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Short Communication

Determination of the suitable planting date and plant density for different cultivars of barley (*Hordeum vulgare L.*) in Fars

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In order to determine the suitable planting date and plant density in different cultivars of barley (*Hordeum vulgare L.*) in semi arid region, an experiment was conducted at Research Farm, Lamard, Fars, Iran in 2002 to 2003. The main plots were planting dates, November 6th and December 6th, the sub plots were plant densities, 250, 350 and 450 plants per m^2, and the sub sub plots were three cultivars of barley, namely: Kavir, Rayhanee and Karun. Effect of planting date was significant on the number of days from planting to physiological maturity. Cultivar had significant effect on the number of days from planting to physiological maturity, plant height, grain yield and harvest index. The interaction between planting date and cultivar was significant on aboveground biomass and grain yield, and also, the interaction between plant density and cultivar was significant on grain yield. Early sowing was as a result in a decrease in grain yield. The differences in grain yield between different plant densities demonstrated the remarkable influence of sowing density on this important factor. It seems that cultivation of karun, with 450 plants per m^2 in November 6th is suitable for this region.

Key words: Planting date, plant density, cultivars, barley.

INTRODUCTION

Yield response of barley varies with different environmental variables, including planting date, plant density, cultivars, soil type, N feritilizer, residual fertility and etc. Lenssen (2008) reported that in three planting dates mid-April (early), late May (mid) and mid-June (delayed), early planting of barley resulted in excellent forage yields. Kirby and Faris (2005) in their study reported that, increasing density from 50 to 1600 plants m^{-2}, reduce the leaf number from 10.2 to 8 and caused stem inter node elongation to start earlier at a lower node. Final stem length was reduced due to earlier cessation of growth. They also reported that the apex reached the double ridge stage 6 days earlier than at the lowest density. The rate of primordium production was markedly affected. They also reported that there were small differences in the length of shoot apex or ear during growth, but earlier cessation of growth in the higher densities led to a shorter ear. Arisnabarreta and Miralles (2008) reported that changes in the number of grains per unit area were correlated with crop growth rate in different lines of barley during the critical period for yield determination. A demand for cultivars better suited to environmentally-friendly or low-input management systems is likely to arise (Linderberg et al., 2003). The dietary neutral detergent fiber concentration was 30.6 and 28.8% for BM and BJ, respectively. Optimum plant density and planting date in different cultivars of barley in Lamard in Fars province has not been investigated. This study aimed at determining the determination of optimum sowing date and plant density of barley for achievement of maximum grain yields under conditions of semi arid climate in the central of Iran.

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Table 1. Soil test of agriculture research field (0 to 15 cm and 15 to 30 cm).

Depth (cm)	SP	EC (ds/m)	PH	OC (%)	N (%)	P (a.v.a) (mg/kg)	K (a.v.a) (mg/kg)
0-15	60	1.72	7.8	0.73	0.09	30	360
15-30	60	1.9	7.9	0.67	0.09	28	354

Table 2. Analysis of variance for experimental characteristics.

S.O.V	D.f	Number of days from planting to physiological maturity	Plant height	Number of tiller	Aboveground biomass	Grain yield	Harvest index
Replication	2	91.26	11.80	2.07	6.69	98.48	0.41
Planting date	1	74.12*	2.67	0.02	10.67	55.16	4.68
Error (a)	2	35.48	12.50	0.52	88.72	67.22	0.54
Plant density	2	2.30	85.91*	9.46*	36.24	1.14*	2.76*
Planting date ×plant density	2	2.31	18.39	0.02	20.06	11.11	22.00
Error (b)	8	3.40	9.29	1.07	38.98	49.14	18.00
Cultivar	2	57.33**	1062.35**	0.24	120.52	55.73**	32.47**
Planting date ×cultivar	2	8.26	1.50	0.68	320.67*	67.49**	92.59
Plant density ×cultivar	4	7.30	23.41	1.23	43.67	98.12*	45.10
Planting date ×plant density ×cultivar	4	74.20	10.56	1.02	34.89	25.71	915.00
Error (c)	24	13.17	10.96	0.704	391.06	48.20	57.00

*significant at 0.05 significance in F-tests, **significant at 0.001 significance in F-tests

MATERIAL AND METHODS

An experiment was conducted at Research Farm, Lamard, Fars, Iran in 2002 to 2003. A split split plot layout within randomized complete block design was used and divided into three replications. The main plots were planting date (November 6th and December 6th), the sub plots were plant density (250, 350 and 450 plants per m^2) and the sub sub plots were three cultivars of barley, namely, Kavir, Rayhanee and Karun. One week before sowing, soil samples were taken at 0 to 15 and 15 to 30 cm. The soil texture was clay loam (Table 1). In each plot, 6 lines were used, rows, number 1 and 6 and also 0.5 m from start and end of lines were omitted. The length of each line was 10 m. The distance between plots and between blocks was 1 and 2 m, respectively. Hand weeding was done for eradication of weeds. The first irrigation was done just after cultivation. The other irrigations were done according to plant requirements in distinct planting dates. For providing N element, N fertilizer was applied in two split (half of it was used before planting and half of it was used one week before anthesis stage). All plots were evaluated on 1 m^2 area. In order to measure the seed yield and dry matter, plants were cut and after drying, dry matter and seed yield was measured. Six plants were randomly selected in each plot to measure plant height. Harvest index was computed as the ratio of the seed yield to Aboveground dry matter. The Multiple Range Test of Duncan performed the separation of means. All statistics were performed with MSTATC program (version 2.10).

RESULTS AND DISCUSSION

The effect of planting date on the number of days from planting to physiological maturity was significant (P<0.05) (Table 2). The minimum number of days was related to November 6th (199.56 days), the number of days in December 6th was 215.60 days (Table 3). In December 6th, the barley's seedling was affected by cold weather. The effect of plant density was not significant on the number of days from planting to physiological maturity. The effect of cultivar on the number of days from planting to maturity was significant (P<0.01) (Table 2). There was no significant difference in the number of days from planting to maturity between Karun and other cultivars. The number of days from planting to maturity in Kavi cultivar was 207.28 days (Table 3). The effect of plant density on plant height was significant (P<0.05) (Table 2). The highest plant height was related to 450 plants per m^2 (96.66 cm), and the lowest plant height was observed at 250 plants per m^2 (92.39 cm). There was significant increase in plant height from 250 plants per m^2 to 450 plants per m^2. The effect of cultivar on plant height was significant (P<0.01) (Table 2). The highest plant height was related to Karun (103.72 cm) (Table 3).

The effect of plant density on the number of tillers was significant (P<0.05) (Table 2). The lowest number of tiller was related to 450 plants per m^2 (1.11), and the highest number of tillers was achieved in 250 plants per m^2. There was a significant difference in number of tiller between 250 plants per m^2 with other treatments (Table 3). Planting date and plant density had no significant effect on Aboveground biomass (Table 2). There was no significant difference in Aboveground biomass between 450 plants per m^2 with 350 and 250 plants per m^2. The

Table 3. Mean comparison of the number of days from planting to physiological maturity, plant height (cm), the number of tillers, Aboveground biomass (g/cm^2), grain yield (kg/ha) and harvest index (%).

Treatment	Number of days from planting to physiological maturity	Plant height	Number of tiller	Aboveground biomass	Grain yield	Harvest index
Planting date						
Nov 6th	199.56b	95.07a	1.82a	1259.37a	4872.61a	41.72a
Dec 6th	215.60b	94.63a	1.78a	1298.15a	4760.92	42.30a
Plant density						
250 plants/m^2	207.56a	92.39b	2.56a	1291.67b	4716.00b	41.57b
350 plants/m^2	207.17a	95.61a	1.72b	1297.50ab	4840.92a	42.15a
450 plants/m^2	208.00a	96.66a	1.11b	1301.10a	4893.38a	42.31a
Cultivar						
Rayhanee	198.89c	90.33b	1.89a	1290.00c	4341.48c	40.34c
Kavir	207.28b	90.50b	1.67a	1296.67b	4566.73b	42.10b
karun	216.56a	103.72a	1.83a	1303.61a	5542.09a	43.58a

Common letters within each column do not differ significantly.

effect of cultivar on Aboveground biomass was not significant (Table 2). The highest Aboveground biomass was observed in Karun (1303.61 g/m^2). There was no difference between Karun with other cultivars (Table 3). The effect of interaction between plant density and cultivar, and also the interaction between planting date, plant density and cultivar on Aboveground biomass was not significant (Table 2). The effect of planting date on grain yield was not significant, but the effect of plant density on grain yield was significant ($P<0.05$) (Table 2). The maximum grain yield was related to 450 plants per m^2 (4893.38 kg/ha) (Table 3). At optimum plant density, plants show efficient use of available water, light and nutrients while under high plant density, higher competition among plants will be occur. Also, plant height was inversely related with grain yield. The effect of cultivar on grain yield was significant ($P<0.01$) (Table 2). The highest grain yield was related to Karun (5542.09 kg/ha), and the lowest one was achieved in Rayhanee (4341.48 kg/ha). It seems that plantation of Karun cultivar should be recommended to semi arid region's farmers. The interaction between planting date and cultivar had significant effect on grain yield ($P<0.01$). Also, the interaction between plant density and cultivar had signifi-cant effect on grain yield ($P<0.05$). The effect of planting date on harvest index was not significant, but plant density had significant effect on harvest index ($P<0.05$) (Table 2). The maximum harvest index was related to 450 plants per m^2 (42.31) (Table 3). Cultivar had significant effect on harvest index ($P<0.01$) (Table 2). The maximum harvest index was related to Karun cultivar (43.58) and the minimum one was achieved in Rayhanee (40.34). There was significant difference in harvest index between karun cultivar and other cultivars (Table 3). It seems that different cultivars of barley were sensitive to planting date and plant density. Early sowing in Lamard region, was resulted in a decrease in grain yield. The differences in grain yield between different plant densities demonstrated the influence of sowing density on this critical factor. It seems that cultivation of Karun, with 450 plants per m^2 in November 6th is suitable for this region.

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