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Productivity, quality and profitability of barley (*Hordium vulgare*) as affected by genotypes and dates of sowing

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ABSTRACT

A field experiment was conducted at Research Farm, R.B.S. College, Bichpuri, Agra during two consecutive winter seasons of 2011-12 and 2012-13, to study the effect of dates of sowing and genotypes on productivity, quality and economics of barley. The four dates of sowing and four genotypes were tested in split plot design with three replications. The results revealed that the maximum spike length (7.6 cm), spikelets spike^{-1} (17.9), grains spike^{-1} (39.0) and weight of grains spike^{-1} (1.7 g) were noted with 5 November date of sowing closely followed by 15 November. The crop sown on 15 November registered 19.5, 9.13 13.4 higher grain, straw and biological yield than 5 December, respectively. Significantly higher protein yield and nitrogen uptake were recorded in crop sown on 15 November over other dates of sowing. The highest net returns (₹ 47,700 ha^{-1}) and B:C ratio (2.74) were obtained with crop sown on 15 November. Among different genotypes, RD 2668 produced significantly higher yield attributes and yields viz. grain (48.7 q ha^{-1}), straw (64.5 q ha^{-1}), biological (113.2 q ha^{-1}) and protein yield (621.7 kg ha^{-1}) and uptake of nitrogen through grain and straw over other genotypes. Maximum net returns (₹ 48,000 ha^{-1}) and B:C ratio (2.75) were recorded with variety RD 2668 over other varieties.

Key Words: Barley, dates of sowing, genotypes, yield, quality, economics

INTRODUCTION

Barley (*Hordeum vulgare* L.) is a member of the grass family and a major cereal grain. Now–a-days, barley has become a viable and useful crop in winter owing to release of improved varieties and upcoming of improved industries in India, especially in Punjab, Haryana and Rajasthan. As an important cereal crop, barley is cultivated successfully in a wider range of climate all over the world. It is a dual purpose crop, i.e. food and feed for human being and animals, and a valuable input for malt industry. It is the fourth important cereal crop after wheat, rice and maize in the world (Kaur and Mahal, 2016). Results of All India Barley Improvement Crop Project (AIBICP) indicate that sowing time of barley differs in accordance with agro-climatic zones of the country. Too much delay in the time of sowing, however, results in the reduction of crop yield. This is mainly because of low temperature prevailing at the time of sowing. Not only this, when crops are sown late, they mature slightly late. The grains of late crop are shriveled due to hot and desiccating westerly winds prevailing during the month of March and April. Cultivar plays a vital role in crop production. Any cultivar of barley before recommended for general cultivation for particular region must be judged for its potential, tolerance against disease in general and in particular responsiveness to added water and fertilizer and adaptability to different agro-climatic conditions. Thus the value of stable and high yielding cultivar has been universally recognized as an important factor for boosting crop production (Jadon *et al.*, 2015). The new cultivars display improvements including disease resistance, plant architecture (stand ability), seed quality and yield, whilst there are also changes in flowering and maturity that could affect agronomic management. Consequently, different varieties with different genetic make-up mature at different rates but the difference in greater when sown early. In spite of cultivation of high yielding varieties, improved cultural practices and plant protection measures, fevourable weather is must for good harvests (Jat *et al.,* 2013). Thus, keeping the above facts in view, the present investigation was conducted to study the effect of dates of sowing and genotypes on productivity, quality and economics of barley.

MATERIALS AND METHODS

A field experiment was conducted during *Rabi* seasons of 2011-12 and 2012-13 at Research Farm, R.B.S. College, Bichpuri, Agra,

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(27^0 2' North latitude, 77^0 9' East longitude and altitude of 163.4 m above mean sea level). The total rainfall was received of 58 mm during the crop growth period and most of which 34 mm was received in the month of February. The experimental soil was sandy loam in texture containing organic carbon 3.2 g kg^{-1}, available N 188.4, P 18.0 and K 190.0 kg ha^{-1} with pH 8.0. Sixteen treatment combinations comprising four dates of sowing (5 November, 15 November, 25 November and 5 December) and four genotypes (BH 902, RD 2552 73, DWRUB 52 and RD 2668) were tested in split plot design and replicated thrice with dates of sowing in main plot and genotypes in sub-plots. The crop was sown on 5, 15, 25 November and 5 December during 2011and 2012 and harvested on 08, 16, 24 and 30 March 2012 and 6, 14, 21 and 26 March during 2013, respectively. The crop was fertilized with nitrogen (90 kg) and phosphorus (30 kg P_2O_5) and potassium (20 kg K_2O ha^{-1}) in all the treatments. Urea, diammonium phosphate and muriate of potash were used as the source of N, P_2O_5 and K_2O, respectively. Half dose of nitrogen and entire quantities of P_2O_5 and K_2O were applied at the time of sowing as basal dressing and remaining half amount of nitrogen was top dressed after first irrigation. The seed rate and row spacing were 100 kg ha^{-1} and 23 cm apart, respectively. The crop was grown successfully by adopting standard agronomic practices. The growth characters were recorded at harvest stage. The straw yield was computed by deducting the grain yield from the total biological yield. The N content in grain and straw was estimated by modified Kjeldahl method (Jackson, 1973) and the protein content was computed using factor 6.25 multiplied by N content in grain and straw. Similarly, the N uptake by barley was determined by multiplying grain and straw yield with their respective concentrations in grain and straw. The economics was work out based on pooled yield data and considering price of input and output of the prevailing market rate. Data were analyzed with analysis of variance as suggested by Gomez and Gomez (1984). Treatments were compared by computing the F-test. The significant differences between treatments were compared by critical difference at the 5% level of probability.

RESULTS AND DISCUSSION

Yield attributes and yield

The yield attributes and yield of barley were influenced significantly due to dates of sowing and genotypes (Table 1). Crop sown on 15 November recorded higher number of ear head m^{-1} row length, which was statistically at par with crop sown on 5 November. The highest spike length (7.6 cm) was recorded with 5 November date of sowing followed by 15 November. Number of spikelets $spike^{-1}$ was higher when crop was sown on 5 November, being at par with 15 November and 25 November dates of sowing. The reduction might be due to very low temperature in late sown conditions during vegetative growth stage, which slows the cell division and cell expansion. These reduced cell expansion also had effect on meristematic development of yield attributes (Mukherjee, 2012). Significantly higher grains $spike^{-1}$ and weight of grains $spike^{-1}$ were obtained with 5 November and also 9.8 and 17.9 % more over 5 December sowing, respectively. The maximum 1000-grains weight was obtained with 15 November sowing. The reduction in 1000-grains weight due to delay in sowing was mainly attributed to reduction in growth and shriveled grains because of forced maturity which occurred due to sudden temperature rise and westerly wind prevailed during milking and grain filling stage. Our results confirm earlier studies those of Meena *et al.*, (2015). The highest grain, straw and biological yields were produced by crop sown on 15 November, which was significantly superior to other dates of sowing and also registered 19.5, 9.13 and 13.4 higher grain, straw and biological yield than 5 December, respectively. A reduction in photosynthesis under heat stress leads to reduced growth, accelerated leaf senescence and decreased grain yield in crop. Significantly higher harvest index of 5.4% was recorded with 15 November than 5 December. This is mainly ascribed to accelerated phenological development of crop under low temperature. The accelerated development leads to increase in overall biomass accumulation, thus increase harvest index (Kumar *et al.* 2016). The entire yield attributes viz.ear head m^{-1} row length, spike length, spikelets $spike^{-1}$, grains $spike^{-1}$ and weight of grains $spike^{-1}$ were significantly higher

Table 1: Yield attributes and yield of barley as affected by dates of sowing and genotypes (pooled data of 2 years)

Treatments	Ear head m^{-1} row length	Spike length (cm)	No. of spikelets^{-1} spike	No. of grains^{-1} spike	Weight of grains^{-1} spike (g)	Test weight (g)	Biological yield (q ha^{-1})	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Harvest Index (%)
Dates of sowing										
5th November	85.0	7.56	17.9	39.5	1.65	42.02	106.18	45.60	60.58	42.9
15th November	86.7	7.34	17.4	37.0	1.56	42.58	111.76	48.89	62.87	43.7
25th November	81.5	7.08	17.2	36.1	1.45	40.67	102.17	43.60	58.57	42.6
5th December	79.3	6.76	17.0	36.0	1.40	39.32	98.52	40.91	57.61	41.5
SEm±	1.09	0.12	0.26	0.15	0.03	0.16	0.45	0.40	0.55	0.17
C.D. (P=0.05)	3.26	0.36	0.77	0.46	0.07	0.47	1.33	1.20	1.66	0.51
Genotypes										
BH 902	77.5	7.36	18.0	36.1	1.59	43.74	102.97	44.03	58.94	42.7
RD 2552	77.9	6.96	16.9	28.3	1.21	40.56	101.32	43.28	58.04	42.7
DWRUB 52	86.6	6.77	16.1	27.5	1.18	38.79	101.11	42.96	58.15	42.4
RD 2668	90.5	7.65	18.6	36.6	1.69	41.50	113.22	48.72	64.50	43.0
SEm±	0.75	0.08	0.19	0.09	0.02	0.12	0.35	0.36	0.38	0.09
C.D. (P=0.05)	2.23	0.23	0.58	0.27	0.05	0.36	1.04	1.08	1.10	0.28

Table.2 Quality, uptake of nitrogen and economics of barley as affected by dates of sowing and genotypes (pooled data of 2 years)

Treatments	Protein content in grain (%)	Protein yield (Kg ha^{-1})	Nitrogen uptake (Kg ha^{-1})		Cost of cultivation (x10^{3} ₹ ha^{-1})	Gross return (x10^{3} ₹ ha^{-1})	Net return (x10^{3} ₹ ha^{-1})	B:C ratio
			Grain	Straw				
Dates of sowing								
5th November	12.02	548.69	87.79	50.22	27.4	70.6	43.2	2.58
15th November	12.22	597.53	95.60	53.38	27.4	75.1	47.7	2.74
25th November	12.45	543.88	87.02	50.90	27.4	67.7	40.3	2.47
5th December	12.84	525.78	84.12	50.91	27.4	64.3	36.9	2.35
SEm±	0.07	3.93	0.95	1.04	-	-	-	-
C.D. (P=0.05)	0.20	11.77	2.85	3.12	-	-	-	-
Genotypes								
BH 902	12.53	551.43	88.23	51.39	27.4	68.3	40.9	2.50
RD 2552	12.19	526.97	84.32	48.29	27.4	67.2	39.8	2.45
DWRUB 52	12.03	515.79	82.53	47.07	27.4	66.9	39.5	2.44
RD 2668	12.78	621.68	99.47	58.66	27.4	75.4	48.0	2.75
SEm±	0.06	3.21	1.04	0.85	-	-	-	-
C.D. (P=0.05)	0.17	9.62	3.07	2.53	-	-	-	-

with genotype RD 2668 over other genotypes. The maximum 1000-grains weight was obtained with BH 902 followed by RD 2668 and both genotypes were significantly superior over other genotypes. The increased parameters might have attributed to higher manufacture of food and its subsequent portioning toward sink. The availability and supply of nutrients to formation ultimately increase the grains and 1000-grains weight. Similar finding were observed by Balwan *et al.*, (2017). Among different genotypes, RD 2668 produced significantly higher grain (48.7 q ha^{-1}), straw (64.5 q ha^{-1}), biological (113.2 q ha^{-1}) yield and harvest index (43.3%) over other genotypes. The percentage increases in grain, straw and biological yield with RD 2668 over DWRUB 52 were 13.5, 10.9 and 11.98%, respectively.

Quality

Change in sowing time of crop had marked influence on protein content in grain of barley. The crop sown on 5 December recorded significantly higher protein content in grain (12.8%) over early dates of sowing. Late sown crop had more protein over first sowing because late sown crop had more concentrations of nitrogen in the grain due to its lower yield. This higher nitrogen concentration in late sown crop gave higher protein content in grain. Significantly higher protein yield was produced by the crop sown on 15 November over other dates of sowing and this treatment produced more protein yield by 13.6% over 5 December sowing. Though the late sown crop had higher protein content, but the yields were higher in first sown crop and protein production depends upon the protein content and grain yield. Hence, higher yield obtained in first sown crop has compensated towards more protein production as compared to late sown conditions. These results are in conformity with these of Singh *et al.* (2013) and Kumar *et al.* (2016). Amongst different genotypes, highest protein content in grain (12.8%) and protein yield (621.7 kg ha^{-1}) were recorded with RD 2668, which was significantly higher over other genotypes and represented an increase of 6.2 and 20.5% over DWRUB 52, respectively. Since RD 2668 has more grain yield, the production of protein on unit area basis may be due to better grain yield with this genotype. Similar results were reported by Lal *et al.* (2017).

Uptake of nitrogen

Uptake of nitrogen by the crop due to dates of sowing and genotypes were of significant order (Table 2). The crop sown on 15 November utilized significantly higher nitrogen by grain (95.6 kg ha^{-1}) and straw (53.4 kg ha^{-1}) over other dates of sowing. The uptake of nitrogen in grain and straw was reduced to the extent of 12.0 and 4.6%, respectively due to crop sown on 5 December compared to that with 15 November. It is obviously that nitrogen uptake is directly associated with grain yield and nitrogen content. Crop sown on 15 November produced the higher yields which resulted in higher uptake of nitrogen (Jadon *et al.*, 2015 and Kumar *et al.*, 2016). Among different genotypes, highest nitrogen uptake by grain and straw was recorded with genotype RD 2668, which was significantly superior to other dates of sowing. The increase in nitrogen uptake by grain and straw of barley owing to RD 2668 over DWRUB 52 was the tune of 20.5 and 24.6%, respectively. The difference in N uptake by various genotypes of barley may be due to variation in their production capacity of grain and straw. Kumar *et al.* (2016) also reported similar results.

Economics

Economic analysis showed that the highest gross return, net return and B:C ratio of ₹ 75,100 ha^{-1}, ₹ 47,700 ha^{-1} and 2.74, respectively were gained with crop sown on 15 November followed by 5 November. Late sowing (5 December) reduced the gross return by 14.4%, net return by 22.6% and B:C ratio by 14.2% over 15 November. The reduction in the gross and net returns and B:C ratio was mainly due to the laser grain and straw yield of the crop sown on 5 December. RD 2668 recorded maximum gross return (₹ 75,400 ha^{-1}), net return (₹ 48,000 ha^{-1}) and B:C ratio (2.75) over other varieties. This could be owing to its higher grain and straw yields than the other 3 varieties. These results are in constituent with findings of Kumar *et al.* (2016) and Lal *et al.* (2017).

It may be concluded from the study that the crop sown on 15 November produced significantly higher yield. Likewise, protein and N uptake were also higher under 15 November sowing of barley crop. Amongst genotypes, RD 2668 was found to be most suitable for agro-climatic conditions of Agra and exhibited 10.7, 12.6 and 13.5% higher grain yield over genotypes BH 902, RD 2552 and DWRUB 52, respectively.

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