



Effect of irrigation regime and plant density on yield and yield components of chickpea (*Cicer arietinum* L.)

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Received 14 September 2020; Accepted 2 November 2020

Extended abstract

Introduction

Legumes contain an average of 18-32% protein and are an important source of protein for low-income people (Majnoon Hussein, 2008). Chickpea (*Cicer arietinum* L.) Is known for its resistance to moisture changes; this plant shows physiological and morphological changes under conditions of water scarcity (Ghorbanli et al., 2001). Chickpea grows in a wide range of weather conditions from the subtropical to Mediterranean regions of western Asia, northern Africa, and southern and southwestern Europe (Toker et al. 2007). Environmental stresses are the most important factor that limits crop production of chickpea. The most critical environmental stresses that have a negative effect on crop production are water and heat stresses (Rahbarian et al. 2011). By applying the effect of different levels of irrigation and plant density on yield and yield components of chickpea, grain yield, 1000-seed weight, the number of pods per plant and harvest index decreased during drought stress (Raei et al., 2008). Severe drought stress, by reducing the water uptake by the roots, disrupts the transfer of sap in the phloem, which ultimately leads to a decrease in nutrient uptake and the activity of antioxidant enzymes (Armand et al. 2016). Plant density is one of the most important management factors on crops that will affect plant yield. When competition for growth increases, the yield will be decreased. The selection of appropriate plant density should be based on environmental factors such as cultivar, cultivation target, weed competition, seed size, soil moisture content, and plant characteristics including plant height, plant density, leaf angle, and production capacity of the growing environment (Khajehpour, 2008). According to the above, this study was conducted to investigate the effects of different levels of irrigation and planting density on some agronomic traits of white chickpea in Karaj.

Material and methods

To investigate the effect of water regime and plant density on some agronomical traits of chickpea (*Cicer arietinum*), a split-plot experiment based on randomized complete block design with three replications conducted at the College of Agriculture and Natural Resources of Karaj, Iran in 2015. The water levels included eight levels (I1 =full irrigation at all growth stages, I2 = irrigation to grain filling and then stop, I3 = irrigation to podding and then stop, I4 = irrigation to flowering and then cut, I5 = 50% of full irrigation at all growth stages, I6 = 50% of full irrigation to grain filling and then stop, I7 = 50% of full

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irrigation to podding and then stop, I8 = 50% of full irrigation to flowering and then stop, considered as the main factor and plant density at three levels (30, 40 and 50 plants.m⁻¹) as subplots. Geographical characteristics of this farm include 1321 meters above sea level, longitude 51 degrees east, latitude 35 degrees and 48 minutes north. This region has a hot and dry climate with an average rainfall of 33 years, about 248 mm.

Results and discussion

The results showed that increasing water deficit stress reduced the growth traits and ultimately the grain yield of chickpea cultivar ILC 482. Increasing plant density increased the growth traits of yield components and grain yield. The highest grain yield (2892 kg. ha⁻¹) was obtained in full irrigation (I1), and the lowest (1075 kg. ha⁻¹) gained from I4. The highest grain yield (2068 kg. ha⁻¹) was acquired at 40 plants m⁻¹.

Conclusions

The results of this study showed that low water stress reduced the yield of chickpeas, but since Iran has low average rainfall, it is possible to achieve a good yield by using 50% irrigation at all stages of growth.

Keywords: 1000-seed Weight, Chickpea, Low irrigation, Plant density, Yield

Table 1. Some Physical and chemical soil properties of the experimental site

Depth cm	Available K mg kg ⁻¹	Available P mg kg ⁻¹	pH	EC dS m ⁻¹	Soil texture	Sand	Silt	Clay	OC	Total N
	-----					----- % -----				
0-30	125	8.3	8.4	0.97	Clay Loam	25	44	31	0.76	0.09

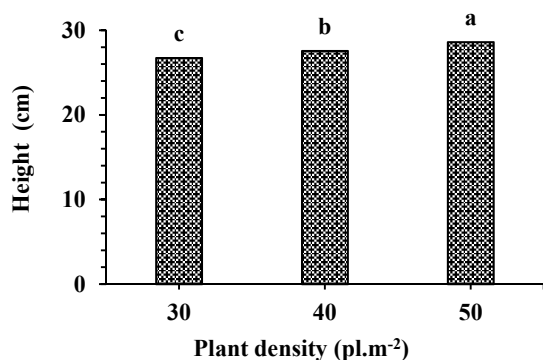


Fig. 2. Effect of plant density on plant height

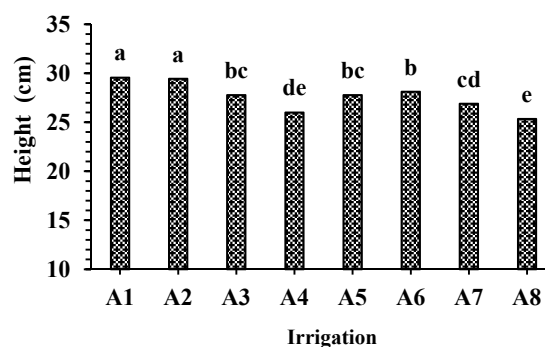


Fig.1. Effect of irrigation regime on plant height. A1=full irrigation at all growth stages, A2= irrigation to grain filling and then cut, A3= irrigation to podding and then cut, A4= irrigation to flowering and then cut, A5= 50% of full irrigation at all growth stages, A6= 50% of full irrigation to grain filling and then cut, A7= 50% of full irrigation to podding and then cut and A8= 50% of full irrigation to flowering and then cut. The numbers with the same letters are not significantly different.

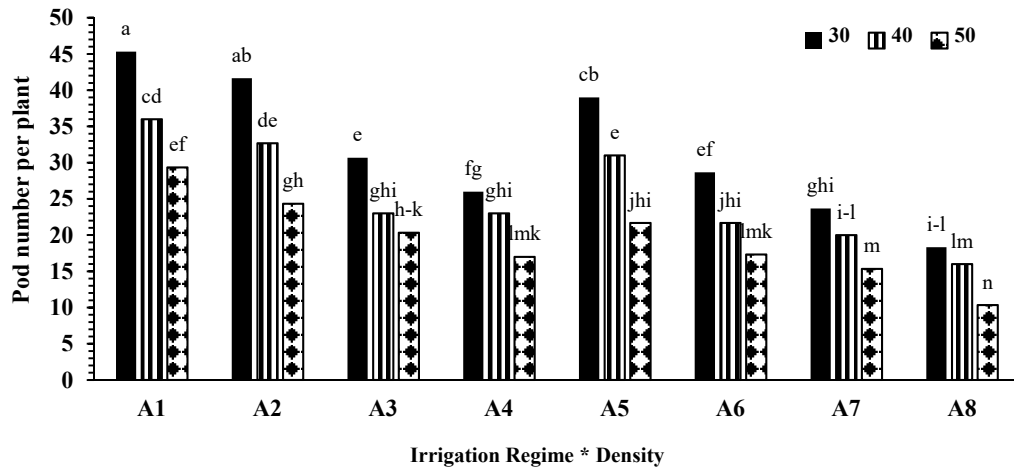


Fig. 3. Effect of irrigation regime and plant density (30,40 and 50 pl.m⁻²) on pod number per plant. A1=full irrigation at all growth stages, A2= irrigation to grain filling and then cut, A3= irrigation to podding and then cut, A4= irrigation to flowering and then cut, A5= 50% of full irrigation at all growth stages, A6= 50% of full irrigation to grain filling and then cut, A7= 50% of full irrigation to podding and then cut and A8= 50% of full irrigation to flowering and then cut. The numbers with the same letters are not significantly different.

Table 2. Mean squares for yield and yield components of chickpea as affected by irrigation regime and plant density

S.O.V	df	Length	Pod per Plant	Seed perPod	Seed per Plant	1000-seed Weight
Replication	2	0.3472 ^{ns}	4.18 ^{ns}	0.00013 ^{ns}	2.26 ^{ns}	2.85 ^{ns}
Irrigation Regime (I)	7	20.25 ^{**}	486.12 ^{**}	0.09067 ^{**}	909.31 ^{**}	7527.92 ^{**}
Ea	14	0.9980	5.72	0.00107	3.64	23.04
Density (D)	2	21.18 ^{**}	894.43 ^{**}	0.06693 ^{**}	1139.08 ^{**}	1419.47 ^{**}
D * I	14	0.7837 ^{ns}	14.44 [*]	0.00067 ^{ns}	14.21 ^{**}	43.81 ^{**}
Eb	32	1.104	5.79	0.00066	4.91	14.18
CV%		3.8	9.43	2.22	7.68	1.43

Table 2. Continued

S.O.V	df	Seed Yield of single plant	Seed Yield per hectare	Biological yield	Harvest Index
Replication	2	0.2082 ^{ns}	14919.1 ^{ns}	100200.89 ^{ns}	5.09 ^{ns}
Irrigation Regime (I)	7	43.42 ^{**}	3609856.2 ^{**}	8995567.22 ^{**}	180.98 ^{**}
Ea	14	0.3525	9708.13	54805.34	6.22
Density (D)	2	36.09 ^{**}	110485.92 ^{**}	638416.48 ^{**}	122.17 ^{**}
D * I	14	0.4337 ^{ns}	13252.41 ^{ns}	126405.83 ^{**}	4.22 ^{ns}
Eb	32	0.2913	10993.04	45637.59	2.26
CV%		9.31	5.26	5.02	3.26

Ns,* and **: Significant at 5 and 1%, respectively

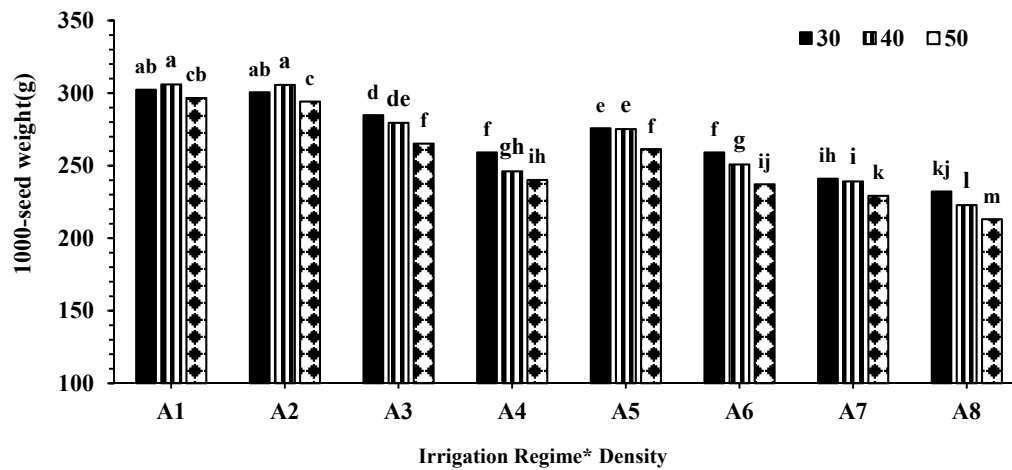


Fig.4. Effect of irrigation regime and plant density (30,40 and 50 pl.m⁻²) on 1000- seed weight. A1=full irrigation at all growth stages, A2= irrigation to grain filling and then cut, A3= irrigation to podding and then cut, A4= irrigation to flowering and then cut, A5= 50% of full irrigation at all growth stages, A6= 50% of full irrigation to grain filling and then cut, A7= 50% of full irrigation to podding and then cut and A8= 50% of full irrigation to flowering and then cut. The numbers with the same letters are not significantly different.

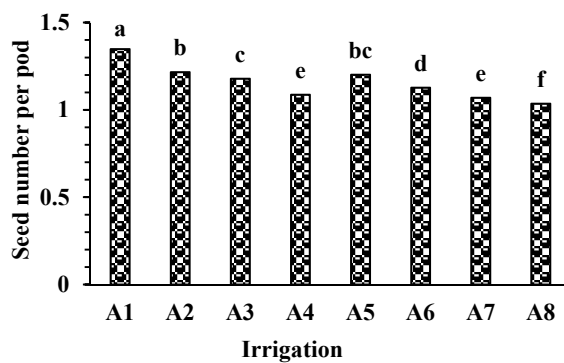


Fig.6. Effect of different irrigation regime on seed number per pod. A1=full irrigation at all growth stages, A2= irrigation to grain filling and then cut, A3= irrigation to podding and then cut, A4= irrigation to flowering and then cut, A5= 50% of full irrigation at all growth stages, A6= 50% of full irrigation to grain filling and then cut, A7= 50% of full irrigation to podding and then cut and A8= 50% of full irrigation to flowering and then cut. The numbers with the same letters are not significantly different.

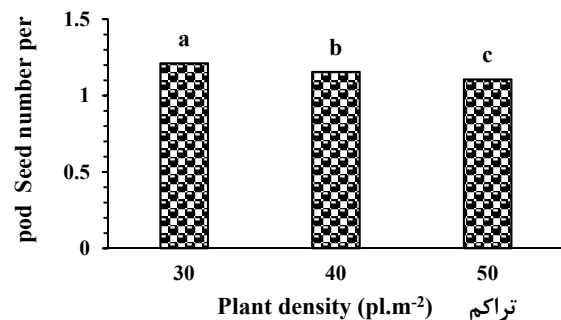


Fig. 5. Effect of plant density on seed number per pod

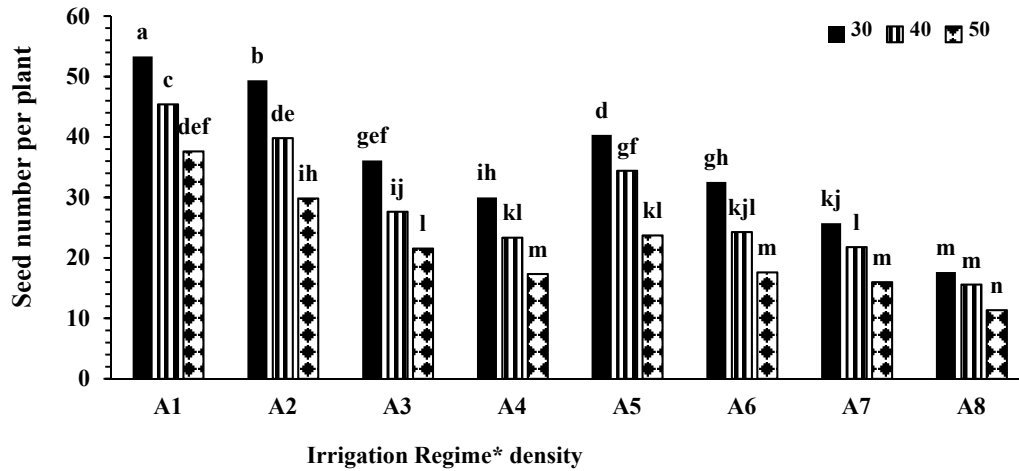


Fig. 7. Effect of irrigation regime and plant density (30,40 and 50 pl.m⁻²) on seed number per plant. A1=full irrigation at all growth stages, A2= irrigation to grain filling and then cut, A3= irrigation to podding and then cut, A4= irrigation to flowering and then cut, A5= 50% of full irrigation at all growth stages, A6= 50% of full irrigation to grain filling and then cut, A7= 50% of full irrigation to podding and then cut and A8= 50% of full irrigation to flowering and then cut. The numbers with the same letters are not significantly different

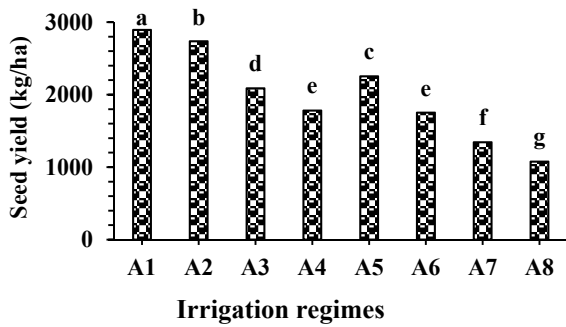


Fig.10. Effect of irrigation regime on seed yield per hectare. A1=full irrigation at all growth stages, A2= irrigation to grain filling and then cut, A3= irrigation to podding and then cut, A4= irrigation to flowering and then cut, A5= 50% of full irrigation at all growth stages, A6= 50% of full irrigation to grain filling and then cut, A7= 50% of full irrigation to podding and then cut and A8= 50% of full irrigation to flowering and then cut. The numbers with the same letters are not significantly different

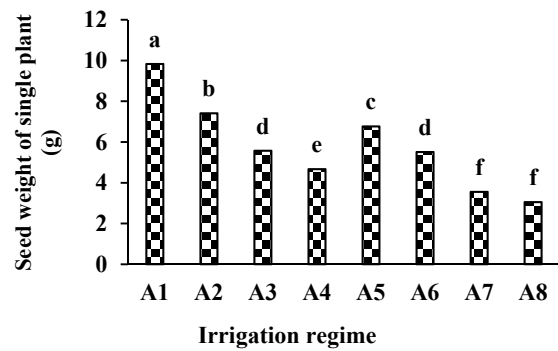


Fig.8. Effect of different irrigation on seed weight of single plant. A1=full irrigation at all growth stages, A2= irrigation to grain filling and then cut, A3= irrigation to podding and then cut, A4= irrigation to flowering and then cut, A5= 50% of full irrigation at all growth stages, A6= 50% of full irrigation to grain filling and then cut, A7= 50% of full irrigation to podding and then cut and A8= 50% of full irrigation to flowering and then cut. The numbers with the same letters are not significantly different

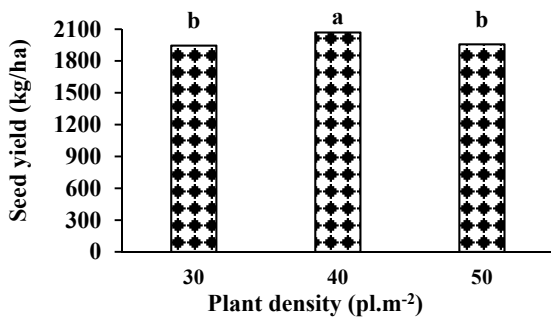


Fig.11. Effect of plant density on seed yield per hectare

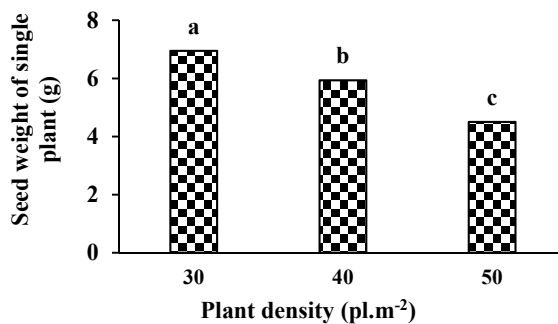


Fig. 9. Effect of plant density on seed weight of single plant

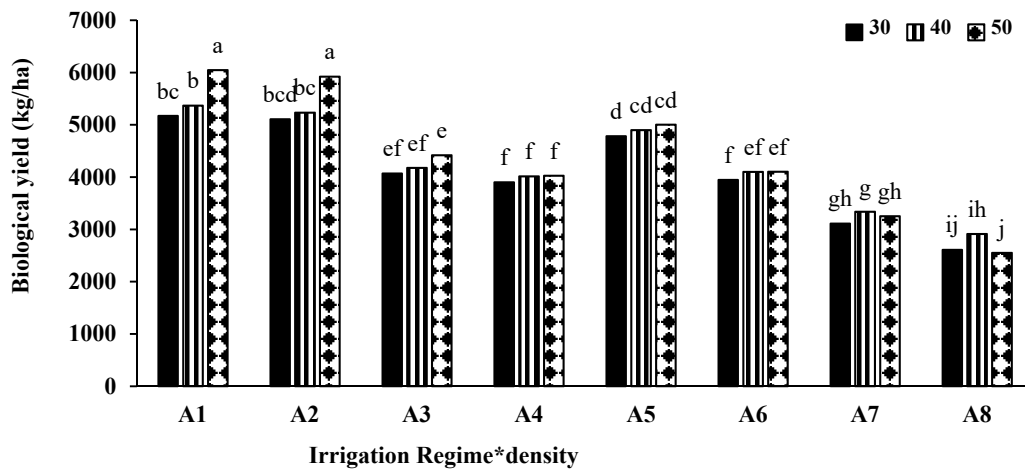


Fig.12. Effect of irrigation regime and plant density (30,40 and 50 pl.m⁻²) on biological yield. A1=full irrigation at all growth stages, A2= irrigation to grain filling and then cut, A3= irrigation to podding and then cut, A4= irrigation to flowering and then cut, A5= 50% of full irrigation at all growth stages, A6= 50% of full irrigation to grain filling and then cut, A7= 50% of full irrigation to podding and then cut and A8= 50% of full irrigation to flowering and then cut. The numbers with the same letters are not significantly different

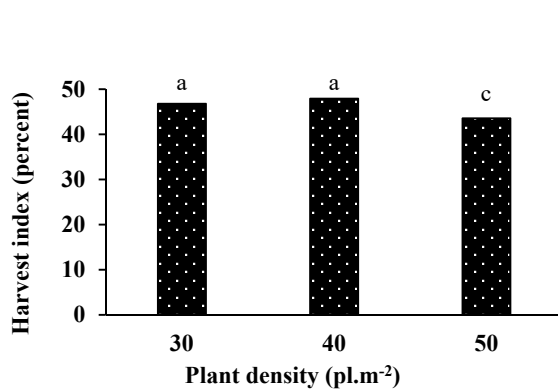


Fig.14. Effect of density on harvest index per hectare

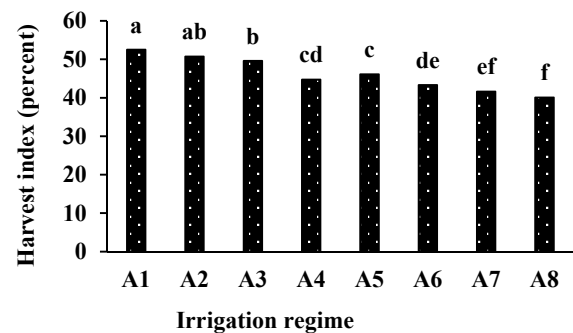


Fig. 13. Effect of irrigation Regime on harvest index per hectare. A1=full irrigation at all growth stages, A2= irrigation to grain filling and then cut, A3= irrigation to podding and then cut, A4= irrigation to flowering and then cut, A5= 50% of full irrigation at all growth stages, A6= 50% of full irrigation to grain filling and then cut, A7= 50% of full irrigation to podding and then cut and A8= 50% of full irrigation to flowering and then cut. The numbers with the same letters are not significantly different