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Full Length Research Paper

The effect of sowing date and row spacing on yield and yield components on Hashem chickpea variety under rainfed condition

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In order to investigate the impacts of sowing date and row spacing on yield and yield components of Hashem chickpea variety, a field experiment was conducted in 2005 at farm of Dorood Faraman (Kermanshah-Iran). In this study, the sowing date in three level (6, 23 November and 6 December) and the row spacing in three level on rows (20, 30 and 40 cm) were evaluated with complete randomized block design in factorial arrangement. Results of experiment showed that there are significant differences for planting date and planting density effects of plant height, number of branch per plant, distance between 1st pod to soil, number of pod per plant, number of grain per plant, biological yield and grain yield. The maximum grain yield belongs to sowing date 6 November and row spacing 30 cm. However maximum number of pod per plant and grain per plant belong to 40 cm row spacing but higher number of pod and grain per unit area in 20 cm row spacing results in increasing grain yield in this row spacing. Results show increasing planting density resulted in decreased yield components, but on the other hand increased plant number compensated for decrease of yield components. Also we found that planting at 6th December had higher distance of pod from soil surface and thus easier for mechanized harvesting.

Key words: Chickpea, sowing date, row spacing, grain yield, yield components.

INTRODUCTION

Among pulse, chickpea (*Cicer arietinum* L.) is the most important crop having high percentage of protein. Ckickpea's nutritional value, on one hand and its ecological properties, on the other have put it at the second place at the world level and at the first place in Iran and some arid and semi-arid countries (Dehnavi, 1999). Ckickpea is an important crop in Western Asia and Northern Africa. It is of special importance in dry farming in Western areas of Iran so that the dominant rotation on non-irrigated lands of these areas is in the form of rainfed chickpea rainfed cereals (wheat and barley) (Rastegar, 1998).

Considering that the area under non-irrigated chickpea cultivation in kermanshah province reaches 200,000 ha (2004) a year and given that farmers of this region plant chickpea in spring as well as with respect to low level of average yield of chickpea in spring plantings due to the shortness of the plant growing phase, susceptibility of local Bivenij mass chickpea to ascochyta blight disease and difficulties with its traditional harvest, the yield of non-irrigated chickpea in Kermanshah can be improved considerably by planting autumn varieties resistant to ascochyta blight disease and suitable for mechanized harvesting. In kermanshah region, this research was done to study the interaction of planting density and planting date on the yield and yield components of Hashem variety of chickpea (with the type of erect plant, resistant to ascochyta blight disease and suitable for mechanized harvesting) and to determine proper autumn planting date as well as to introduce the best density.

In their experiment on five varieties of non-irrigated chickpea; Hashem ILC-482 Arman, FLIP 93 - 93 and local Grit mass on 3 planting dates of March 18th (first planting date), January 5th (second planting date) and April 17th (third planting date), Pezeshkpur et al. (2005) concluded that grain yield is higher on the first and second dates than the third one. Having tested Hashem variety of chickpea on 3 planting dates of December 6th, January 21st and March 6th with different planting densities

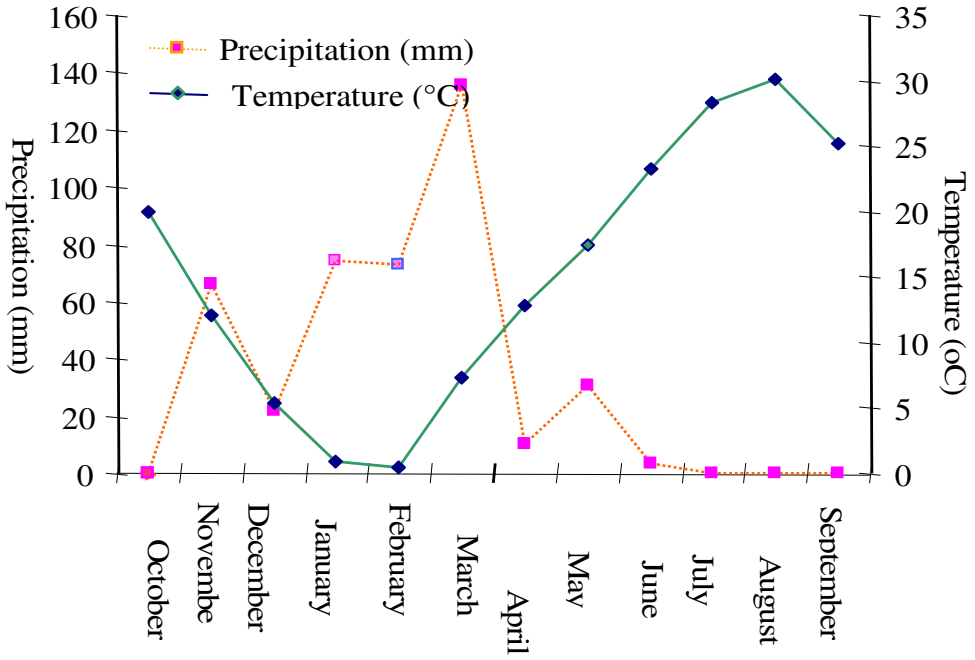

Figure 1. Mean precipitation and temperature in the Dorood – Faraman region, during the 2004-2005 farming year.

(16, 32, 48 and 64 plants), Mohammadnejad et al. (2005) concluded that, the number of fertile pods on primary branch, grains per pod, the weight of 100 grains and grain yield per unit area were affected by planting date.

In examining the most appropriate plant density and planting date for new variety of Hashem chickpea in Golestan province, Sabbaghpur (2002) studied 4 planting dates (October 23rd, November 6th, November 23rd and December 6th) on 4 plant densities (13.3, 20, 29, 40 plants per m^{-2}) and stated that planting date of November 23rd with 29 plants m^{-2} produced the highest yield.

During their study on the trend of grain filling, yield and yield components affected by density for 3 varieties of non-irrigated chickpea in Kermanshah climate, Shams et al. (2005) concluded that variety and density had a significant effect on grain yield and that the highest grain yield was produced by variety 12 - 60 - 31 with 28 plants m^{-2}. Pezeshkpur et al. (2005) showed that increasing plant density from 54 plants m^{-2} to 66 had a positive effect on yield increase.

During a research under heading of "Assessing the possibility of fall or autumn planting of chickpea in Mashhad", Goldani, (1997) concluded that, among 4 planting dates of November 29th, March 14th, April 14th and May 22nd, the first planting date November 29th had high one - plant yield due to the increase in duration of vegetative and germinative growing period increase in dry weight of organs, number of pods (r = 95%) and number of grains (r = 96%).

Singh et al. (1988) reported that, the number of grains per plant decreases as the plant density increases. But the number of grains per unit area is higher in high densities than that in low ones. Harper (1993) considers grain's weight as one of invariable components in grain yield which is rarely affected by planting density.

In a study performed on chickpea varieties affected by different planting density, Shams et al. (2005) argued that the number of sub-branches under the effect of density, the number of nodes on main stem and harvest index all were affected by variety.

MATERIALS AND METHODS

This research was carried out at Dorood - Faraman Jihad Agriculture Service Center (Kermanshah) Iran (47°20′ E, 34°20′ N), with the climate of cold, semi - arid at the elevation of 1,362 m from sea level with annual mean precipitation of 435 mm in farming year of 2004 - 2005 (Figure 1).

The experiment was done as a factorial one in the from of basic complete randomized design with 4 replications; row spacing factor included row spacing of 10 (T 1), 30 (T 2) and 40 (T 3) cm at 3 levels and planting date factor included February 6th (D1), November 22nd (D2), December 6th (D3) at 3 levels. Prior to the field preparation, soil sampling was done from several points of the field randomly from the depth of 0 to 30 cm; and soil analysis was performed at the laboratory of Kermanshah Water and Soil Research Department (Table 1).

On the field before planting, this experiment consisted of 9 treatments and 36 test plots each of which with the length of 4 m and width of 0.8 - 1.6 m. Each plot included 4 planting lines and a 0.5 m space was intended between any 2 neighboring plots. Replications were spaced apart 1 m from each other.

Hashem variety of chickpea with kaboli type is the first variety resistant to ascochyta blight disease; it has type of erect plant. It is suitable for mechanized harvesting and its planting was performed

Table 1. Chemical and physical characteristics of the soil.

Texture	Sand (%)	Clay (%)	Silt (%)	K (ppm)	P (ppm)	N (%)	C (%)	EC (mmohs/cm)	pH	Depth (cm)
Silty clay	9	37.7	52	300	8	0.12	1.1	0.49	7.4	0-30

Table 2. Analysis variance of some agronomical characteristics.

SOV	df	Plant height	Distance the first pod to soil surface	No. sub - branch	No. pods per plant	No. seeds per plant	weight of 100 seed	Seed yield	Biological yield	Harvest index
Rep	3	12.439	0.639	0.180	0.546	1.554	1.257	10.113	541.730	2.821
D	2	110.514**	68.830**	12.202**	56.504**	100.725**	1.837 ^{ns}	2819.498**	14176.481**	9.380 n ^{ns}
T	2	38.935 **	78.048**	9.970**	14.912**	25.710**	2.165 ^{ns}	12657.617**	44873.322**	8.347 ^{ns}
D×T	4	5.906 ^{ns}	0.930 ^{ns}	0.359 ^{ns}	4.397*	10.103**	5.911 ^{ns}	571.531*	2851.294**	2.247 ^{ns}
Error	24	5.573	0.463	0.136	5.573	0.905	5.328	202.252	402.961	7.983
C.V (%)	-	7.25	9.35	11.60	12.10	8.05	7.64	12.35	8.53	6.07

NS: Non-significant at p<0.05; *: significant at 5% level of probability; and *: significant at 1% level of probability. D, T and D×T: planting date, row spacing and planting date × row spacing, respectively.

on intended dates. To avoid the loss from terrestrial fungi, seeds were disinfected by fungicide Mancozeb toxin at the ratio of 1.5:1000.

Perennial and annual weeds were weeding out in 2 turns manually during vegetative and generative periods. To control the loss from pod borer (*Helicoverpa viriplace*) of chickpea, spraying was done with swin toxin by back pump sprayer at the ratio of 3 kg ha^{-1}. Ten plants from each plot were used to determine yield components and morphological properties of plant. Measurement properties included the number of pods per plant, number of grains per plant, weight of 1000 grains, number of sub - branches, height of the first pod to soil surface, harvest index and biological yield. Grain yield was taken and noted after eliminating 2 sidelines and 0.5 m from both ends of middle line.

RESULTS AND DISCUSSION

Results showed that there was a significant difference (p = 1%) between density and different planting dates in terms of plant height (Table 2). Among varied densities, row 20 cm space with the height of 35.63 cm had the highest height followed by row 30 and 40 spaces with the height of 32.44 and 29.57 cm, respectively (Table 3).

Singh and Sharma (1988) reported that, there was a positive correlation between plant height and the number of plants per unit area due to more competition for light. Comparing various planting dates showed that planting date of November 6th had the highest plant height because of the increase in duration of the period of plant growth. Rezvani and Sadeghi (2005) had stated that plant height increase as the duration of growth period increases. In this connection, Rahemi and Soltani (2005), Rezvani and Sadeghi (2005) and Goldani et al. (2000) observed plant height increase with high densities and early planting dates in their experiments.

There was a significant difference (p = 1%) between density and various planting dates in terms of the distance of forming the first pod to soil surface. Among densities, row 20 and 40 cm space had repeatedly the highest (9.22 cm) and the lowest (4.6 cm) distances in terms of forming the first pod to soil surface. Among varied planting dates, November 6th and December 6th had respectively, the highest and lowest distances of forming the first pod to soil surface.

According to Rahemi and Soltani (2005), the height of the first pod to soil surface increases with earlier planting dates as well as with the increase in density. There was a significant difference (p = 1%) between density and different planting dates in terms of the number of sub-branches, but not between interaction of density × planting dates in this respect. The maximum number of sub-branches was related to row 40 cm space and the minimum of it was related to row 20 cm space (Table 3). The highest number of sub-branches (4.2) was also associated with planting dates of November 6th and the lowest one (2.2) was associated with December 6th. Goidani et al. (2000), Jalilian et al. (2005), Shams et al. (2005) and Singh et al. (1988) have examined the effects of density and planting date on the number of sub-branches and stated that the number of sub-branches decreases with the increase in density and with delayed planting. For the number of pods per plant , a statistically significant difference (p = 1%) was observed between density and different planting dates. Results showed that there was also a significant difference (p = 5%) in terms of the interaction of planting date × density on the number of pods per plant. Row 40 cm spacing had the highest number of pods per plant (9.68) and the lowest (7.49) was related to row 20 cm spacing.

Table 3. Comparison of means some agronomical characteristics.

Treatment	Plant height (cm)	Distance the first pod to soil surface (cm)	No. sub - branch	No. pod per plant	No. seed per plant	100 weight seed (g)	Seed Yield (kg/h)	Biological yield (kg/h)	Harvest Index (%)
D1	35.63A	225/9A	4.258A	11.02A	15.04A	30.09A	1320A	2748A	45.65A
D2	32.44B	7.992B	3.33B	8.367B	11.00B	29.88A	1113B	2182B	4649A
D3	29.57C	4.600C	2.258C	6.725C	9.425C	30.64A	1021B	2127B	47.42A
T1	33.85A	9.800A	2.20C	7.492C	10.32C	29.72A	1421A	2857A	47.09A
T2	33.30A	7.317B	3.35B	8.942A	11.89B	30.39A	1242B	2528B	46.90A
T3	30.49B	4.700C	4.00A	6.683A	13.25A	30.50A	790C	1673C	45.56A
D1T1	35.67A	12.27 A	3.225C	10.75AB	11.98C	31.13A	1721A	3495A	46.89A
D1T2	37.78A	9. 100BC	4.150B	10.80AB	15.98A	29.82A	1415B	3014B	45.59A
D1T3	33.45BCD	6.300 DE	5.400A	11.52A	17.17A	29.31A	825E	1735E	44.47A
D2T1	34.40ABC	9.975B	2.125D	7.55D	11.50B	28.40A	1345BC	2620C	46.85A
D2T2	42.88BCD	8.375C	3.175C	8.20CD	9.85C	30.18A	1211BCD	2336CD	47.58A
D2T3	30.05DEF	5.625E	3.800B	9.35BC	11.65B	31.07A	783E	1591E	45.04A
D3T1	31.48CDE	7.150D	.250E	4.175E	7.50D	29.63A	1198CD	2457CD	47.54A
D3T2	29.25EF	4.475F	2.725C	7.825CD	9.85C	31.17A	1099D	2234D	47.54A
D3T3	27.98F	2.175G	2.800C	8.175CD	10.93BC	31.12A	764E	1691E	47.17A

Columns with identical letter(s) are not significantly different at the 5% level of probability. (DMRT) for D, T and D×T: planting date, row spacing and planting date × row spacing, respectively.

The highest and lowest number of plant per plant were repeatedly pertained to planting dates of November 6th and December 6th interaction of planting date × density shows that planting date of November 6th × row 20 cm spacing had the maximum number of pods per plant (11.52) and the minimum number (4.17) belonged to the planting date of December 6th × row 40 cm spacing. The number of pods per chickpea plant is among qualities highly affected by density and planting date, which decreases with increasing density and delayed planting (Pezeshkpur et al., 2005; Goldani, 1997; Mohammadnejad and Soltani, 2005).

There was a significant difference (p = 1%) between density and various planting dates in terms of the number of grains per plant, so was for interaction of planting date × density. For the number of grains per plant, planting date of November 6th had the highest value followed by planting dates of November 22nd and December 6th (Table 3). The number of grains per plant increases as the density decreases (Sing and Sharma, 1988). Treatment of planting date of November 6th in row 40 cm spacing had the highest number of grains per plant (17.17) and the lowest one (11.65) was related to the treatment of planting date of December 6th in row 20 cm spacing. Singh (1989) reported that, increase in density affects the number of grains per plant, causing it to decrease; but the number of grains per unit area is higher in high density than low ones.

Many researchers believe that increase in yield is due to increase in the number of grains (Bagheri et al., 1997; Pezeshkpur, 2002; Pezeshkpur and Marzai Heidri, 2002; Hejazi, 1994; Koochaki and Banyanaval, 1989). Planting date, density and their mutual effect had no significant impact on the weight of 100 grains. Hernandez and Hill (1983) reported that plant density could not produce any significant difference to the weight of chickpea 100 grains. For grain yield, there was a significant difference (p = 1%) between planting date and density, so also was for interaction of planting date and density (p = 5%). The highest and lowest yields were obtained from planting dates of November 6th (1,320 kg ha^{-1}) and December 6th (1,021 kg ha^{-1}), respectively.

Many researchers agree that, early planting dates have higher yields (Pezeshkpur et al. 2005; Rezvanimoghaddam and Sadeghi Samarjan, 2005; Subbaghpur, 2002; Gholliour and Soltani, 2005; Mohammadnejad and Soltani, 2005). Row 20 cm spacing had higher yields (1,421 kg ha^{-1}) than the other two row spacings, that is, 30 and 40 cm (1,242 and 790 kg ha^{-1} repeatedly).

In this relation, Singh et al (1988) declared that, yield increased significantly with the increase in density of erect and tall genotypes form 33 to 50 plants m^{-2} by decreasing the row spacing form 30 to 20 cm. Pezeshkpur et al. (2005), Shams et al. (2005) and Ahmadian et al. (2005) believe that yield of chickpea increases with increasing density form 33 to 54 plants m^{-2}.

There was a significant difference (p = 1%) between varied dates and densities of planting and their interaction in terms of biological yield. Among planting dates, date of November 6th with 2,748 kg ha^{-1} had the highest biological yield and dates of November 22nd and December 6th with 2,182 and 2,127 kg ha^{-1}, respectively,

were placed lower. Row 20 cm spacing had the highest biological yield (2,857 kg ha^{-1}) followed by row 30 and 40 cm spacing (2,582 and 1,673 kg ha^{-1} repeatedly).

Among various treatments, the highest and lowest biological yields were respectively obtained fromplanting date of November 6th × row 20 cm spacing and planting date of December 6th × row 40 cm spacing. Experimental results showed that although one plant-weight decreased with high densities, this weight reduction was made up by increasing the number of plant per unit area and biological yield per unit area was higher in high densities than low ones. In their experiment, Rastegar et al. (1998) reported similar results. According to the results of this research, planting date and density as well as their mutual effects had no significant impact on harvest index. Bagheri et al. (1997) argued chickpea harvest index was obtained at a spectrum from 20 to 47%, having a positive direct relation with grain yield. Katiyar (1980) proclaimed in his report that, harvest index decreases with high densities because of delayed formation of sub-branches which have high share of plant dry weight per unit area.

Conclusion

The results of the present research showed that maximum yield of grain was observed with planting date of November 6th and related to row 20 cm spacing. The highest numbers of pods and grains per plant was associated with row 40 cm spacing. Higher numbers of pods and grains per unit area (at row 20 cm spacing) caused this density to have maximum yield, so that, results showed that although the increase in density decreased one-plant yield components, this reduction was compensated by increasing the number of plants per unit area. Also, planting date of November 6th had the maximum distance of forming the first pod to soil surface, facilitating its mechanized harvest.

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