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Response of Barley to Sowing Date and Fertilizer Application under Rainfed Condition

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Abstract: Among the cultural practices, sowing date and fertilizer application are the major limiting factors to achieve production potential of the crop. Field experiment was conducted at the Arid Zone Research Institute, D.I.Khan, to investigate the effect of sowing date and fertilizer application on growth and grain yield of barley. Plant height, days to maturity yield components and grain yield of barley were significantly affected Sowing dates. Planting of barley in mid October produced the highest grain yield (3576 kg ha^{-1}) compared with planting in mid November (2228 kg ha^{-1}) irrespective to fertilizer use. Grain yield and yield components of barley were also affected by application fertilizer levels. The grain yield was increased by different levels of fertilizer by 13 to 51% over control crop yield of 2262 kg ha^{-1} irrespective to sowing date. The interacting effect of sowing date and fertilizer levels indicated that the highest grain yield of 4293 kg ha^{-1} was obtained from the treatments of October sowing with 60-40 kg ha^{-1}NP fertilizer followed by 4227 kg ha^{-1}yield in the same date of sowing and 90-60 kg ha^{-1} NP fertilizer. Thus, it can be concluded from these results that October sowing with 60-40 kg ha^{-1} fertilizer might be the sustainable approach for achieving the highest production of barley under rainfed condition in Pakistan.

Key words: Barley (*Hardeum vulgare* L.) · Sowing time · Fertilizer level · Grain yield · Rainfed condition

INTRODUCTION

Sowing date and fertilizer rate control crop yield. Effect of sowing time and fertilizer levels on the yield of barley was tested under rainfed condition. The differences in production of early and late sown crops may be due to favourable temperatures at different growth stages, which may increase photosynthetic rate, assimilates the supply for seed and seed growth rate in early sown crops than late planting. Many research workers indicated that early planting increased the yield attributes and yield of different crops than late planting in different climatic conditions [1-4]. Berrada [5] concluded that early November sowing of barley gave much higher yield as compared with late November sowing. Similarly, Bates [6] found that up to 71% more grain yield was achieved by earlier planting than late sowing of barley, wheat, triticale, rye and oat crops. Khan *et al.* (7) found that early planted wheat, barley and triticale crops produced maximum grain yields than late sown crops. Other studies,..... [8-13] indicted that delayed planting of crops decreased the yield due to reduction in leaf area and dry matter accumulation of different crops .

Normally, very little fertilizer is applied to barley crop. But the importance of balanced fertilizer for increased crop production can not be denied. The rising cost of chemical fertilizer and their timely availability is a constraint in their adequate use. Although fertilizer application increases crop production but in appropriate practices that are followed during cultivation lead to low out put of the applied fertilizer compared with the actual potential of fertilizer efficiency. Zia *et al.* [14] indicated that the use of correct fertilizer can increase crop yield upto 50% in Pakistan. Aslam *et al.* [15] found that the maximum grain yield of barley 2995 kg ha^{-1} was harvested from 69-69 N P kg ha^{-1} treatment compared with 1507 kg ha^{-1} yield of

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control treatment. Similarly, Turk *et al.* [16] indicated that the highest grain yield of barley under 120 kg N ha^{-1} among N rates owing to highest number of spikes m^{-2} (537.5) and number of grains apike^{-1} (56.3) of barley than control. Ahmad and Rashid [7] found that NPK fertilization significantly increased the yield of wheat by 224% over control (1302 kg ha^{-1}). Imran *et al.* [18] reported that 160-80-50 kg ha^{-1} gave the maximum grain yield of wheat, while increasing fertilizer over that level decreased the grain yield as well as its contributing factors like plant height, tillers plant^{-1} and spike length of wheat.

The objectives of this study were to determine the effect of sowing date and fertilizer application under rainfed condition, so that the barley can be grown at suitable planting time with optimum fertilizer level for increasing crop production in arid and semi-arid regions in Pakistan.

MATERIALS AND METHODS

This study was carried out at the Arid Zone Research Institute, D.I.Khan during 2005-06 to find out suitable time of sowing and optimum dose of fertilizer for getting maximum grain yield of barley under rainfed condition. The crop was sown on two different time of sowing i.e. 12-10-2005 and 12-11-2005 with four different levels of fertilizer including 0-0, 30-20, 60-40 and 90-60 kg NP ha^{-1}. All the nitrogenous and phosphatic fertilizer were applied in the form of urea and single super phosphate (SSP), respectively at the time of land preparation. The trial was laid out in a split plot design keeping sowing date in the main plots and the fertilizer levels in the sub-plots. A net plot area of 5 x 1.80 m with six rows at a distance of 30 cm apart was used in three replications. Prior to sowing a composite soil sample from 0-30 cm depth was collected for laboratory analysis (Table 1). Adequate plant protection measures were undertaken for maintenance of the crop. Agro meteorological data recorded during the growing season of crop are given in Table 2.

The data on different parameters of growth, yield components and grain yield of barley was recorded compiled and then subjected to analysis of variance (ANOVA) technique to determine the significance of variation in yield components and yield due to sowing date, fertilizer levels and their interactions. Duncan's multiple range (DMRT) test was employed for individual means comparison of the two factors and their interaction as prescribed by Steel and Torrie [19].

Table 1: Soil properties before sowing of the crop.

Properties	Value
pH	8.2
EC (dSm^{-1})	1.9
Organic matter (%)	0.40
Extractable P mg kg^{-1}	7.2
Extractable K mg kg^{-1}	101
Clay (%)	52.0
Sand (%)	35.5
Silt (%)	12.5
Texture	Clayey

Table 2: Air temperature and rainfall data during crop growing season.

	Temperature °C		
Month	Maxi.	Mini.	Rainfall (mm)
October 2005	23	17	0
November 2005	27	10	0
December 2005	22	6	6
January 2006	20	4	3
February 2006	26	9	53
March 2006	27	13	4
April 2006	36	18	4

Source: Agromet unit, AZRI, D.I.Khan.

RESULTS AND DISCUSSION

Data in Table 3 indicated that sowing date and fertilizer levels had significantly affected the plant height of barley. Early sowing produced significantly taller plants of 86.63 cm compared with 71.92 cm at late sowing. Different levels of fertilizer also affected on plant height of barley. Data revealed that plant height ranging from 69.52 to 86.80 cm linearly increased with increasing level of fertilizer. The tallest plant of 86.80 cm was produced in the treatment of 90-60 NP kg ha^{-1} followed by 82.45 cm with 60-40 NP kg ha^{-1}, while the lowest plant height of 69.52 cm was recorded with the control treatment. The interacting effect of planting date and fertilizer application also affected the plant height of barley. The maximum plant height of 94.43 cm was recorded with the treatment of early sowing when received the highest dose of fertilizer (96-60 kg ha^{-1}), while the minimum plant height of 60.96 cm was recorded with late sowingxwithout fertilizer. These results suggested that early sowing with fertilizer application might have improved the vegetative growth of crop, which ultimately increased plant height of barley.

Data presented in Table 3 indicated that the number of tillers plant^{-1} was found non-significant with sowing date, while it was significantly affected by fertilizer levels. Number of tillers plant^{-1} (1.62) produced in control

Table 3 Data on plants growth, yield attributes and grain yield of barley as influenced by sowing time and fertilizer levels.

Treatments	Plant height (cm)	Number of tillers plant^{-1}	Number of grains spike^{-1}	1000 grains weight (g)	Grain yield (kg ha^{-1})	% increase in grain yield
Sowing dates (SD)						
T1 (12-10-05)	86.63 a	2.41	53.50 a	47.03 a	3576 a	--
T2 (12-11-05)	71.92 b	2.02	51.25 b	46.01 b	2228 b	60
LSD	3.21	NS	1.20	0.78	127.0	
Fertilizer level (F) kg ha^{-1}						
F1 (0-0)	69.52 d	1.62 c	45.00 c	45.33 c	2262 c	--
F2 (30-20)	78.33 c	2.08 b	51.50 b	46.02 b	2559 b	13
F3 (60-40)	82.45 b	2.49 a	57.00 a	47.48 a	3429 a	51
F4 (90-60)	86.80 a	2.68 a	56.50 a	47.27 a	3359 a	48
LSD	2.336	0.341	2.224	0.292	160.77	
Interaction (SDXF)						
SD1XF1	78.06 d	1.60 c	46.00	45.50	2725 c	--
SD1XF2	84.70 c	2.20 b	52.00	46.33	3060 b	12
SD1XF3	89.30 b	2.73 a	58.00	48.13	4293 a	57
SD1XF4	94.43 a	3.10 a	58.00	48.17	4227 a	55
SD2XF1	60.96 g	1.63 c	44.00	45.16	1798 f	--
SD2XF2	71.98 f	1.97 bc	51.00	45.70	2058 e	14
SD2XF3	75.60 e	2.20 b	56.00	46.83	2565 d	42
SD2XF4	79.16 d	2.26 b	54.00	46.36	2492 d	38
LSD	2.85	0.39	NS	NS	85.94	

NS:Non-significant

Means followed by the same letter don't differ significantly at 5% level of probability.

treatment was significantly low than that other fertilizer treatments. The highest number of tillers plant^{-1} (2.68) was produced with fertilizer level of 90-60 kg ha^{-1} followed by 2.49 with 60-40 kg ha^{-1} showing non significant difference to each other. The data further evinced that the interacting effect of sowing date and fertilizer levels was also significant. Early sown crop with 90-60 kg ha^{-1} fertilizer level produced highest number of tillers plant^{-1} (3.10) followed by the crop sown on the same date with fertilizer level of 60-40 kg ha^{-1} produced 2.73 tillers plant^{-1}. The differences between the two treatments was statistically at par suggesting thereby that 60-40 kg ha^{-1} might be the optimum level of fertilizer for crop growth.

Data in Table 3 showed that the number of grain spike^{-1} was significantly affected by sowing date and fertilizer application. Early sown crop gave more number of grains spike^{-1} (53.50) compared with 51.25 grains in late sown crop. Application fertilizer also increased the number of grains spike^{-1} than control. Number of grains spike^{-1} 57 and 56 was produced with 60-40 and 90-60 kg ha^{-1} fertilizer level, respectively were statically at par. The lowest number of grains spike^{-1} (45) was obtained from control plot. The interaction of sowing time and fertilizer level was found non-significant regarding the number of grains spike^{-1} of barley. The crop sown earlier with fertilizer level of 60-40 kg ha^{-1} and 90-60 kg ha^{-1} produced equal number of 58 grains spike^{-1}. Both of sowing dates without fertilizer suppressed the crop growth resulting in a reduction in number of grains production under rainfed condition.

Data (Table 3) indicated that early sowing date significantly increased the thousand grains weight of barley than later sowing. The application of fertilizer also significantly affected the 1000 grains weight of barley. All the levels of fertilizer increased the thousand grains weight of barley than control crop. The 1000 grains weight (47.48g) of 60-40 kg ha^{-1} was significantly more than the rest of treatments except 47.27 g obtained with 90-60 kg ha^{-1}, while the lowest 1000 grains weight of 45.33 g was recorded with control treatment. The interacting effect of sowing date and fertilizer level did not affect significantly the 1000 grains weight of barley. However, the early sown crop with 90-60 kg ha^{-1} fertilizer gave maximum 1000 grains weight of 48.17 g followed by same date of sowing with 60-40 kg ha^{-1} showing 48.13 g 1000 grains weight of barley. The crop grown without fertilizer at both the sowing time gave minimum 1000 grains weight as compared to other treatments under study.

Table 3 showed that sowing date and fertilizer levels significantly affected the yield of barley. The early sowing of crop produced the highest grain yield of barley showing 60 % increase over control crop yield of 2228 kg ha^{-1}. These results were supported by Berrada [5], Bates [6], Khan et *al.* [7], Khalil *et al.*[11]and Rifat & Jamro [13]. The grain yield of barley was also affected significantly by the different levels of fertilizer. The grain yield ranging from 2262 to 3459 kg ha^{-1} showed 13, 51 and 48% increase over control crop yield of 2262 kg ha^{-1} with 30-20, 60-40 and 90-60 kg ha^{-1} fertilizer levels, respectively. These results are in line with the findings of Zia *et al.* [14] and Ahmad & Rashid [17]. The data further evinced that 60-40 kg ha^{-1} showed maximum increase (51%) in grain yield of barley than low and high dose of fertilizer. Thus, suggesting that this level of fertilizer (60-40 kg ha^{-1}) might be the optimum level used efficiently in limited moisture under rainfed condition. These results were supported by Imran *et al.* [18]. The interacting effect of sowing time and fertilizer level revealed that the grain yield of barley was significantly affected with different treatment of combination. The highest grain yield of 4293 kg ha^{-1} was obtained from the treatment of early sown crop with fertilizer level of 60-40 kg ha^{-1} followed by grain yield of 4227 kg ha^{-1} with the same date of sowing and fertilizer level of 90-60 kg ha^{-1} showing non-significant difference to each other. All other treatments of combination gave significantly low grain yield of barley. These results are in harmony with Hussain and Ready [20] whom reported similar effect of dates of sowing and nitrogen level on the yield of pearl millet.

The findings of this study suggested early sowing in the month of October with fertilizer level of 60-40 kg ha^{-1} to achieve the highest grain yield of barley under rainfed condition. Thus, this technology for barley cultivation can be recommended for adoption to the arid and semi-arid areas of the country.

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