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Original article

The effect of deficit irrigation on yield and water use efficiency of lentil (*Lens culinaris* Medik.)

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Extended abstract

Introduction

Lack of water resources and drought stress is one of the most important characteristics of arid areas. Therefore, selecting the resistant plant and appropriate irrigation method is the best approach to manage water resources in these areas. Furthermore, lentil (*Lens culinaris* Medik.) as a cold spring legume is one of the most suitable plant under these conditions. The deficit irrigation method is one of the most important options for decreasing water losses and maximize water use efficiency in arid areas. However, the purpose of this study was evaluation of managing drought stress using deficit irrigation and its effect on lentil production and water use efficiency in climatic condition of Saravan.

Materials and methods

For evaluation of deficit irrigation on lentil production a split plot experiment based on a randomized complete block design with four replications was conducted in the Agricultural Research Station, Higher Educational Complex of Saravan during the growing season of 2018-2019. Main plots were including four levels of irrigation (60, 80, 100 and 120%). Sub plots were two lentil landraces (Baluchestan and Kurdestan). Planting was done on November 30. Moreover, irrigation was carried out in control (full irrigation) whenever 35% of allowed water depletion was extracted at soil depth of 20 cm. At each irrigation interval, the soil moisture was returned to the field capacity point at depth of 60 cm. The amount of deficit moisture content of different layers of soil was calculated from the following equation:

$$MD_{Control} = (\theta_{FC} - \theta_{10cm}) + (\theta_{FC} - \theta_{20cm}) + \ldots + (\theta_{FC} - \theta_{60cm}) \quad [1]$$

In this equation, MD was the amount of moisture deficiency based on mm, ϴFC was the volumetric moisture content of the soil in the field capacity of the field and ϴ 10cm, 20cm, 30cm, 40cm, 50cm and 60cm were the volume of soil moisture at a depth of 10, 20, 30, 40, 50 and 60 cm, respectively.

The amount of irrigation water for each plot in the control treatment was calculated based on the following equation:

$$IControl = MDControl \times A \quad [2]$$

In the equation of 2, I was the amount of irrigation water based on liter, MD was the amount of moisture deficiency (mm) calculated in equation 1 and A is plot area (m^2).

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Deficit irrigation was done at the same time as the control treatment, but irrigation was carried out at each irrigation interval according to different levels of deficit irrigation (60, 80%).

The amount of water at different levels of deficit irrigation was calculated as follows:

$$I_{\text{Deficit irrigation at 80 percentage}} = I_{Control} \times 0.80 \qquad [3]$$

$$I_{\text{Deficit irrigation at 60 percentage}} = I_{Control} \times 0.60 \qquad [4]$$

Results and discussions

Overall, the results showed that the effect of deficit irrigation on grain yield, biological yield, harvest index, number of pods and seed per plant and water use efficiency was significant. The highest grain yield was obtained for Baluchestan cultivar in 120 and 100% water requirement with 680 and 643 kg ha^{-1}, respectively. Furthermore, the highest harvest index was obtained in Baluchestan cultivar and 80% water treatment (0.24) treatments. Although, Baluchestan cultivar and 80% water requirement treatments encountered with 10% reduction in grain yield compared to 100% water requirement, its biological yield decreased 27% compared to 100% water requirement, which eventually led to an increase in harvest index. On the other hand, the greatest water use efficiency was observed in Balochistan cultivar and 80% water requirement treatment with 2.9 kg ha^{-1} mm^{-1}. Although the yield of 80% water requirement was 58 kg ha^{-1} less than 100% water requirement, but its water use efficiency was 0.3 kg ha^{-1} mm^{-1} more than 100% water requirement.

Conclusions

Therefore, given that the area is considered as arid area, it is possible by reducing irrigation water and allocating it to critical stages especially flowering and pod filling stages and also other crops improve grain yield and the water use efficiency.

Acknowledgement

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***Keywords*:** Harvest index, Landrace, Number of pods per plant, Number of seeds per plant

Table 1. Analysis of variance (MS) for yield and yield components of two lentil landraces at different levels of irrigation.

S.O.V.	d.f	Water use efficiency	Pods/plant	Seeds/plant	1000- seed Weight	Grain yield	Biological yield	Harvest Index
Replication	3	0.0078^{ns}	2.5431^{ns}	3.0481^{ns}	1.4828^{ns}	177^{ns}	28794^{ns}	0.0150*
Irrigation level(I)	3	0.6401**	926**	874**	1.4072^{ns}	111320**	2487946**	0.2541**
Error (I)	9	0.0082	3.0456	3	1.2028	394	6693	0.0011
Landrace (L)	1	2.7203**	442**	1908**	19.6289**	138928**	349933**	1.025*
L × I	3	0.0324**	49**	88**	1.6358^{ns}	4499**	193394**	0.1145**
Error (∏)	12	0. 0292	8.3166	11.8543	0.4327	1184	19409	0.0084
C.V%		*6.6611*	*5.8234*	*7.8126*	*3.9641*	*7.1553*	*5.2337*	*3.4211*

ns: Non-significant, *and **: Significant at 0.05 and 0.01 probability levels, respectively

Table 2. Correlation coefficients between yield and yield components and water use efficiency

		1	2	3	4	5	6	7
1	**Seed yield**	1						
2	**Biological yield**	0.86**	1					
3	**Harvest index**	0.68**	0.23 ns	1				
4	**Pods/plant**	0.96**	0.91**	0.56**	1			
5	**Seed/plant**	0.98**	0.80**	0.71**	0.92**	1		
6	**1000 seed weight**	-0.17ns	0.09 ns	-0.40ns	-0.13ns	-0. 35ns	1	
7	**Water use efficiency**	0.78**	0.41 *	0.91**	0.70**	0.82**	-0.47ns	1

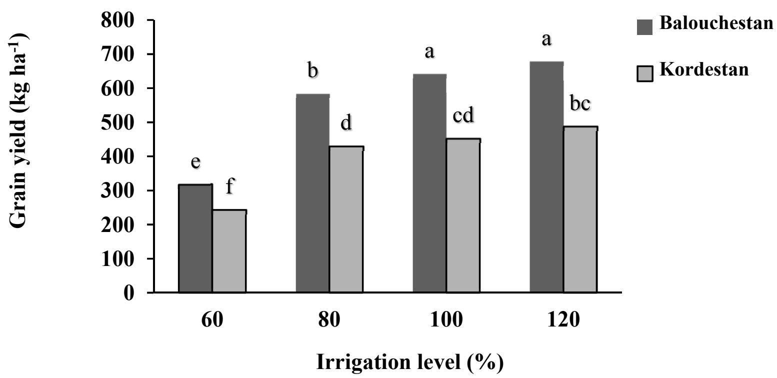

Fig. 1. The effect of irrigation levels on grain yield of Baluchestan and Kurdestan landrac

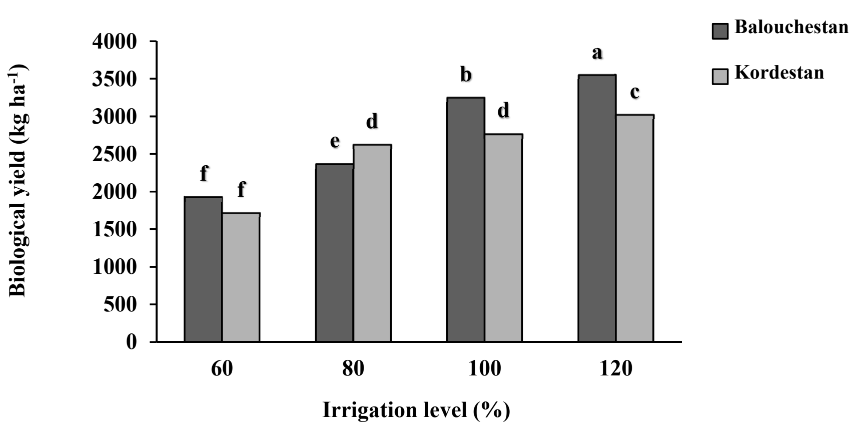

Fig. 2. The effect of irrigation levels on biological yield of Baluchestan and Kurdestan landraces

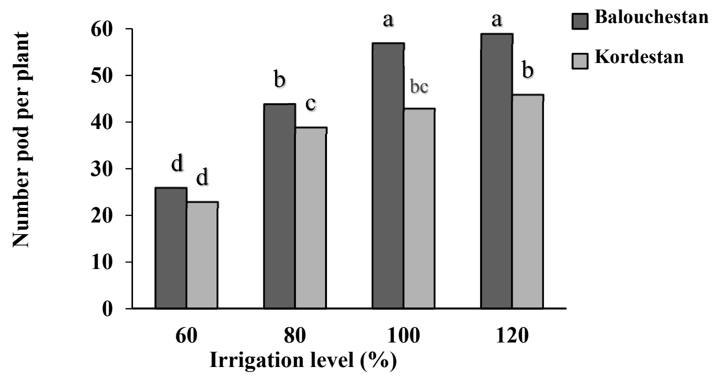

Fig. 3. The effect of irrigation levels on number pod per plant of Baluchestan and Kurdestan landraces

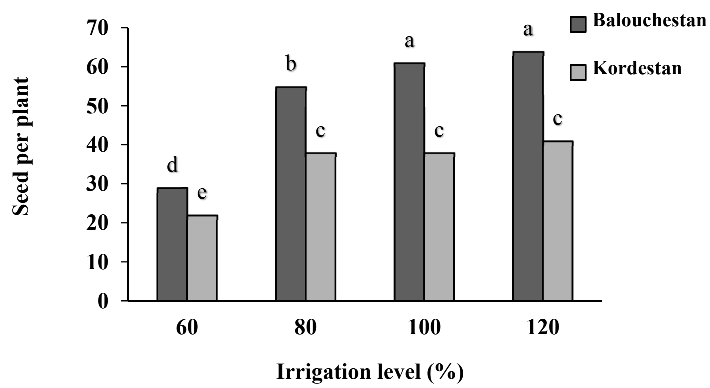

Fig. 4. The effect of irrigation levels on number seed per plant of Baluchestan and Kurdestan landraces

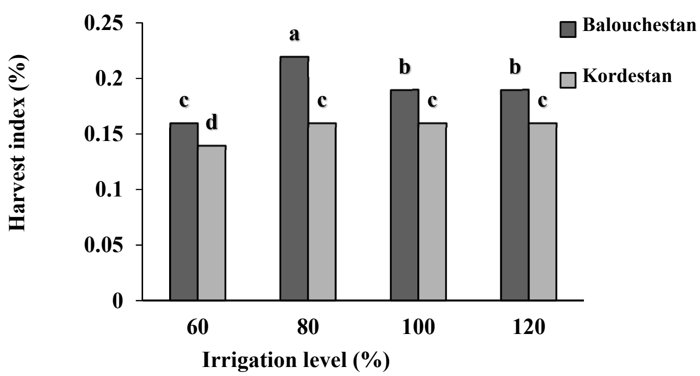

Fig. 5. The effect of irrigation levels on harvest index of Baluchestan and Kurdestan landraces.

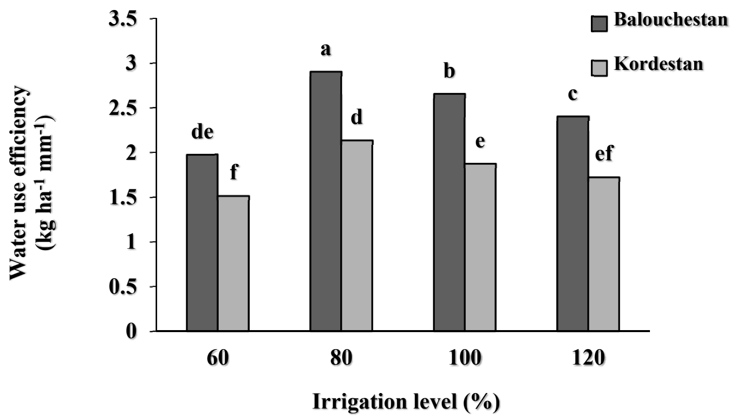

Fig. 6. The effect of irrigation levels on water use efficiency of Baluchestan and Kurdestan landraces