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Effect of Sowing Dates and Levels of Nitrogen on Yield Attributes, Protein Content and Economics of Barley (*Hordeum vulgare* L.)

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A B S T R A C T

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 N ha^{-1}) which were on Different Date of sowing viz., 20th Oct, 30th Oct, 10th Nov. The experimental results revealed that Yield parameters viz. grain yield (5.23 t/ha) and straw yield (8.37 t/ha) were recorded to be significantly higher under treatment T_{11}(10 November+75 Kg Nitrogen ha^{-1}), whereas protein content (11.52 %) were significantly higher with treatment T_{12} 10 November + 90 Kg Nitrogen ha^{-1}, Economics at gross return (₹ 95042.50 ha^{-1}), net return (₹63033.90 ha^{-1}) and BC ratio (₹ 2.97) were significantly higher with treatment T_{11} (10 November+75 Kg Nitrogen ha^{-1}).

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). 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).

Traditionally considered as a poor man's crop, barley in India is favoured because of its low input requirement and better adaptability to harsh environments, 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 a productivity of 2552 kg/ha during 2015-16 in India (Anonymous *et al.*,2016).

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). Nitrogen (N) is commonly the most limiting nutrient for crop production in the majority of the world's agricultural areas and therefore adoption of good N management strategies often results in large economic benefits to farmers. Among the most important management practices influencing grain protein content is N fertilize application rate and timing. Increasing N fertilizer rates can result in higher grain protein content (Buskiene and Uselis 2008).

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)] 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 and 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.

Results and Discussion

Effect on Yields and Yield attributes

The grain yield (5.23 t ha^{-1}) and Straw yield (8.37 t ha^{-1}), was also higher with treatment. T_{11} (10 November + 75 Kg Nitrogen ha^{-1}) It might be due to cumulative effect of growth and yield-attributing characters owing to fertilization.

Table.1 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	--

Table.5 Economics effect of date of sowing and nitrogen levels in barley

Treatments No.	Treatments combination	Cost of cultivation(₹)	Gross return (₹)	Net return(₹)	BC ratio
T_1	20October+45 Kg Nitrogen ha^{-1}	31030.30	73655.00	42624.70	2.37
T_2	20 October + 60 Kg Nitrogen ha $^{-1}$	31519.45	84945.00	53425.55	2.70
T_3	20 October + 75 Kg Nitrogen ha^{-1}	32008.60	86270.00	54261.40	2.70
T_4	20 October+ 90Kg Nitrogen ha^{-1}	32497.75	74917.50	42419.75	2.31
T_5	30 October + 45Kg Nitrogen ha^{-1}	31030.30	70692.50	39662.20	2.28
T_6	30 October + 60 Kg Nitrogen ha^{-1}	31519.45	73412.50	41893.05	2.33
T_7	30 October + 75 Kg Nitrogen ha^{-1}	32008.60	64402.50	32393.90	2.01
T_8	30 October + 90 Kg Nitrogen ha^{-1}	32497.75	74242.50	41744.75	2.28
T_9	10 November+ 45Kg Nitrogen ha^{-1}	31030.30	74317.50	43287.20	2.39
T_{10}	10 November + 60 Kg Nitrogen ha^{-1}	31519.45	86730.00	55210.55	2.75
T_{11}	10 November + 75 Kg Nitrogen ha^{-1}	32008.60	95042.50	63033.90	2.97
T_{12}	10November + 90 Kg Nitrogen ha^{-1}	32497.75	81612.50	49114.75	2.51

Respectively when grain were sell at ₹ 12.25/kg and straw at ₹. 3/kg.

Table.2 Effect of sowing date and levels of nitrogen on protein (%)

Treatments No.	Treatments combination	Protein (%)
T_1	20October+45 Kg Nitrogen ha^{-1}	8.21
T_2	20 October + 60 Kg Nitrogen ha^{1}	9.45
T_3	20 October + 75 Kg Nitrogen ha^{-1}	10.33
T_4	20 October+ 90Kg Nitrogen ha^{-1}	10.83
T_5	30 October + 45Kg Nitrogen ha^{-1}	8.73
T_6	30 October + 60 Kg Nitrogen ha^{-1}	9.82
T_7	30 October + 75 Kg Nitrogen ha^{-1}	10.72
T_8	30 October + 90 Kg Nitrogen ha^{-1}	11.05
T_9	10 November+ 45Kg Nitrogen ha^{-1}	9.66
T_{10}	10 November + 60 Kg Nitrogen ha^{-1}	10.70
T_{11}	10 November + 75 Kg Nitrogen ha^{-1}	11.10
T_{12}	10 November + 90 Kg Nitrogen ha^{-1}	11.52

Table.3 Cost of cultivation effect of date of sowing and nitrogen levels in barley

S. No.	Particulars	Unit	Qty	Rupees (₹)	Cost (₹ ha^{-1})
A	Land preparation				
1	Ploughing	Hours	3 hr	660	2040
2	Disc harrowing	Hours	3 hr	690	2070
3	Layout preparation	Labours	10	300	3200
B	Fertilizer application				
1	Urea (46% N)	Kg	70	15	1050
2	DAP	Kg	20	35	700
3.	MOP	Kg	20	35	700
3	Labour for fertilizer application	Labours	3	200	600
C	Seed sowing				
1	Seed	Kg	100	35	2500
2	Labour per sowing	Labours	8	200	1600
D	Irrigation				
1	Tube well charge	Hours	8	100	800
2	Labour per irrigation	Labours	3	300	900
E	Inter-culture				
1	Thinning and Weeding	Labours	10	200	2000
F	Plant protection				
1	Choloroparopase	lit	3	350	1150
2	Labour per spray	Labours	4	200	800
G	Harvesting				
1	Harvesting	Labours	15	200	3000
2	Threshing	Labours	14	200	2800
H	Rental value of land	Months	4	800	3200
I	Supervision charges	Months	4	900	3400
	Total cost of cultivation (ha^{-1})				**32010**

Table.4 Variable cost for barley

Treatment	Total amount of nutrient (Kg)	Rate (₹ kg^{-1})	Total cost of nutrients (₹)
A) Urea			
1) 45 kg N ha^{-1}	80.82	15	1212.30
2) 60 kg N ha^{-1}	113.43	15	1701.45
3) 75 kg N ha^{-1}	146.04	15	2190.60
4) 90 kg N ha^{-1}	178.65	15	2679.75
B) DAP	43.47	35	1521.45
C) MOP	33.33	35	1166.55

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). Similar findings were also reported by Meena *et al.*, (2012) and Singh *et al.*, (2013).

Effect on protein content and economics of barley

Among the treatments T_{12} (10 November + 90 Kg N ha^{-1}).produced significantly higher protein content, i.e. at (11.52), Economics at gross return (₹ 95042.50 ha^{-1}), net return (₹63033.90 ha^{-1}) and BC ratio (₹ 2.97) were significantly higher with treatment T_{11} (10 November + 75 Kg Nitrogen ha^{-1}). Taalab *et al.*, (2015) Grain protein content was found to be significantly influenced by N application rate, and N time of application. Grain protein content under different N application rates ranged from 10.83 to 13.68 %. Over all, grain protein content was found to increase with increasing N application rate. The highest grain protein content (13.68 %) was obtained at the highest N rate (100 kg N acre-1) under four splits application of nitrogen. Similar findings were also reported by Brian *et al.*, (2007). Paniya *et al.*, (2015) at observed higher net return (₹ 65800.55) and benefit cost ratio (4.01) when N was applied at 90 kg ha^{-1} to barley. Similar findings were also reported by Katiyar and Uttam (2007) in barley.

On the basis of above findings it can be concluded that the grain yield (5.23t ha^{-1}), straw yield (8.37t ha^{-1}), yield attributes and Economics BC ratio (₹ 2.97) were found to be the best with treatment T_{11} (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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