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Effect of sowing dates and levels of nitrogen on growth and yield of Barley (*Hordeum vulgare* L.)

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Abstract
A field experiment was conducted during the *rabi* season of 2017 in Barley crop (var. "RD2035") at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Allahabad (U.P.). The experiment was laid out in Randomized Block Design with 12 treatment combinations, consisting of Four nitrogen levels (45,60,75 and 90 kg Nha^{-1}) which were on Different Date of sowing viz., 20th Oct, 30th Oct, 10th Nov. The experimental results revealed that growth parameters viz. plant height, no. of tillers per $hill^{-1}$, Crop growth rate (CGR),Relative growth rate (RGR), plantdry weight and Yield attributes viz. No. of effective tillers m^2, grains $spike^{-1}$ and grain yield (5.23 t/ha) and straw yield (8.37 t/ha) were recored to be significantly higher under treatment T_{11}(10 November+75 Kg Nitrogen ha^{-1}), where as Length of $spike^{-1}$ were recorded to be significantly higher under treatment T_3(20 October + 75 Kg Nitrogen ha^{-1}) andtest weight was significantly higher with treatment T_9(10 November+ 45Kg Nitrogen ha^{-1}).

Keywords: barley, date of sowing, level of nitrogen, growth and yield

Introduction
Barley (*Hordeum vulgare* L.) is an important cereal crop of the world. Among cereals, it ranks fourth with respect to area and production after wheat, rice and maize and is a hardy crop grown throughout the temperate, tropical and sub-tropical regions of the world. It is a *rabi* cereal crop in India and usually used as food for human beings and feed for animals and poultry birds (Singh *et al.*, 2012) [14]. There are evidences to indicate that it is one of the oldest crops known to have been cultivated in India. Barley is quite nutritious cereal. The grains of barley contain 8-10% protein, good amount of carbohydrates, minerals and vitamin. B complex and forms a staple food for many people in India. The dishes like chapati, sattu etc. are prepared from barley flour In addition, The energy rich drinks are also prepared from the malt extracts of barley. In India, about 90% of the barley produced is used for human consumption, while in USA and European countries most of it is used as cattle feed. The barley grains make palatable and nutritious livestock feed, the straw is used as forage and green forage either directly fed to the animals or used for making hay and silage. It is a *rabi* cereal crop is India and usually used as food for human beings and feed for animals and poultry birds (Singh *et al.*, 2012) [14].

Traditionally considered as a poor man's crop, barley in India is favoured because of its low inputrequirement and better adaptability to harshenvironments, likely drought, salinity/alkalinity and marginal lands. Barley occupied nearly 5.90 lac ha^{-1}area producing nearly 15.05 lac tonnes of grain, with aproductivity of 2552 kg/ha during 2015-16 in India (Anonymous *et al*., 2016) [3].

Different doses of nitrogen significantly influenced the grain yield and yield parameters. For the highest grain yield, nitrogen doses of 100 kg N ha^{-1} were the best when considering nitrogen fertilizer only. (Shirazi *et al.*, 2014).

Increasing levels of nitrogen from 60 to 90 kg ha^{-1}significantly enhanced plant height, number of effective tillers, spike length, number of grains $spike^{-1}$ and test weight and grain yield $ha^{-1}$of malt barley. (Narolia *et al*., 2013) [5].

Date of sowing is one of the most important factors for higher yield production as it determines the optimum time of sowing of the crop. An optimum time of sowing enhances the efficiency of barley by exploiting growth factors in an effective manner. As dual purpose barley, plant provides green fodder during lean period, the right time of sowing for availability of green fodder for longer time should be optimally utilized and therefore, the effects of various dates of sowing on dual purpose barley are quite remarkable. The staggered sowing is a common practice to obtain high quality green fodder for longer duration.

Optimum date of sowing is necessary for maximum possible yield of good quality green fodder because availability of highest nutritive stage for longer duration is desired. However it is essential to follow proper date of sowing to utilize the optimum time of sowing efficiently [Singh *et al* (2017) [7].] considering with alone point a field experiment was planned to field out the effect of sowing date and levels of nitrogen on growth and field of barley.

Materials and Methods

A field experiment was conducted during the Rabi season of 2017 in barley crop at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Allahabad (U.P.). The experiment consisted of different dates of sowings 20th Oct, 30th Oct, 10th Nov, four nitrogen levels, viz. 45, 60,75 and 90 kg N ha-1 laid out in a Randomized Block Design with twelve treatment combinations, replicated thrice. The soil of the experimental field was sandy loam in texture with pH 7.6, low in organic carbon 0.42%, available P (13.50 kg ha-1) and available K (257.04 kg ha-1). Nitrogen, Phosphorus and Potassium were applied through urea, DAP (Di Ammonium Phosphate) and muriate of potash, respectively. Half dose of nitrogen was applied as per treatment and full dose of phosphorus, potassium were applied as basal and remaining nitrogen as per treatment was top dressed at tillering stage. The crop received five uniform irrigations. All the growth and yield attributes were recorded using standard procedure and grain yield was calculated at 12% moisture content. The crop growth rate (CGR) and Relative Growth Rate (RGR) was calculated using the standard procedure and formulae.

Table 1: Effect of sowing date and level as of nitrogen on growth attributes of barley

Treatments No.	Treatments combination	Growth attributes 100 DAS			Growth rate (60-80DAS)	
		Plant height (cm)	Number of tillers plant^{-1}	Plant Dry weight (g)	Crop growth rate (g m^{-2} Days^{-1})	Relative growth rate (g m^{-2} days^{-1})
T_1	20October+45 Kg Nitrogen ha^{-1}	55.05	3.13	13.79	0.44	0.09
T_2	20 October + 60 Kg Nitrogen ha^{-1}	54.67	4.46	14.64	0.16	0.01
T_3	20 October + 75 Kg Nitrogen ha^{-1}	59.85	5.00	14.30	0.35	0.06
T_4	20 October+ 90Kg Nitrogen ha^{-1}	59.77	4.06	12.66	0.22	0.01
T_5	30 October + 45Kg Nitrogen ha^{-1}	64.19	4.26	15.08	0.40	0.06
T_6	30 October + 60 Kg Nitrogen ha^{-1}	62.8	4.26	16.02	0.41	0.08
T_7	30 October + 75 Kg Nitrogen ha^{-1}	65.98	4.40	15.90	0.54	0.06
T_8	30 October + 90 Kg Nitrogen ha^{-1}	70.62	4.66	15.02	0.62	0.08
T_9	10 November+ 45Kg Nitrogen ha^{-1}	72.96	3.04	13.76	0.20	0.04
T_{10}	10 November + 60 Kg Nitrogen ha^{-1}	75.68	3.13	12.77	0.39	0.01
T_{11}	10 November + 75 Kg Nitrogen ha^{-1}	78.34	5.24	18.77	0.64	0.11
T_{12}	10 November + 90 Kg Nitrogen ha^{-1}	74.12	5.10	12.62	0.60	0.03
	F test	S	S	S	S	S
	SEd (±)	1.49	0.50	1.40	0.12	0.01
	CD (P=0.05)	3.09	1.04	2.90	0.24	0.03

Table 2: Effect of sowing date and level as of nitrogen on yield attributes barley

Treatments No	Treatments combination	Yield attributes			
		Number of Spikelets hills^{-1}	Length of Spike (cm)	Number of Grains spike^{-1}	Test weight (g)
T_1	20October+45 Kg Nitrogen ha^{-1}	5.73	8.14	53.53	40.27
T_2	20 October + 60 Kg Nitrogen ha^{-1}	4.80	7.86	52.80	42.15
T_3	20 October + 75 Kg Nitrogen ha^{-1}	5.60	8.94	59.06	40.72
T_4	20 October+ 90Kg Nitrogen ha^{-1}	4.80	7.80	51.60	42.45
T_5	30 October + 45Kg Nitrogen ha^{-1}	4.46	7.96	50.40	41.84
T_6	30 October + 60 Kg Nitrogen ha^{-1}	5.00	8.62	56.86	41.71
T_7	30 October + 75 Kg Nitrogen ha^{-1}	5.20	7.82	54.33	41.01
T_8	30 October + 90 Kg Nitrogen ha^{-1}	5.00	8.23	55.13	43.83
T_9	10 November+ 45Kg Nitrogen ha^{-1}	4.66	7.46	53.8	43.85
T_{10}	10 November + 60 Kg Nitrogen ha^{-1}	4.73	8.00	57.06	41.32
T_{11}	10 November + 75 Kg Nitrogen ha^{-1}	5.73	7.73	61.06	42.70
T_{12}	10 November + 90 Kg Nitrogen ha^{-1}	4.86	8.35	59.20	41.79
	F test	S	S	S	S
	SEd (±)	0.37	0.29	2.85	0.72
	CD (P=0.05)	0.77	0.6	5.91	1.49

Table 3: Effect of sowing date and level as of nitrogen on Yield barley

Treatments No.	Treatments combination	Yield		Harvest index (%)
		Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	
T_1	20October+45 Kg Nitrogen ha^{-1}	3.90	8.08	32.55
T_2	20 October + 60 Kg Nitrogen ha^{-1}	4.79	6.30	43.19
T_3	20 October + 75 Kg Nitrogen ha^{-1}	4.68	8.30	36.05
T_4	20 October+ 90Kg Nitrogen ha^{-1}	4.03	7.56	32.16
T_5	30 October + 45Kg Nitrogen ha^{-1}	3.91	6.07	39.17
T_6	30 October + 60 Kg Nitrogen ha^{-1}	4.19	4.94	45.89
T_7	30 October + 75 Kg Nitrogen ha^{-1}	3.50	6.15	36.26
T_8	30 October + 90 Kg Nitrogen ha^{-1}	3.99	7.53	34.63

T_9	10 November+ 45Kg Nitrogen ha^{-1}	4.02	7.3	35.51
T_{10}	10 November + 60 Kg Nitrogen ha^{-1}	4.80	7.42	39.27
T_{11}	10 November + 75 Kg Nitrogen ha^{-1}	5.23	8.37	42.55
T_{12}	10 November + 90 Kg Nitrogen ha^{-1}	4.43	7.89	35.95
	F test	S	S	NS
	SEd (±)	0.43	0.94	4.28
	CD (P=0.05)	0.88	1.94	--

Results and Discussion

Effect on growth attributes of barley

Among the treatments T11 (10 November + 75 Kg N ha-1). produced significantly higher growth attributing characters, i.e. plant height (78.34 cm) at 100 DAS, No. of tillers per plant-1 (5.24)at 100 DAS, dry weight (18.77 g) at 100 DAS and Crop growth rate (0.64 g m2day) at 60-80 DAS and Relative growth rate (0.11gg-1 days-1) at 60-80 DAS.

Mukherjee *et al* (2012). Observed that Sowing in the second week of November (15 November) showed better growth attributes, plant height (86 cm), Tillers per plant-1 (6.21) and dry weight (21 g).Sowing in mid-November (15th November) showed the best grow the results in his experiment. Jan et.al. (2011). Observed that the treatment having 75 kg N/ha showed better results of plant height(110 cm), Tillers per plant-1 (7.14) and even dry weight (22.21) to be better than the rest of N levels among the treatments. Similar findings were also reported by Zeidan, M.S. 2007.

Effect on yields and yield attributes

Effective number of Spike Per hill-1 (5.73), number of grains spike-1 (61.06) significantly higher with treatment T11 (10 November + 75 Kg Nitrogen ha-1). The results are in close agreement with the findings of Alam *et al*. (2007) [1] and Ghasemi *et al*. (2012) [6] and Baladezaie *et al*. (2011) [4]. The length of spike (8.94 cm) was significantly higher with T3 (20 October + 75 Kg Nitrogen ha-1). Similar findings were also reported by Singh and Misra. (1979) and Narolia *et al*. (2013) [5]. The test weight (43.85 g) was significantly higher with T9 (10 November+ 45Kg Nitrogen ha-1) Similar findings were also reported by Tripathi *et al*. (2013) [11] and Sawar *et al*. (2010). The grain yield (5.23 t ha-1) and Straw yield (8.37 t ha-1), was also higher with treatment. T11 (10 November + 75 Kg Nitrogen ha-1) It might be due to cumulative effect of growth and yield-attributing characters owing to fertilization. Greater availability of metabolites (photosynthates) and nutrients to developing reproductive structures seems to have resulted in increase in all the yield-attributing characters which ultimately improved the yield of the crop Singh *et al*. (2010) [12].

Similar findings were also reported by Meena *et al*. (2012) [9] and singh *et al*. (2013) [7].

Conclusion

On the basis of above findings it can be concluded that the grain yield (5.23t ha-1), straw yield (8.37t ha-1), number of tillers per plant-1 and other growth and yield attributes were found to be the best with treatment T11(10 November + 75 kg Nitrogen ha-1). These findings are based on 1 season; trial therefore, further trials may be required for considering it for recommendation.

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