitrogen (376.32 kg ha^{-1}), high in available phosphorus (30.32 kg ha-1) and medium in available potassium (130 kg ha^{-1}). The experiment was laid-out in split- plot design with three dates of sowing 20th October (D_1), 16th November (D_2) and 10th December (D_3) in main plot and four levels of Nitrogen (0, 30, 60, 90 kg ha^{-1}) in sub plots replicated four times. A uniform basal dose of 30 kg P2O5/ha in the form of Super Phosphate (16% P_2O_5) was applied before sowing. Nitrogen was applied as per treatments in the form of urea (46% N). A uniform seed rate of 90 kg ha^{-1} used. Crop was sown with the row spacing of 22.5 cm as per treatments. Weeds were controlled manually twice by hoeing the crop at 30 and 60 days after sowing. After sowing plant height, dry matter and growth parameters in each plot was recorded at 30day interval. In order to study the influence, the dry matter production, plant samples were taken from one-meter row length in each plot after removing the root, the remaining plant samples were first sun-dried and then dried in an electric oven at 70°C for 72 hr till constant weight and the weight (g) was recorded. The crop was harvested from net plot and threshed with the help of thresher. After threshing and winnowing, the weight of grain obtained from each net plot area was recorded in kg/ plot and then converted in q ha^{-1}. Data were analyzed in SAS 9.4 using the GLM procedure to evaluate differences between the treatments and means were compared LSD test at $p < 0.05$.

Result and Discussion

Effect of Date of Sowing and Nitrogen Levels on Growth

Date of sowing had a significant influence on growth characters of barley. Plant height was significantly higher in crop sown on 20th October which remained statistically at par with crop sown on 16th November and both were significantly better than crop sown on 10th December. The possible reason for significantly shorter plants when sowing was done on 10th December may be ascribed to the fact that vegetative phase of crop growth coincided with the low temperature, which reduces the growth of the plant by affecting its various metabolic processes. Data pertaining to dry matter accumulation showed that crop sown on 20th October & 16th November has accumulated statistically similar dry matter at all growth stages and were better than 10th December sown crop. The possible reason for higher dry matter in these treatments could be due to higher plant height which has resulted in higher photosynthate accumulation adding to more dry matter. Similar findings were reported by Fahad and Samir, (2015) [8]. Trend of changes of crop growth rate at different date of sowing indicates higher in crop sown on 20th October over the other date of sowing at 90 DAS [Fig-1]. However, CGR at harvest was highest in 16 November sown crop as compare to other date of sowing. Similar results were reported by Singh, (2005) [15]. It has been discussed earlier that 16th November and 20th October sown crop experienced more favourable climatic conditions. Also, due to shortening of growing season because of late sowing total dry matter production was reduced in 10th December sown crop which reduced its yield. Similar results were reported by Chandra, *et al*., (2015) [5]. Plant height was significantly influenced with variable nitrogen levels. Application of 90 kg ha^{-1} nitrogen had resulted in significantly higher plant height and dry matter accumulation in comparison to all other treatments. However, application of 30 and 60 kg ha^{-1} nitrogen was found to be statistically at par with each other and significantly higher than the control. Similar results were reported by Mohammadi and Farideh, (2014) [11]. Among different N levels, highest crop growth rate was found with application of nitrogen @ 90 kg ha^{-1} as compared to other lower levels of nitrogen [Fig-2]. Similar result was found by Jena, *et al*., (2014) [9] and Chandra, *et al*., (2015b) [5], Alam, *et al*., (2005) [1].

Table-1 Effect of date of sowing and nitrogen levels on plant height, dry matter accumulation of barley crop

Treatments	Periodic Plant height (cm)			Periodic dry matter (q/ha)		
	60 DAS	90 DAS	At harvest	60 DAS	90 DAS	At harvest
Date of sowing						
20-Oct	39.17	86.00	92.95	2.08	3.95	8.90
16-Nov	38.25	85.82	92.8	2.16	3.77	8.84
10-Dec	36.2	76.95	88.56	2.01	3.58	8.07
LSD (p=0.05)	0.36	0.44	0.56	0.05	0.23	0.06
Nitrogen Level						
0 kg ha^{-1}	37.90	74.18	90.9	1.94	2.47	6.36
30 kg ha^{-1}	38.00	75.14	91.36	2.01	3.64	8.00
60 kg ha^{-1}	37.6	76.78	91.41	2.14	3.83	8.47
90 kg ha^{-1}	37.94	78.13	92.05	2.24	4.12	8.90
LSD (p=0.05)	NS	0.43	0.48	0.05	0.21	0.05

Effect of Date of Sowing and Nitrogen on Yield and Yield Attributes of Barley

The results of the study on response of barley (*Hordeum vulgare* L.) yield attributes to nitrogen and date of sowing are presented [Table-1]. The effective tiller was significantly influenced by the date of sowing. Effective tillers were significantly higher in crop sown on 20th October (364.69) than 16th November (358.16) and 10th December (347.66). Similar results were reported by Donovan, *et al*., (2011) [7]. It is known that high temperature at the time of tillering of cereal crops wheat and barley is differential to tillers production. Crop sown on dates D_1 and D_2 experienced higher temperature than sown during December (D_3) which favoured production of more number of tillers. Significantly less number of effective tiller under D_3 might also be attributed to it's shorter growing period, due to which the late tiller could not turn out to be effective. The date of sowing had significant effect on the spike length of crop sown on 16th November was significantly higher than crop sown on other dates. However, spike length of the crop sown on 20th October and 10th December were also found significant with each other. Similar results were reported by Alam and Haider, (2007) [2] and Donovan, *et al*., (2015) [7]. Numbers of grains per spike were significantly higher when crop was sown on 16th November than the other sowing dates. Significantly least number of grains per spike was observed in crop sown on 10th December. Similar results were obtained by Rashid and Khan, (2010) [14], Juskin and Halm, (2003) [10] and Patel, *et al.* (2004) [11]. However, least number of grains per spike under crop sown on 10th December might be attributed to reduced spike length due to shorter duration of crop. Highest 1000-grain weight was obtained when crop was sown on 16th November which was significantly highest than the crop sown on 10th December but statistically at par with crop sown on 20th October. These finding are in close conformity with the results of Juskin & Halm, (2003) [10], Patel, *et al*., (2004) [11], Donovan, *et al*., (2015) [7], The higher 1000-grain weight under 16th November and 20th October sown crop might be due to the reason that the D_1 sown crop took significantly more number of days from heading to maturity, thus got longer period for photosynthates translocation to grain, where as in later sown crop (10th December). Grain yield is a function of the various growth characters and yield attributes. Crop sown on 16th November recorded higher grain yield which was statistically similar with that of 20th October sown crop and both were significantly superior over 10th December sown crop. It has been discussed earlier that 16th November and 20th October sown crop experienced more favourable climatic conditions. Also, due to shortening of growing season because of late sowing total dry matter production was reduced in 10th December sown crop which reduced its yield. Similar results were reported by Pankaj, *et al*., (2015) [12]. Significant ($p<0.05$) differences were observed in effective tillers m-2, no. of grains spike^{-1}, grain yield, biological yield due to various levels of Nitrogen. More effective tillers m^{-2} (359.67), highest number of grain spike^{-1} (37.37), 1000 grain weight ((35.99 g), grain yield (33.88 q ha^{-1}) and biological yield (85.65 q ha^{-1}) was produced by the application of 90 kg N ha^{-1}.

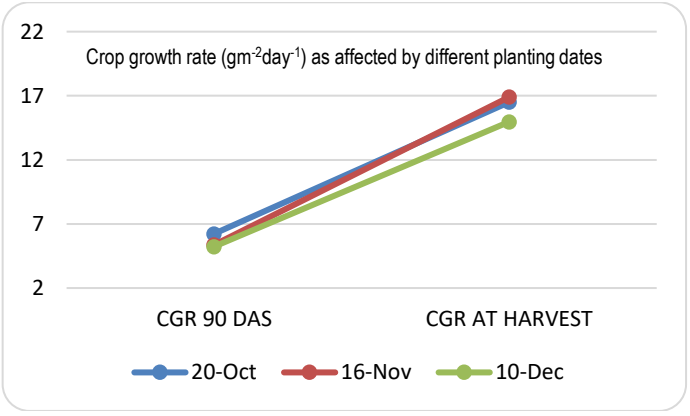

Fig-1 Trend of changes of crop growth rate (gm^{-2}day^{-1}) in different planting dates

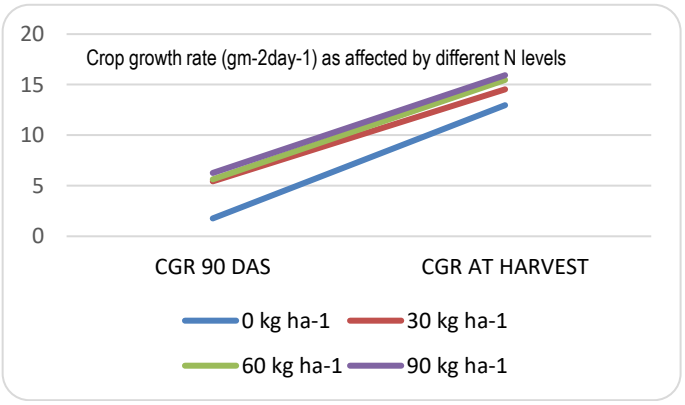

Fig-2 Trend of changes of crop growth rate (gm^{-2}day^{-1}) by variable N application rates

Table-1 Effect of various treatments on yield contributing characters (effective tillers (m^2), Spike length (cm), No. of grain per spike, 1000-grain weight (g) and yield (q ha^{-1})

Treatment	Effective Tiller (m^2)	Spike length (cm)	No. of grains Per spike	1000-grain Weight (g)	Grain Yield (q ha^{-1})	Biological Yield (q ha^{-1})
Date of sowing						
October 20	364.69	7.48	34.91	38.55	31.85	85.13
November 16	358.61	7.84	36.53	39.79	32.38	84.32
December 10	347.66	6.73	33.75	26.65	28.58	80.53
LSD (p=0.05)	0.33	0.30	0.02	1.8	1.26	0.09
Nitrogen level						
Control	354.31	7.35	33.34	35.04	28.23	80.79
30 kg ha^{-1}	355.80	7.42	34.16	35.09	29.68	82.67
60 kg ha^{-1}	357.55	7.46	35.4	35.86	31.97	84.20
90 kg ha^{-1}	359.67	7.58	37.37	35.99	33.88	85.65
LSD (p=0.05)	**0.43**	**NS**	**0.03**	**NS**	**1.46**	**0.07**

Improvement in number of grains per spike due to higher nitrogen levels might be due to better partitioning of carbohydrates from leaf to reproductive parts resulting in increased number of grains per spike. These findings are in close conformity with the results of Singh, *et al*., (2005) [16]. Each increment in N significantly increased number of gains per spike. Similar results were reported by Mohammadi and Farideh, (2014) [13], Shokat and Mani, (2015) [15]. Application of nitrogen found to be a non-significant effect on spike length. Similarly, N level did not cause significant variation on this 1000 grain weight. These findings are in close conformity with the results of Yadav, *et al*., (2012) [17]. With increasing nitrogen levels from 0 kg ha^{-1} to 90 kg ha^{-1} grain and biological yield significantly increased. Higher grain as well as biological yield was obtained with application of 90 kg of nitrogen which was significantly superior over all other nitrogen levels. This might be attributed to better growth which ultimately contributed toward higher grain yield. Jena, *et al*., (2014) [9] also reported better yield with application of optimum nitrogen dose.

Conclusion

It was observed that plant height, dry matter and biological yield significantly higher with crop sown on 20th October and 16th November sown crop. Application of 90 kg ha^{-1} nitrogen significantly increases all the growth parameter. Spike length, number grain per spike, 1000- grain weight grain and biological yield significantly higher with crop sown on 16th November sown crop.

Application of research: Application of 90 kg ha^{-1} nitrogen significantly increases effective tiller, number grain per spike as well as grain and biological yield.

Research Category: Crop Science

Abbreviations:
CGR: Crop growth rate
Kg: Kilogram
Ha^{-1}: Per Hectare
q ha^{-1}: quantile per hectare

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