

Growth and Yield Response of Two Chickpea Cultivars (*Cicer arietinum* L.) to Skipping One Irrigation

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ABSTRACT

Two field experiments were carried out at El-Rayyan, Fayoum Governorate, Egypt, during the two successive winter seasons of 2010/2011 and 2011/2012 to study the growth and yield response of two chickpea cultivars (*Cicer arietinum* L.) to skipping one irrigation (3rd or 4th irrigation). Results can be summarized as follows: Skipping one irrigation led to significant reduction in all characters under this study in the both seasons (plant height, total dry weight / plant(g), number of branches /plant, number of capsules /plant, dry weight of capsules /plant(g) and dry weight of leaves /plant(g)) at 115 days from sowing. There were significant varietal differences between Giza- 3 and Giza- 2 in all growth characters in 115 days from sowing in both seasons. Whereas, Giza-3 surpassed Giza-2 in plant height, total dry weight/ plant, number of branches and capsules/plant and dry weight of capsules and leaves/plant (g) at 115 days after sowing. Skipping one irrigation significantly decreased yield and its components in both seasons i.e. weight of capsules/ plant (g), seed yield / plant (g), seed index, shelling %, seed, straw and biological yields (kg/fad.) and harvest index. It was clear that chickpea cultivars significantly differed in weight of capsules/ plant (g), seed yield / plant (g), shelling % , seed index, seed, straw and biological yields(kg/fad.). Data revealed that Giza- 3 cultivar significantly yielded out Giza-2 cultivar in yield /fad. Results showed that skipping one irrigation led to declined in protein and carbohydrate percentages compared with the control. In the same time Giza- 3 and Giza-2 cultivars differed in crude protein and carbohydrate percentages. The interaction between skipping one irrigation and chickpea cultivars was significant in all characters under this study. It is obvious from data the best treatments was normal irrigation with Giza- 3 cultivar.

Key words: Growth .Yield. Chickpea. Cultivars. Skipping one irrigation.

Introduction

Chickpea (*Cicer arietinum* L.) is an important pulse crop grown and consumed all over the world, especially in the Afro-Asian countries. It is a good source of carbohydrates and protein, and the protein quality is considered to be better than other pulses. Chickpea has significant amounts of all the essential amino acids except sulfur containing types, which can be complemented by adding cereals to daily diet (Jukanti *et al.*, 2012). It can be a very useful legume crop for incorporation into short-term rotation and for fixation of nitrogen in soil and its fertility (Ali and Kumar, 2009).

Increasing chickpea yield per unit area can be achieved by breeding high yielding cultivars. Significant differences in chickpea cultivars have been shown by many workers (Bakhsh, *et al.*, 2007, Amal *et al.*, 2010, Akay, 2011 and El-Habbasha *et al.*, 2012).

Losing of crops yield which induced by drought is quite important and may also exceeds losses from all other stress factors. Drought stress is one of the major abiotic stresses in agriculture worldwide. Plants grown under drought condition have a lower stomatal conductance in order to conserve water. Consequently, CO₂ fixation is reduced and photosynthetic rate decreases, resulting in less assimilate production for growth and yield of plants (Mafakheri *et al.*, 2010). Water plays a vital role in all living organisms (Önder *et al.*, 2011). Human is still seeking to find solutions for the water scarcity problem. The solutions should be environmentally friendly for human health and sustainable agriculture (Kahraman *et al.*, 2011).

Although chickpea is considered a drought-sensitive species, the selection cultivars that can grow under water-deficit conditions constitute a more effective method of minimizing the repercussions of exposure to drought. Differential genotypic in chickpea response to drought stress, as a result of variation in physiological parameters has been reported (Gunes *et al.*, 2006, Gunes *et al.*, 2008).

Thus the objective of this study is to investigate growth, yield and its components as well as some chemical constituents of two chickpea cultivars affect skipping one irrigation.

Materials And Methods

Two field experiments were carried out at El-Rayyan Fayoum Governorate, Egypt, during the two successive winter seasons of 2010/2011 and 2011/2012 to study the growth and yield response of two chickpea cultivars (*Cicer arietinum* L.) to skipping one irrigation. Some physical and chemical characters of soil (30 depths) in the experimental site were as follows: sand 52.5%, silt 20%, clay 27.5%, pH 8.02, organic matter 0.84% ,CaCO₃, 20.9% ,EC 2.9 mmhos/cm³, soluble N 74 ppm soil measured as described by Chapman and Pratt (1978).

The experimental design was split- plots design with four replicates. Skipping one irrigations (normal irrigation as a control (L₁), skipping the third irrigation (L₂) and skipping the fourth irrigation (L₃) were assigned to the main plots and two cultivars (Giza-3 and Giza-2) were randomly distributed in the sub plots.

NPK fertilizer were added at the rate of 15kg N/fad. as ammonium nitrate 33% N, 150 kg /fad. as calcium super phosphate (15.5% P₂O₅) and 50 kg/fad. as potassium sulphate (48% K₂O) before sowing. Chickpea seeds were planted on first week of December in the two seasons, after inoculated with Rhizobium strain and irrigated just after sowing. The experimental unit area was 10.5 m² consisting of fifteen rows (3.5 m long and 20 cm between rows), 20 cm between hills. Normal irrigation, where six irrigations were applied during the season at 2 weeks intervals. The normal agronomic practices of growing chickpea were practiced till harvest as recommended by Legumes Research Dept. A.R.C., Giza.

1-Growth characters:

A random sample of ten plants from each plot was taken at 115 days after sowing to the laboratory where the following characters were recorded.

- | | |
|--------------------------------------|-------------------------------------|
| 1- Plant height (cm) | 2- Total dry weight/plant (g). |
| 3- Number of branches/plant | 4- Number of capsules/plant. |
| 5- Dry weight of capsules/plant (g). | 6- Dry weight of leaves /plant (g). |

2-Yield and yield components:

At harvest, a random sample of ten plants was taken from each plot to determine the following.

- | | |
|-----------------------------------|---------------------------|
| 1- Weight of capsules /plant (g). | 2- Yield /plant (g) |
| 3- Seed index (g) | 4- Shelling % |
| 5- Seed yield (kg/fad.). | 6- Straw yield (kg/fad.). |
| 7- Biological yield (kg/fad.). | 8- Harvest index |

Where, seed, straw and biological yields "Kg/fad." were determined from the whole area of experimental unit and then converted to yield per fad.

3-Chemical constituents:

Protein and carbohydrate percentages in seed were determined of infratec 1241 Grain Analyzer.

Statistical analysis:

All data were subjected to statistical analysis according to procedure outlined by Snedecor and Cochran (1990). Treatments means were compared by L.S.D test.

Results And Discussions

1-Growth characters:

It is clear from Table (1) that skipping one irrigation significantly decreased all growth characters i.e. plant height, total dry weight / plant(g), number of branches /plant, number of capsules /plant, dry weight of capsules /plant(g) and dry weight of leaves /plant(g) at 115 days after sowing. The highest values of almost studied characters were recorded to normal irrigation while, higher reduction of the previous characters was registered when chickpea plants were exposed skipping the 3rd irrigation. The negative action of skipping irrigation on growth characters chickpea plants might be reduced the photosynthetic rate which resulted in impede the growth.

These results are in agreement with those obtained by Nayyar *et al.*, (2006) and Gunes *et al.*, (2008) who showed that early water stress affected dry matter production and biomass in chickpea. It could be concluded that decreased water availability under drought results in reduced photosynthetic rate resulting in less assimilate

production for growth of plants. In this concern, Kurdali *et al.*, (2013) indicated that water restriction during the post-flowering period in chickpea considerably affect growth and N₂- fixation.

Data presented in Table (1) show significant the differences between Giza- 3 and Giza- 2 in all growth characters in 115 days after sowing in both seasons. Whereas, Giza-3 surpassed Giza-2 in plant height, total dry weight/ plant, number of branches and capsules/plant and dry weight of capsules and leaves/plant (g) at 115 days after sowing. It could be concluded that varietal differences between chickpea cultivars may be due to genetical differences between cultivars and growth habit as well as the differences between genotypes concerning partition of dry matter. These results of varietal differences in growth parameters are in agreement with those obtained by (Singh and Sandhu 2006. Amal *et al.*, 2010, Akay, 2011 and El-Habbasha *et al.*, 2012).

Table (1) showed that the interaction between skipping one irrigation and cultivars significantly affected growth characters, i.e. plant height, total dry weight /plant, number of branches and capsules/plant and dry weight of capsules and leaves/plant (g) at 115 days after sowing. Although skipping one irrigation affected all growth characters in chickpea, distinct genotypic differences were observed between the two cultivars. Specifically, Giza-3 expressed a relatively high potential for growth even under, skipping irrigation whereas the growth of Giza-2 was severely hindered. Results were in accordance with those obtained by Pradeep *et al.*, (2011). It is worthy to mention that Reza *et al.* (2013) showed that there was wide variation in tolerance to drought stress among chickpea genotypes.

Table 1: Effect of skipping one irrigation, cultivars and the interaction on some growth characters of chickpea plants at 115 days after sowing.

Characters		Plant height (cm)	Total dry weight(g)	Number of branches	Number of capsules	Weight of capsules(g)	Dry weight of leaves(g)
Treatments							
Skipping one irrigation	Control(L ₁)	60.40	77.26	4.59	26.69	41.86	26.01
	3 rd (L ₂)	54.71	70.65	4.46	24.39	40.02	24.74
	4 th (L ₃)	58.76	74.96	4.53	25.21	40.83	25.35
LSD 5%		1.84	1.67	0.87	0.02	0.29	0.36
Cultivars	Giza 3	62.95	83.32	5.21	29.58	46.39	29.38
	Giza2	52.96	65.26	3.84	21.28	35.41	21.35
LSD 5%		4.19	0.99	0.95	0.01	0.32	0.34
Control (L)	Giza 3	66.02	87.27	5.27	32.04	48.14	30.54
	Giza2	54.78	67.25	3.92	21.35	35.58	21.48
L ₂	Giza 3	58.66	78.14	5.16	27.55	44.88	28.24
	Giza2	50.76	63.16	3.75	21.22	35.16	21.24
L ₃	Giza 3	64.17	84.55	5.21	29.16	46.15	29.35
	Giza2	53.36	65.36	3.85	21.27	35.50	21.35
LSD 5%		7.25	1.72	1.64	0.02	0.56	0.59

II- Yield and its components:

Table (2) show that skipping one irrigation significantly decreased yield and its components i.e weight of capsules/ plant (g), seed yield / plant (g), shelling % and seed index. Higher reduction in weight of capsules/ plant(g) (11.09 %), seed yield / plant(g) (14.83 %), seed index (4.39 %) and shelling % (13.49 %) were under skipping the 3rd irrigation, whereas omitting the 4th irrigation gave lower reduction compared to the normal irrigation. Significant difference was observed in seed, straw and biological yields due to skipping one irrigation in the same table. The maximum seed and biological yields (933.05and 2778.98 kg /fad. respectively) of chickpea were recorded under normal irrigation and was followed by omitting the 4th irrigation. The higher seed yield under normal irrigation can be attributed to higher weight of capsules/ plant (g), seed yield / plant (g) and seed index. The results are almost same as were reported by Ghassemi-Golezani *et al.*, (2008) who noticed that grain yield and yield components were significantly affected by irrigation regime.

Harvest index was significantly increased when chickpea plants were normal irrigation (control) only. Increased harvest index resulted in the increased crop yield probably due to more partitioning of dry matter to reproductive parts. However, the differences between skipping the 3rd and 4th irrigations were not significant for this parameter. These results are in agreement with those obtained by Leport *et al.*, (2006) and Paramesh and Salimath (2008). Water deficit hampers physiological processes related to yield. In this concern, Mafakheri *et al.*, (2010) stated that photosynthesis is limited by drought stress due to stomatal (stomatal closure) and non stomatal (impairments of metabolic processes) factors, resulting in less assimilate production for growth and yield of plants.

Table 2: Effect of skipping one irrigation, cultivars and the interaction on yield and yield components of chickpea plants.

Characters		Weight of capsules	Seed yield	Seed index	Shelling %	Seed yield	Straw yield	Biological yield	Harvest index
Treatments		per plant (g)		(g)		(Kg/fad.)			
Skipping one irrigation	Control(L ₁)	41.09	31.36	25.74	75.73	933.05	1845.93	2778.98	33.46
	3 rd (L ₂)	36.54	26.71	22.27	72.41	885.04	1768.58	2653.62	33.23
	4 th (L ₃)	39.49	29.61	23.76	74.33	912.38	1834.76	2747.14	33.07
LSD 5%		0.44	0.46	0.13	1.19	7.66	11.11	10.67	0.27
Cultivars	Giza 3	45.00	35.12	27.24	77.88	1022.51	1894.99	2917.50	35.04
	Giza2	33.08	23.34	20.61	70.43	797.80	1737.85	2535.65	31.47
LSD 5%		0.51	0.50	0.09	0.61	4.87	11.08	10.87	0.20
Control(L ₁)	Giza 3	47.23	37.33	29.19	78.98	1042.22	1921.65	2963.88	35.16
	Giza2	34.96	25.40	22.30	72.48	823.88	1770.20	2594.08	31.76
L ₂	Giza 3	42.22	32.19	25.32	75.97	993.99	1868.66	2862.64	34.72
	Giza2	30.85	21.23	19.22	68.84	776.09	1668.50	2444.59	31.75
L ₃	Giza 3	45.56	35.84	27.22	78.70	1031.32	1894.66	2925.98	35.25
	Giza2	33.42	23.38	20.31	69.96	793.44	1774.86	2568.30	30.89
LSD 5%		0.88	0.86	0.16	1.06	8.43	19.19	18.82	0.35

Data recorded in Table (2) concluded that chickpea cultivars significantly differed in weight of capsules/plant, seed yield/plant, seed index, shelling %, seed, straw and biological yields/fad., Data observed clearly that Giza-3 cultivar significantly outweighed Giza-2 cultivar in weight of capsules/plant, seed yield/plant, shelling %, seed index, seed yield/plant, seed, straw and biological yields/fad. Several studies pointed out to the significant differences in chickpea cultivars (Bakhsh, *et al.*, 2007; Amal *et al.*, 2010, Akay, 2011 and El-Habbasha *et al.*, 2012).

Concerning the effect of interaction, data recorded in Table 2 indicated that the highest values of almost studied characters were recorded with Giza -3 under normal irrigation, while the lowest values of same characters were recorded to Giza -2 under skipping the 3rd irrigation.

The superiority of Giza- 3 in growth characters led to the production of higher seed yield per plant (g), seed and biological yields /fad. compared to Giza-2 in the same skipping irrigation. These results suggest that the relative tolerance of Giza -3 is linked to its ability to protect its photosynthetic against skipping irrigation. Overall poor yield of the chickpea cultivars under skipping one irrigation may be resulted from the lower photosynthesis rate

III-Chemical constituents:

It is clear from (Fig 1 and 2) that there was a significant decrease in protein and carbohydrate percentages of chickpea seed due to skipping one irrigation. These results may be due to the decrease of growth and yield which in turn reflected negative on chemical of chickpea seeds. These results are in a harmony with those obtained by Gunes *et al.*, (2008) who found that decreasing water availability under drought generally results in reduced total nutrient uptake and frequently reduces the concentrations of mineral nutrients in chickpea.

Data presented in Fig (1 and 2) indicated that chickpea cultivars Giza-3 and Giza-2 differed in the crude protein and carbohydrate %. It concluded that Giza-3 variety exceeded Giza-2 variety in protein and carbohydrate percentages. These results may be due to increase of growth and yield which in turn reflected positively on chemical constituents of chickpea seeds (Singh and Sandhu, 2006).

As for the interaction effect between skipping one irrigation and cultivars Fig (1 and 2) show that the highest content protein and carbohydrate in seed were recorded in Giza-3 under normal irrigation, meanwhile Giza-2 under skipping the 3rd irrigation produced the lowest content of protein and carbohydrate in seed.

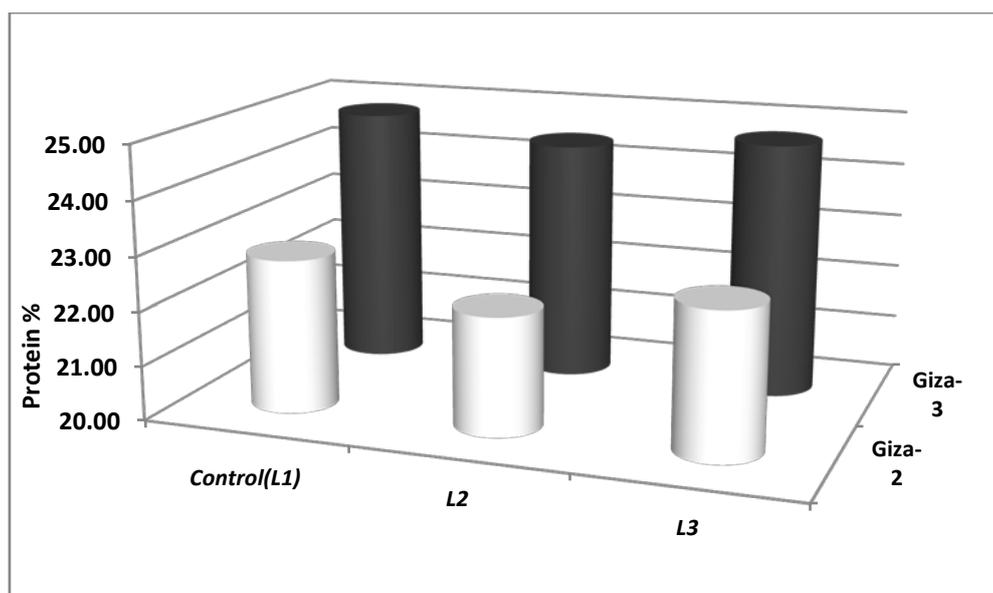


Fig. 1: Effect of interaction between skipping one irrigation and cultivars on protein%.

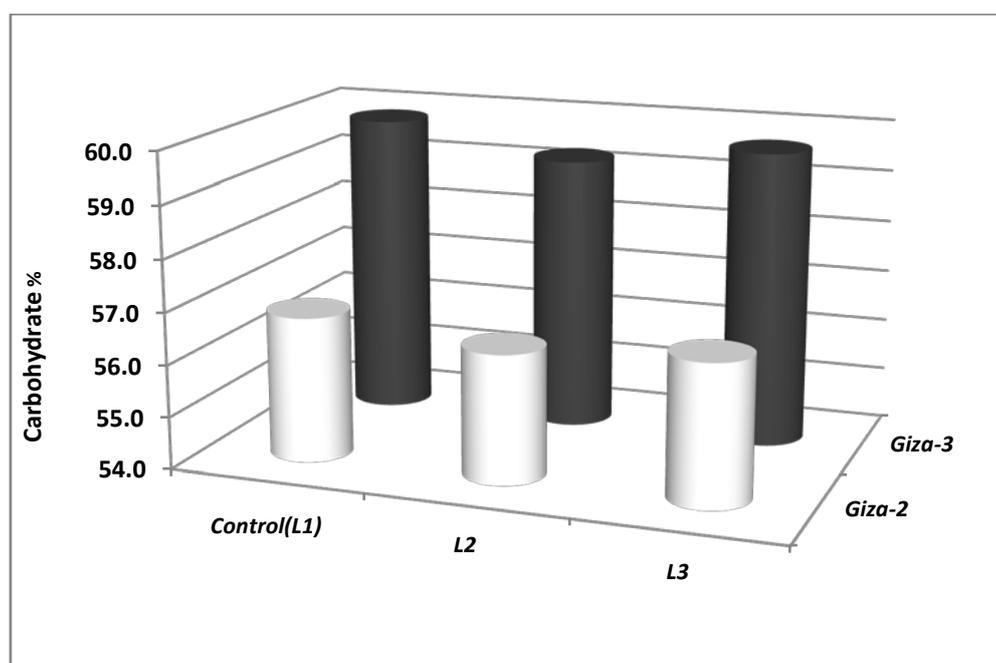


Fig. 2: Effect of interaction between skipping one irrigation and cultivars on carbohydrate%

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