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Evaluation of barley (*Hordeum vulgare* L.) cultivars under different dates of sowing in *Terai* zone of West Bengal

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ABSTRACT

An experiment was conducted at Instructional Farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, West Bengal, India during rabi 2014-15 and 2015-16 to assess the performance of barley cultivars under different dates of sowing. The experiment was laid out in split plot design with three dates of sowing(November 19-23, December 1-3 and December 9-13) in main plots and six barley cultivars(HUB 113,K 603,K 409,K 551, K 560 and K 201) as sub-plot treatments with three replications. Delayed sowing significantly decreased the plant height, LAI, dry matter production, grain and straw yield. Maximum plant height, LAI, dry matter accumulation, crop growth rate, grain and straw yield and other yield attributes were recorded in 19-23 November sowing. Crop sown under November 19-23 recorded grain yield of 2.89 t ha^{-1}, 17.95 and 46.70 per cent higher than the crop was sown under late (December 1-3) and very late (December 9-13) sown conditions, respectively. K 551 recorded higher tiller number as well as CGR value at all growth stages. Among the cultivars, K 551 was the highest yielder (3.21 t ha^{-1}) followed by K 409(2.97 t ha^{-1}).

Keywords: Barley, cultivars, dates of sowing, yield

Barley is also one of the important winter cereals in India covering an area of 7.07 lakh hectares with a production of 16.13 lakh tonnes and productivity of 2.28 t ha^{-1} (Anonymous, 2016). Barley is being cultivated in marginal and problematic lands as rainfed crop consequently resulting to lower yield. As the crop is having high industrial importance, the agronomic aspects need specific attention to address the increased productivity of the crop. As per climatic condition and moisture levels, barley can be suitably grown in *terai* Zone of West Bengal but there are some constraints also in this zone. Mainly the soil is acidic in nature and chronic deficiency of boron in the soil may results in the poor grain setting in most of the *rabi* crops. Despite constraints like high residual moisture in the soil during the initial phase of crop growth due to late causation of monsoon, there are some natural advantages for cultivation of rabi crops like barley. A large number of high yielding varieties have been developed for this crop at various centres in India. These varieties have high yield potential and the grain is of better quality. To achieve the potential yield level of these high yielding varieties of barley, time of sowing play an important role. In North Eastern Plains Zone (NEPZ) of India, optimum sowing time of barley is 15th November to 24th November and it may be extended up to 10th December to 16th December. Though many works on these aspects have been done in different areas of the country but no information is available about its cultivation technology under terai zone of West Bengal. Keeping this background in view, the present investigation was taken up to assess the performance of various barley cultivars under different dates of sowing.

MATERIALS AND METHODS

The experiment was conducted at Instructional Farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, West Bengal, India during *rabi seasons* 2014-15 and 2015-16. The soil was sandy loam having organic C 0.89%, mineralizable N -169.34 kg ha^{-1}, available P_2O_5 -57.91 kg ha^{-1}and available K_2O-166.70 kg ha^{-1}with pH 5.65. The experiment was laid out in split plot design with three dates of sowing(November 19-23, December 1-3 and December 9-13) in main plots and six barley cultivars (HUB 113,K 603,K 409,K 551, K 560 and K 201) in sub plots having plot size of 5 m x 4 m.The fertilizer dose applied in the experiment field was 60:30:20 kg N, P_2O_5 and K_2O per hectare, respectively. A basal application of half of N along with full dose of P_2O_5 and K_2O were given as basal in the form of urea, single super phosphate (SSP) and muriate of potash (MOP), respectively. Rest of nitrogen was topdressed after first irrigation. The crop was sown in lines 20cm apart with seed rate of 100 kg ha^{-1} after adjusting 1000 seed weight at 38 g. Three irrigations at active tillering, flag leaf emergence and at milking stages were given to the field.

Each plot was divided into almost equal halves before recording biometrical observations. Half of each plot was kept undisturbed for determining yield and remaining half was used for recording biometrical observations including destructive sampling. The data on growth attributes were recorded periodically while the data on yield attributes were recorded at harvest. The data on grain yield and straw yield were also taken

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Table 1: Growth attributes of different barley cultivars under varying dates of sowing (pooled data)

Treatments	Plant height(cm)	LAI	Dry matter accumulation at harvest (g m^{-2})	No. of tiller m^{-2}			Crop growth rate (g m^{-2}day^{-1})			
				DAS			DAS			
				30	50	70	30-45	45-60	60-75	75-90
Dates of sowing										
19-23 November	101.63	3.70	611.40	142	213	287	6.09	12.04	14.86	9.74
1-3 December	97.17	3.58	549.90	148	189	257	5.87	11.17	14.70	9.18
9-13 December	92.86	3.47	442.20	132	175	230	5.36	10.86	14.69	8.54
SEm(±)	**1.86**	**0.03**	**11.59**	**1.14**	**2.77**	**3.79**	**0.09**	**0.28**	**0.23**	**0.24**
LSD(0.05)	**7.30**	**0.12**	**45.54**	**4.48**	**10.88**	**14.89**	**0.36**	**1.08**	**NS**	**0.96**
Cultivars										
HUB 113	97.42	3.67	477.40	138	200	228	6.12	9.9	12.32	8.62
K 603	102.74	3.59	483.20	135	209	243	5.78	10.9	14.93	9.03
K 409	98.50	3.57	571.00	145	215	253	5.87	10.2	16.88	8.89
K 551	96.56	3.88	654.60	136	210	269	6.06	11.4	18.13	9.89
K 560	99.11	3.68	592.70	146	212	246	4.66	11.0	14.32	9.38
K 201	92.00	3.71	445.80	144	198	220	6.16	10.9	11.92	9.11
SEm(±)	**2.10**	**0.05**	**12.24**	**1.17**	**4.36**	**5.64**	**0.14**	**0.25**	**0.45**	**0.26**
LSD(0.05)	**6.06**	**0.14**	**35.36**	**3.39**	**12.51**	**16.19**	**0.42**	**0.72**	**1.29**	**0.74**

Table 2: Yield attributes and yields of different barley cultivars under varying dates of sowing (pooled data)

Treatments	Spike length(cm)	No. of spike m^{-2}	No. of grains spike^{-1}	Test weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
Dates of sowing							
19-23 November	7.90	242	45.3	36.51	2.89	6.04	32.36
1-3 December	7.28	223	40.8	36.42	2.45	5.09	32.47
9-13 December	7.26	212	40.6	36.29	1.97	4.42	30.82
SEm(±)	**0.27**	**0.69**	**0.40**	**0.45**	**0.09**	**0.17**	**0.91**
LSD(0.05)	**NS**	**2.69**	**1.55**	**NS**	**0.34**	**0.66**	**NS**
Cultivars							
HUB 113	6.68	210	39.1	34.47	2.27	5.68	28.55
K 603	7.16	226	41.5	36.86	2.64	5.13	33.96
K 409	7.59	239	46.1	37.56	2.97	6.17	32.57
K 551	7.93	255	46.6	38.37	3.21	4.97	39.23
K 560	7.42	228	42.7	37.17	2.48	5.20	32.28
K 201	6.62	195	37.4	34.02	1.98	5.43	26.72
SEm(±)	**0.24**	**2.24**	**1.33**	**0.56**	**0.13**	**0.27**	**0.86**
LSD(0.05)	**0.69**	**6.47**	**3.83**	**1.62**	**0.40**	**0.77**	**2.47**

at harvest and harvest index were calculated accordingly. Two years data were pooled following the procedure for statistical analysis using statistical software MSTAT-C version 2.1 (Michigan State University, USA). Significant differences between the treatments were compared by using LSD at 5 % level of significance.

RESULTS AND DISCUSSION

November 19-23 sowing resulted in maximum and significantly higher plant height, LAI, dry matter accumulation, no of spikes m^{-2}, grains per spike, grain and straw yield than other dates of sowing (Table 1 and 2). Spike length, thousand grain weight and HI were at par among different sowing dates. Dry matter accumulation was reduced to 27.67% under December 9-13 sowing against November 19-23 sowing. Maximum plant height (101.63 cm), LAI (3.70) and dry matter accumulation (611.40 g m^{-2}) were recorded with the earliest sowing, *viz*., November 19-23 sowing. Higher plant height and dry matter accumulation under early sown crop was reported by Pankaj *et al* (2015a). The cultivars differed significantly in plant height, LAI as well as dry matter accumulation. Highest plant height (102.74 cm) was recorded with K 603, while max LAI (3.88) and dry matter accumulation (654.67 g m^{-2}) were recorded with K 551 reflecting the overall superiority of the cultivar in terms of growth attributes. Higher LAI with increased tiller number *vis-à-vis* spike number attributed to higher biomass production in K 551. Data presented in Table-1 further indicated that tiller production increased significantly upto 70 days after sowing (DAS) in all the cultivars and maximum tiller number (287 m^{-2}) was achieved under November 19-23 sowing. The tiller number sharply reduced to 230 m^{-2} under very late sowing of December 9-13. This decline in tillering ability with delayed sowing was in conformity with the findings of Pankaj *et al* (2015b). As far as crop growth rate was concerned, the values reduced significantly with delayed sowing. Delayed sowing exposed the crop to higher temperature and longer day length during tillering and grain filling period, which might have reduced the tiller number. K 551 recorded higher tiller number as well as CGR value at all the stages of recording observation. For all the cultivars, CGR achieved its peak in between 60-75 days after sowing compared to other dates. Higher values of all growth attributes under November 19-23 sowing was probably due to exposure of the crop to much favourable weather condition as compared to other dates as the temperature reduced sharply during December. Earlier sowing dates permitted the barley crop to grow under satisfactory temperature regime in various phonological stages of growth. Aziz *et al* (2016) reported that the choice of sowing dates in barley served as the most important crop management option under changing climatic scenario and in all the cases the appropriate sowing window would be helpful in avoiding higher temperature during grain filling stage at the end of the season.

Number of spikes m^{-2}(242) and number of grains $spike^{-1}$ (45.3) were recorded maximum under November 19-23 sowing which were drastically reduced to 212 and 40.6, respectively under December 9-13 sowing. Among the cultivars, K 551 reflected its superiority in terms of all yield attributes, viz., number of spike m^{-2}(255), number of grains $spike^{-1}$(46.6), spike length (7.90 cm) and test weight (38.37g).

Crop sown under November 19-23 recorded the highest grain yield of 2.89 t ha^{-1}, which 17.95% and 46.70 % higher than the crop was sown under late (December 1-3) and very late (December 9-13) condition, respectively (Table 2). The higher yield in timely sowing condition could be attributed to favourable temperature at grain development stage which in turn increased the photosynthetic rate, assimilates the supply for seed and seed growth rate in timely sown crops. Higher grain yield of barley under timely sown condition as compared to other sowing dates of barley was also reported by a number of workers (Singh *et al*, 1989; Alam *et al*., 2005; Ram *et al*., 2010).Among the cultivars, K 551 was found to be the highest yielder (3.21 t ha^{-1}) followed by .K 409(2.97 t ha^{-1}). The trend was similar in case of straw yield also. Vegetative stage of the crop reduced with delayed sowing which ultimately reduced the straw yield also (Razzaque and Rafiquzzaman, 2006). It was interesting to note that all the cultivars (except K 551) recorded harvest index between 29-32%, whereas it was 39.23% in case of K-551.

In consideration of the above observation it can be concluded that in t*erai* region of West Bengal barley could be sown during third week of November to obtain higher grain yield and the cultivar K 551 was found suitable for this zone in terms of grain yield.

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