

Original Research Article

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Productivity, Quality and Profitability of Dual Purpose Barley (*Hordeum vulgare* L.) Under Various Planting Techniques and Cutting Practices in Indo-Gangetic Plains of India

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ABSTRACT

Keywords

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The field experiment was conducted during the *rabi* season of 2014-15 at Student's Research Farm Punjab Agricultural University, Ludhiana, Punjab. The experiment was laid out in factorial randomized block design (RBD) with 9 treatments have three planting techniques viz. unidirectional (UD), bidirectional (BD), broadcast (BC) and three cutting practices viz. uncut (UN_C), cut at 50 days after sowing (C₅₀ DAS) and cut at 60 DAS (C₆₀ DAS) with four replications. The emergence, plant height, leaf area index, tillers and dry matter accumulation in bidirectional and uncut treatments was significant. Lodging score was significantly reduced by cutting practices (0%) as compared to uncut (57.27%) treatments. The effective tillers, spike length, test weight, grain (44.60 q ha⁻¹) and biological yield (121.38 q ha⁻¹) were significantly higher in bidirectional planting techniques and uncut treatments. The grain protein was higher recorded in uncut (10.55%) treatment. The net return with economic efficiency was significantly higher in bidirectional planting techniques (53,777 ₹ ha⁻¹ and 324.84 ₹ day⁻¹ ha⁻¹) where as in cutting practices cut at 50DAS (55,756 ₹ ha⁻¹) was found to be significant superior then cut at 60DAS and uncut.

Introduction

Barley (*Hordeum vulgare* L.) is the fourth most important cereal crop of the world after wheat, rice and maize. India supports nearly 20 per cent of world's livestock being the leader in cattle (16%) and buffalo (5.5%) population. The livestock sector contributes 32 per cent for agricultural output, which is 22 per cent of total GDP in India. The shortage in green fodder and dry fodder animals is 21.8 per cent compared with requirement of 560 million tonnes (Kumar *et al.*, 2012). In India it is an important winter season cereal crop and major barley producing states Rajasthan, Uttar Pradesh,

Haryana, Madhya Pradesh, and Punjab. It is grown in our country in 0.63 million ha with a production of 1.20 million tonnes and an average productivity of 1.94 tonnes/ha (Anonymous, 2015). Barley grain has the largest use as animal feed all over the world and in India also a major share of barley grain is used as animal feed either alone or in combination. As a fodder crop, barley has tremendous potential and variation for production of very high amount of digestible dry matter as well as protein yield. Its grains contain 8 to 10 per cent protein and 74 per cent carbohydrates besides the minerals and

vitamin B-complex and thus forms a staple food, cattle feed, malt for manufacturing of beer and other liquor products (Singh *et al.*, 2009). Its straw is also used for making hay and silage. The barley produce from irrigated fertile areas is mainly used for industrial purposes, which accounts to nearly 20-25 per cent of the total production and the remaining quality from rainfed and less fertile area are utilized for cattle feed purpose (Sarkar *et al.*, 2008). The studied in winter grain crops (wheat and barley) when sown in row of orientation East-West or North-South and observed that within wheat and barley crops oriented East-West, the grain yield increased by 24 and 26% as compared with crops oriented in North-South increase in crop yield likely resulted from the increased light interception (PAR) by crops oriented East-West than compared to North-South sown crops (Catherine *et al.*, 2010). The effect of cutting management practices on grain and fodder yield of barley at different stages of cutting (uncut, cut at 45 DAS, cut at 60 DAS and cut at 75 DAS). Uncut treatment significantly resulted the highest grains⁻¹ and 1000-grain weight over rest of the cutting treatments.

However the differences between cutting at 45 and 60 days after sowing were found to be non-significant. The highest green fodder yield was obtained with cutting at 75 DAS, which was superior over cutting at 45 and 60 DAS (Singh *et al.*, 2009). Different planting techniques (row orientation) and cutting management practices will influence the growth and yield of barley and their results will help to develop suitable agronomic practices to increase the productivity and profitability of barley. Keeping this in view, the present investigation was carried out to effect of different planting techniques and cutting practices of the productivity, quality and profitability of barley in indo-gangetic plains of India.

Materials and Methods

The field experiment was conducted during the *rabi* season of 2014-15 at Research Farm Punjab Agricultural University, Ludhiana, Punjab. The crop using variety PL 807 was on sown at 22.5 cm row spacing using 87.5 kg seed ha⁻¹ at Nov.5, 2014 of barley crop. The experiment was laid out in factorial randomized block design (RBD) with 9 treatments have three planting techniques viz. unidirectional (UD), bidirectional (BD), broadcast (BC) and three cutting practices viz. uncut (UN_C), cut at 50 DAS (C_{50 DAS}) and cut at 60 DAS (C_{60 DAS}) with four replications. Statistical analysis by using STAR (Statistical Tool for Agricultural Research), software developed by Department of Plant Breeding Genetics and Biotechnology, IIRI (International Rice Research Institute), Manila, Phillipines based on the procedure of Cochran and Cox (1966).

The experimental field was collected before initiating the experiment and two (0-15 cm and 15-30 cm) composite sample was prepared. The field was moderately alkaline (8.3), electrical conductivity normal (0.40 and 0.30), low in organic carbon (0.30 and 0.18) and low in available nitrogen (130 kg ha⁻¹), medium in available phosphorus (21.31 and 18.2 kg ha⁻¹) and potassium (185 and 156.2 kg ha⁻¹) Havlin *et al.*, (2014). Plant emergence in the marked area were recorded became constant completion of emergence were computed. Plant height of 10 tagged plants in the net plot was recorded. The numbers of tillers in the marked spots of half meter square area each plot were recorded. Dry matter accumulation in the above ground parts was recorded from half meter square area. The leaf area index with the help of leaf scanner and lodging score (0-10) of the crop was recorded by measure lodging crop area of crop in each plot than converted to per cent depending upon extend of lodging at harvest.

Effective tillers were counted at maturity. The spike length of main ear on 10 tagged plants was measured from base of the tip floret excluding awns. During threshing 1000-grains sample was collected from each plot to present the data (Sardana and Zhang 2004). The net return and economic efficiency were calculated following formulas. Economic efficiency ($\text{day}^{-1} \text{ha}^{-1}$) = Net return (ha^{-1}) / Total duration taken crop (days) Rolaniya *et al.*, (2015). Net returns (ha^{-1}) = the net returns were calculated by subtracting the cost of cultivation from the gross returns and presented as ha^{-1} (Sampath and Srinivas, 2017).

Results and Discussion

Growth attributes

The data presented in table 1 showed that the emergence count in BD technique statistically at par with UD technique, but significantly higher BC techniques for completion of emergence. The plant height at 90 and 120 DAS was significantly higher in BD technique and UN_C treatment than other treatments of barley. Plant height was significantly higher when the wheat crop was raised with no cut as compared to the crop where one cut was imposed for taking additional forage yield (Kumar *et al.*, 1999).

The LAI and tillers at 90 and 120 DAS in BD techniques was significantly higher than BC and UD planting techniques. However, BC and UD planting technique were at par. In cutting practices it was observed that the LAI at 90 DAS and 120 DAS of UN_C treatment was significantly higher than C₅₀ DAS and C₆₀ DAS, but C₅₀ DAS was significantly higher than C₆₀ DAS of barley. The crop due to forage harvest, it might be the reason for higher LAI in UN_C treatment. The higher LAI in bidirectional planting technique might be due to better canopy which intercepted more solar

radiation and resulted better growth (Angiras and Sharma, 2016). The tillers count at 90 and 120 DAS UN_C and C₆₀ DAS were statistically at par, but significantly higher than C₆₀ DAS of tillers. This might be due to longer vegetative growth period which resulted in more tillering and more number of tillers per unit area in uncut and cut 50 DAS (Dhillon and Kler, 1998). The dry matter accumulation at 90 and 120 DAS was significantly higher in bidirectional planting techniques compared to other treatments. At 90 and 120 DAS the dry matter accumulation by crop in UN_C treatment was significantly higher than C₅₀ DAS and C₆₀ DAS.

Grain protein and lodging score

The data in table 1 indicate that the grain protein of barley was not influenced by planting techniques but significantly influenced by cutting practices. Protein content in grain was significantly higher in UN_C treatment followed C₅₀ DAS and C₆₀ DAS. Lodging at harvest in bidirectional and broadcast planting techniques was statistically at par, but significantly higher than unidirectional planting techniques and cutting practices in UN_C treatment was highest. Lodging may damage control 100 per cent by cutting practices at C₅₀ DAS and C₆₀ DAS. Lodging is due to the state of permanent displacement of the stems from their upright position. It is induced by external forces exerted by wind, rain, or hail and genetic characters of cultivar.

Yield attributes

The data presented in table 2 showed that BD gave significantly higher number of effective tillers and spike length than BC and UD, but BC and UD were statistically at par. The number of effective tillers and spike length in UN_C and C₅₀ DAS were statistically at par, but significantly higher than C₆₀ DAS. Spike length

might have reduced due to cutting treatment which would have decreased the photosynthetic assimilation from source to sink. Spike length might have reduced due to removal of vegetation which would have decreased the photosynthetic assimilation from source to sink. Thus, stress was imposed on the crop after forage harvest especially when cutting was done after 50 DAS of the crop. Similar results have been earlier reported by Das and Sarxas (2008) in which they observed that spike length in wheat was reduced in

different varieties of wheat. The 1000-grain weight in BD techniques resulted higher test weight than BC and UD planting techniques, but broadcast and unidirectional planting techniques were at par. The test weight in UN_C and C₅₀ DAS were statistically at par, but significantly higher than C₆₀ DAS. Sharma *et al.*, (2001) also reported that in oats forage cutting at 65 DAS produced higher 1000-grain weight than forage cutting at 80 DAS (Fig. 1).

Fig.1 Effect of planting techniques and cutting practices on grain yield (q ha⁻¹), biological yield, net return (₹ ha⁻¹) and economic efficiency (₹ day⁻¹ ha⁻¹)

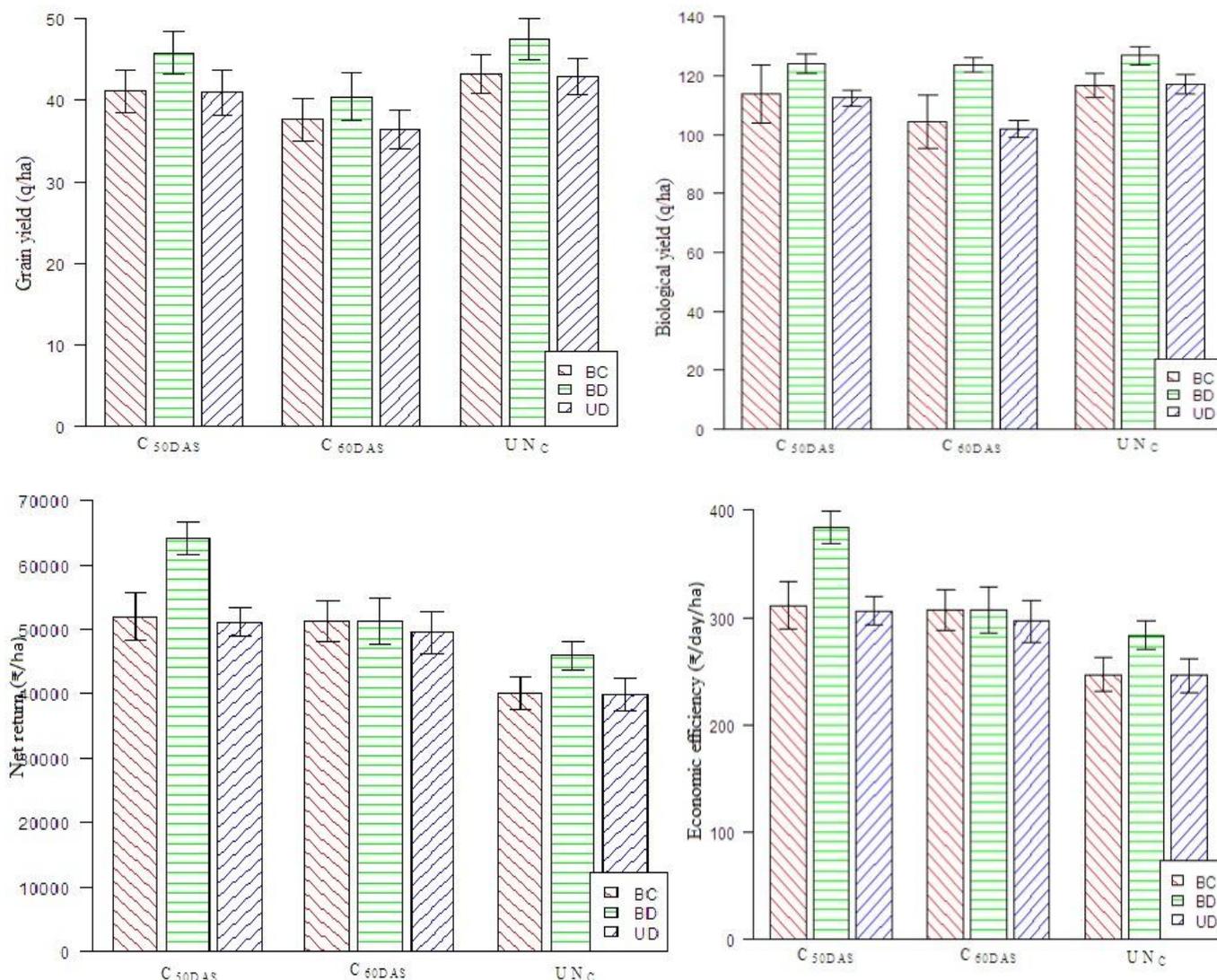


Table.1 Growth attributes, grain protein (%) and lodging score (%) as influenced by planting techniques and Cutting practices of barley

Treatment	Emergence (m ⁻²) 7DAS	Plant height (cm)		LAI		Tillers count (No. m ⁻²)		Dry matter accumulation (q ha ⁻¹)		Grain protein (%)	Lodging score (%)
		90 DAS	120 DAS	90 DAS	120 DAS	90 DAS	120 DAS	90 DAS	120 DAS		
Planting techniques											
Unidirectional	376.00	49.98	81.39	3.16	4.22	421.37	396.19	24.89	96.80	9.93	14.82
Bidirectional	376.83	61.98	92.22	3.55	4.78	461.16	431.19	27.90	108.60	10.39	21.67
Broadcast	324.92	50.50	82.08	3.24	4.07	427.89	401.27	25.01	97.43	9.99	20.78
CD (P=0.05)	17.56	3.37	4.43	0.16	0.20	21.69	22.29	2.67	4.05	NS	1.83
Cutting practices											
Un-cut	359.0	81.60	95.01	4.79	5.23	461.74	435.91	41.78	118.49	10.55	57.27
Cut at 50 DAS	359.50	46.24	86.78	2.84	4.37	448.60	420.94	27.33	106.22	10.12	0
Cut at 60 DAS	359.25	34.62	73.89	2.31	3.46	400.07	371.75	8.70	77.58	9.64	0
CD (P=0.05)	NS	3.37	4.43	0.16	0.20	21.69	22.29	2.67	4.05	0.41	1.83
Interaction	NS	5.81	NS	NS	NS	NS	NS	NS	NS	NS	3.16

Table.2 Yield parameters, yield and economics as influenced by planting techniques and cutting practices of barley

Treatment	Effective tillers (no. m ⁻²)	Spike length (cm)	1000-grain weight (g)	Grain yield (q ha ⁻¹)	Biological yield (q ha ⁻¹)	Harvest index (%)	Gross expenditure (₹ ha ⁻¹)	Net return (₹ ha ⁻¹)	Economic efficiency (₹ day ⁻¹ ha ⁻¹)
Planting techniques									
Unidirectional	347.73	6.73	36.46	40.10	110.53	36.36	22,214	46,837	282.89
Bidirectional	396.04	7.63	38.87	44.60	121.38	36.82	22,214	53,777	324.84
Broadcast	356.34	6.97	36.88	40.65	111.65	36.46	22,214	47,779	288.56
CD (P=0.05)	19.59	0.38	1.62	2.141	3.797	NS	-	2417	14.57
Cutting practices									
Un-cut	396.69	7.62	39.39	44.55	120.25	37.09	22,214	41,928	258.79
Cut at 50 DAS	379.37	7.27	38.45	42.64	116.82	36.62	22,622	55,756	333.85
Cut at 60 DAS	324.05	6.45	34.38	38.16	106.48	35.92	22,622	50,710	303.65
CD (P=0.05)	19.59	0.38	1.62	2.141	3.797	NS	-	2417	14.57
Interaction	NS	NS	NS	NS	NS	NS	-	4161	25.08

Table.3 Interaction effect of different planting techniques and Cutting practices on economics in barley

Planting techniques	Cutting practices	Net return (₹ ha ⁻¹)			Economic efficiency (₹ day ⁻¹ ha ⁻¹)		
		Un-cut	Cut at 50 DAS	Cut at 60 DAS	Un-cut	Cut at 50 DAS	Cut at 60 DAS
Unidirectional		39,841	51,152	49,518	245.90	306.27	296.50
Bidirectional		45,923	64,108	51,310	283.45	383.87	307.27
Broadcast		40,018	52,008	51,300	247.02	311.40	307.20
CD (P=0.05)			4161			25.08	

Yield and Economics

The data presents in table 2 showed that the grain and biological yield varied significantly, BD techniques produced the higher grain and biological yield than BC and BD techniques, but broadcast and unidirectional were planting techniques statistically at par. Vaishya and Singh (2009) reported higher grain yield in cross-planting at 22.5 cm. The results were in line with the findings of Ketata *et al.*, (2011) in which they reported that bidirectional planting for sowing of wheat significantly increased yield of winter wheat. The grain and biological yield in UN_C and C₅₀ DAS were statistically at par, but significantly higher than C₆₀ DAS. The similar results reported by Ram *et al.*, 2012.

The grain yield reduction might be due to shortening of vegetative and reproductive period. The yield components, reduced by clipping, were the most important contribution to loss of grain yield (El-Shatnawi and Haddad, 2004). The different planting techniques of barley viz. bidirectional, broadcast and unidirectional and cutting practices did not affect the harvest index. Interaction effect of planting techniques and cutting practices was found to be non-significant. The highest net return and economic efficiency in bidirectional planting technique were significantly better than other treatments, while it was least under unidirectional planting. In cutting practices highest net return C₅₀ DAS followed by C₆₀ DAS and UN_C treatment lowest net return. The effect of cutting management of oats for forage gave higher net returns, which are in line with the

present findings interaction effect of different planting techniques and cutting practices on the economics of barley crop were found to be significant (Singh *et al.*, 2008).

Interaction effect

Economics

The data in the table 3 indicated that bidirectional planting technique C₅₀ DAS fetched the highest net return (₹ 64,108 ha⁻¹) with economic efficiency (383.87 ₹ day⁻¹ ha⁻¹), while it was followed to be least under UN_C (grain yield) unidirectional planting techniques (₹ 39,841 ha⁻¹) with economic efficiency (245.90 ₹ day⁻¹ ha⁻¹).

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