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Full Length Research Article

Effect of Different Seed Rates and Nitrogen Levels on Growth and Yield of Barley (*Hordeum vulgare* L)

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Abstract

The trial was conducted to evaluation the effect of seed rate and nitrogen levels on growth and yield in barley crop, field experiment was carried out in 2020-21 growing seasons. Experimental units were arranged in Factorial Randomized Block Design (RBD) with three replications. The highest value of growth parameters were obtained in the application of 80 kg ha^{-1} seed rate with nourishing of 120 kg nitrogen ha^{-1}. All of the growth characters viz. plant height (cm), number of functional leaves plant^{-1} (at 90 DAS), number of tillers plant^{-1} and dry weight (g) plant^{-1} at harvest and yield attributes i.e., length of ear (cm), number of grains ear^{-1} and weight of ear (g) were found significantly maximum with the application of seed rate 80 kg ha^{-1} in combination of 120 kg nitrogen ha^{-1}. The significant highest seed yield 40.94 q ha^{-1} was calculated with application of 100 kg ha^{-1} seed rate which was 1.75%, 1.58% and 2.64% more over application of 110 kg, 90 kg and 80 kg ha^{-1} seed rate. Increasing level of nitrogen significantly enhanced seed yield, the 120 kg ha^{-1} nitrogen application gave highest seed yield i.e., 43.63 q ha^{-1} over other nitrogen levels i.e., 100 kg, 80 kg ha^{-1} and the control. The highest benefit cost ratio 1.34 was calculated with 100 kg of seed rate and 1.39 in respect of 120 kg ha^{-1} nitrogen level.

***Key words*:** *Hordeum vulgare* L, Seed rate, Nutrition, Nitrogen, Growth, Yield

Barley (*Hordeum vulgare* L) is one of the most important rabi cereal crop of arid and semi-arid areas of the country. It has some special feature such as tolerant to saline and alkaline conditions has high yielding potentially containing 11.5% protein, 1.13% fat, 3.9% crude fibre, 1.5% Ash and 1.2% minerals. Barley is basically used in making of malt and a fermented drink 'Lugri' its water is found beneficial for those suffering from diarrhea and dysentery patients. In India, Barley hugely used as animal and poultry feed and also as fodder purpose due to its rapidly growing nature [1]. Out of 140.19 mt of global production, India shares 1.29 percent and it is fourth important cereal after Rice, maize and Wheat [2]. During 2020-21 the United States Department of Agriculture (USDA) estimated that the world Barley Production 2020-21 was 149.53 mt, around 0.53 mt more than previous month's projection [3]. In India barley occupied nearly 5.92 lakh hectares area having a production of 16.56 lakh tonnes grain with a productivity of 28.05 q ha^{-1} [4]. The barley is an exhaustive crop as other cereals and requires more nutrients from the soil under assured irrigated condition, the response of nutrients especially nitrogen is low, need careful application. Under limited irrigated areas particularly where the wheat cultivation is difficult, successfully barley crop gives economic higher yield under available input resources. The average productivity of barley is very low in comparison to the attainable yield of 40-50 q ha^{-1}. Increased barley production involves use of different agronomic practices such as improved variety, seed rate, spacing, fertilizer rate and pesticide application at the recommended rate. When, assessing grain yield of a set of cultivars in different nitrogen levels and seed rate changes are commonly observed in the relative yield performance with respect to each other.

MATERIALS AND METHODS

The experiment was conducted at the Brahmanand Post Graduate College, Agricultural Research Farm, Post-Rath, District Hamirpur, Uttar Pradesh (India) during the winter (rabi)

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season of 2020-21. The soil of experimental field was 'parwa' (A category of red soil) with slightly alkaline in reaction (pH 7.6) which was low in available nitrogen (200.83 N_2O kg ha^{-1}), medium in available phosphorus (29.28 P_2O_5 kg ha^{-1}) and high in available potassium (474.16 K_2O kg ha^{-1}) and ranging 0.56% organic carbon content [5]. The trial was laid out in factorial randomized block design with three replications having 16 treatment combinations of four different seed rate i.e., 80 kg, 90 kg, 100 kg and 110 kg ha^{-1} and three nitrogen levels i.e., 80 kg, 100 kg and 120 kg ha^{-1} including control. A uniform dose of phosphorus (60 kg ha^{-1}) through DAP as basal application before sowing and recommended dose of K_2O (40 kg ha^{-1}) were applied via MOP in all treatment combinations. Field was prepared and sown in plots along with recommended package of practices. The field was ploughed with *Desi Plough* and left of 7 days, thereafter, one pre-sowing irrigation was applied to the field. At the right tilth, 4 cross ploughing were done with *Desi Plough*. Others practices viz. interculture, weeding and plant protection measures were applied as need based. The variety 'Prakhar (K-1055)' a six rowed barley developed by CSAU&T Kanpur was purchased from a government approved agri junction shop situated in the local.

Statistically analysis

After the data collection was completed, it was classified, arranged and statistically analyzed according to the statistical program Genstat Discovery 4, and a comparison of the averages of the coefficients was made at the 0.05 probability level 6.

RESULTS AND DISCUSSION

Growth parameters

The results in (Table 1) showed that a significant effect of seed rate and nitrogen level on growth characters viz. Plant height, number of functional leaves, number of tillers and dry weight in barley crop. Non significantly highest number of plant population 109.75 running $meter^{-1}$ were counted with the application of 110 kg seed rate ha^{-1} which was 9.44%, 18.76% and 19.17% more over 100 kg, 90 kg and 80 kg of seed rate ha^{-1}, while the lowest number of plants per running meter (90.58) were counted with 80 kg seed rate. It was due to the highest number of seeds in a running meter distance, however this much number of plant population could not produce maximum seed yield due to competition for light, water and nutrients between them [6-7]. The lowest plant population were counted with the application of 80 kg seed ha^{-1} due to reduced number of seeds in running meter. Different nitrogen levels also influenced non-significantly the plant population per running meter and 100 kg nitrogen per hectare increased maximum number (96.49) of plants running $meter^{-1}$ which was counted more over other nitrogen levels i.e., 120, 80 and control, respectively. Highest number of plant population were counted with 100 kg of nitrogen ha^{-1} due to optimum dose whereas in 120 kg of nitrogen ha^{-1} few of the mortality in barley plants was found during the initial stage of trial growth. The results are in consonance with [8].

Highest plant height 82.46 cm significantly increased with application of 80 kg seed rate ha^{-1} which was 5.36 cm, 8.59 cm and 11.13 cm more than 90 kg, 100 kg and 110 kg of seed rate ha^{-1}, respectively, this is due to the lack of competition between plants, thus increasing their elongation and obtaining adequate food. The decreased plant height in increasing seed rate right from 80 kg to 110 kg ha^{-1} was due to competition for light, nutrients and water between them. These results were agreed with [9]. Increasing levels of nitrogen significantly enhanced plant height up to 120 kg ha^{-1} the highest value 80.6 cm was measured with application of 120 kg nitrogen ha^{-1}, this level of nitrogen application increased 2.28 cm, 5.96 cm and 9.4 cm more over 100 kg, 80 kg and control. The 100 kg application of nitrogen level was significantly more over 80 kg ha^{-1} and the control both, this is attributed due to role that nitrogen fertilization plays in increasing the division and expansion of cells for the developing tops of the stem and leaves and that increasing the leaf area leads to increased shading and this in turn increases the action of auxin and gibberellin on increasing the elongation of the internodes, and then increasing the height. Similar findings were observed by [10-11].

Table 1 Effect of seed rate and nitrogen levels on growth characters of barley

Treatments	Plant population running $meter^{-1}$	Plant height at harvest (cm)	Number of functional leaves $plat^{-1}$ at 90 DAS	Number of tillers $plat^{-1}$ at harvest	Dry weight $plant^{-1}$ (g)
		Seed rate (Kg ha^{-1})			
80.00 (S_1)	90.58	82.46	8.58	5.36	19.70
90.00 (S_2)	91.59	77.10	7.96	5.01	18.42
100.00 (S_3)	100.31	73.87	7.53	4.80	17.66
110.00 (S_4)	109.75	71.33	7.20	4.64	17.05
C.D. at (0.05)	N.S.	1.89	0.16	0.19	0.66
		Nitrogen levels (Kg ha^{-1})			
Control (N_0)	95.17	71.20	6.56	4.63	17.01
80.00 (N_1)	95.43	74.64	7.58	4.84	17.83
100.00 (N_2)	96.49	78.32	8.25	5.10	18.72
120.00 (N_3)	96.17	80.60	8.88	5.25	19.26
C.D. at (0.05)	N.S.	1.89	0.16	0.19	0.66

Number of functional leaves per plant at 90 DAS were significantly differed in decreasing manner up to 110 kg seed rate ha^{-1} and counted maximum with 80 kg of seed rate per hectare (8.58) which was 0.62, 1.05 and 1.38 more over 90, 100 and 110 kg of seed rate ha^{-1} respectively, may be due to optimum moisture and nutrients availability without any competition between them and this value decreased as increasing in seed rate due to over-crowding of number of plants per running $meter^{-1}$ and much competition for light, nutrients and moisture availability. Nitrogen level also influenced the production of function leaves $plant^{-1}$ and the highest number of leaves $plant^{-1}$ (8.88) at 90 DAS were counted with the application of 120 kg nitrogen ha^{-1} which was significantly more over 100 kg, 80 kg nitrogen ha^{-1} and the control also, that is may be due to increasing the level of nitrogen fertilization at a sufficient level led to an increase in the number of leaves ha^{-1} in barley plants, and this result agreed with [12].

Maximum number of tillers $plant^{-1}$ (5.36) were counted with the application of 80 kg seed rate ha^{-1} which were exceeded

6.63%, 10.54% and 13.52% more over 90, 100 and 100 kg of seed rate ha^{-1}. Number of tillers significantly decreased with increasing the seed rate up to 110 kg seed rate ha^{-1} and the lowest value was recorded with 110 kg of seed rate ha^{-1}. Increased level of nitrogen application also increased the number of tillers plant^{-1} and the maximum number of tillers (5.25) were counted with 120 kg nitrogen ha^{-1}, this much value was non-significantly more over 100 kg, while significantly superior on the application of 80 kg nitrogen per hectare application and the control where the minimum value (4.63) was recorded. These results are in support of [13].

Similarly highest value of dry weight plant^{-1} was weighted with the application of 80 kg seed rate (19.70 g) which was significantly superior over the application of 90 kg (18.42 g), 100 kg (17.66 g) and 110 kg (17.05) of seed rate ha^{-1} might be due to large rate of seeds led to competition and reduced the number of tillers, thus reducing the dry weight of stems. Dry weight plant^{-1} (g) non-significantly increased with 120 kg of nitrogen application over 100 kg and was significantly more than 80 kg of nitrogen application and control, the reason for this is attributed to the structural and functional role of nitrogen in increasing vegetative growth, cell division, expansion and elongation, similar results were presented by [14].

Yield attributes

The data given in table (2) shows that effect on yield attributes like length of ear (cm), number of grains ear^{-1} and weight of ear (g) were observed with the application of different seed rate and nitrogen level. Maximum length of ear (9.39 cm) was measured with application of 80 kg seed rate ha^{-1} which was significantly higher over 90 kg, 100 kg and 110 kg of seed rate ha^{-1}, the lowest value (8.14 cm) was measured with application of 110 kg seed rate per hectare. The reason for this was due to the great competition for the length of ear with increase in the rate of seeds compared to the decreased rate of seeds, which gave the highest average length of ear. Nitrogen level also influenced the length of ear and recorded highest value (9.18 cm) up to application of 120 kg nitrogen ha^{-1} which was significantly more over 100 kg and 80 kg of nitrogen level, significantly lowest length of ear (8.11 cm) was measured in control. This is due enhanced growth characters with respective treatment and the role of nitrogen in increasing vegetative growth, cell division, expansion and elongation, which is reflected in the increase in the diameter of the stem and thus the increase in the length of ear (cm), this result agreed with [15].

Number of grains per ear and weight of ear plant^{-1} were found significantly maximum with application of 80 kg seed rate ha^{-1} and these values also decreased with increasing in seed rate up to 110 kg seed rate ha^{-1}, the lowest value in this regard was recorded with highest seed rate of 110 kg ha^{-1}. It might be due to fact that much competition for light, water and nutrients with increasing number of seeds in a unique area due to high seed rate. With regards to nitrogen level non-significantly highest value was recorded with 120 kg of nitrogen level over 100 kg of nitrogen level and it was significantly higher than 80 kg of nitrogen level and control also. Increased level of nitrogen increased the value of number of grains per ear and weight of ear both mainly owing to its growth characters and role of nitrogen in increasing vegetative growth, cell division, expansion and elongation, which is reflected in the increase in the diameter of the stem and thus the increase in the weight and quantity of dry matter in the stem and ultimately increased number of grains ear^{-1} and weight of ear plant^{-1} (g), this result agreed with [16].

Table 2 Effect of seed rate and nitrogen levels on yield attributes of barley

Treatments	Length of ear (cm)	Number of grains ear^{-1}	Weight of ear (g)
		Seed rate (Kg ha^{-1})	
80.00 (S_1)	9.39	40.18	3.18
90.00 (S_2)	8.78	37.73	2.98
100.00 (S_3)	8.42	36.18	2.86
110.00 (S_4)	8.14	34.99	2.76
C.D. at (0.05)	0.14	1.07	0.10
		Nitrogen levels (Kg ha^{-1})	
Control (N_0)	8.11	34.83	2.75
80.00 (N_1)	8.50	36.53	2.88
100.00 (N_2)	8.94	38.41	3.06
120.00 (N_3)	9.18	39.45	3.11
C.D. at (0.05)	0.14	1.07	0.10

Table 3 Effect of seed rate and nitrogen levels on yield and B:C ratio of barley

Treatments	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	B:C Ratio
		Seed rate (Kg ha^{-1})	
80.00 (S_1)	38.30	63.65	1.25
90.00 (S_2)	39.36	65.10	1.30
100.00 (S_3)	40.94	67.75	1.34
110.00 (S_4)	40.19	66.87	1.31
C.D. at (0.05)	1.10	1.55	
		Nitrogen levels (Kg ha^{-1})	
Control (N_0)	35.86	60.15	1.22
80.00 (N_1)	38.18	63.63	1.27
100.00 (N_2)	41.13	67.93	1.32
120.00 (N_3)	43.63	71.67	1.39
C.D. at (0.05)	1.10	1.55	

Effect on yield and B:C ratio

Grain yield data depicted in (Table 3). Grain yield (q ha^{-1}) was calculated on the basis of net plot yield and it was found that significantly highest grain yield (40.94 q ha^{-1}) was calculated with 100 kg seed rate per hectare instead of 110 kg seed rate. Showing that the seeding rate played an important

role in the response of barley. When barley was planted at a lower seeding rate, grain yield positively responded to N fertilizer. As the seeding rate increased, however, yield response to N was hindered. The results indicated that application of higher rates of seed rate did not result in grain yield advantages of grain yield in barley. The 100 kg of seed rate was found 4.27%, 4.01% and 6.89% more over 110, 90 and 80 kg of seed rate ha^{-1}. Though the growth characters and yield attributing characters were highest with the reduced application of seed rate (80 kg ha^{-1} seed rate) but due to lack of ideal plant population it could not impart highest yield, but the seed rate of 100 kg ha^{-1} emerged as optimum plant population and fully utilized the light, nutrients and moisture availability in comparison of 110 kg seed rate ha^{-1} where the grain yield reduced due to crowding and competition for light, nutrients and moisture.

Each level of nitrogen application up to 120 kg ha^{-1} significantly increased the grain yield and the highest grain yield (63.63 q ha^{-1}) was calculated with 120 kg of nitrogen application, while the lowest grain yield (35.86 q ha^{-1}) was calculated with the control. The 120 kg of nitrogen level increased 2.50 q, 4.45 q and 7.77 q grain yield ha^{-1} over 100 kg, 80 kg and the control application of nitrogen level. Similar results were found in the investigation of [17].

Similarly, the straw yield was also calculated in proportion of grain yield and the significantly highest straw yield (67.25 q ha^{-1}) was calculated with 100 kg seed rate which was 0.88%, 2.65% and 4.10% more over 110 kg, 90 kg and 80 kg of seed rate application. Straw yield also increased with increased in nitrogen level, the highest value (71.67 q ha^{-1}) was calculated with 120 kg nitrogen application which was 3.74 q, 8.04 q and 11.52 q ha^{-1} over 100 kg, 80 kg and the control. The trend was owing to its growth characters and yield attributes vis-a-vis role of nitrogen in cell division, expansion and elongation, which is reflected in the increase in the diameter of the stem and thus the increase in the weight and quantity of dry matter in the stem and ultimately grain and straw yield, this result agreed with [18].

B:C ratio

The investigation would not be considered as complete study, if not studying the net profit in recommending method. The highest B:C ration 1.34 was calculated with 100 kg of seed rate and in reference to nitrogen level it was higher in the application of 120 kg nitrogen per hectare (1.39).

CONCLUSION

It is clear from the investigation that the 100 kg of seed rate application impart much growth to the barley plant consequently produced highest yield attributes and finally the yield. The barley plant also responded in highest production and highest benefit up to increasing level up to 120 kg per hectare of nitrogen application.

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