Original article

Study of deficit irrigation on physiological indices, seed yield and yield components traits of chitti bean (*Phaseolus vulgaris* L.) in Yasouj climate conditions

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Extended abstract

Introduction
The common bean (*Phaseolus vulgaris* L.) is considered one of the most important legume crops in the world. It is a staple food for over 300 million people in Latin America and Africa and an important source of protein, fiber, carbohydrates, and trace minerals. Common bean is grown predominantly by small farmers, often in marginal regions, where crop yields are frequently affected by many abiotic factors, in particular water deficit. This study aimed to investigate the effect of water scarcity stress on vegetative and reproductive growth stages on contrary to physiological and agronomic processes in four pinto bean cultivars which evaluated these four cultivars against water scarcity stress.

Materials and methods
In order to study the effect of drought stress levels on some physiological characteristics, yield, and yield components of different bean cultivars, an experiment was conducted with three replication in the crop year of 2014 at as a split-plot in a randomized complete block design Yasouj University. The main factor of the experiment included normal irrigation (Irrigation after 4 days), mild stress (Irrigation after 7 days) and sever stress (Irrigation after 10 days) and the sub-factor included four bean genotypes (Talash cultivar, Sadri cultivar, Khomein local cultivar, Koosha cultivar). Evaluation traits studied physiological characteristics including chlorophyll index, water use efficiency, leaf proline, Yield and yield components (number of pods in plant, number of grain per plant, number of garin per pod, 100-grain weight, grain yield, biological yield, and harvest index).

Results and discussion
The results this research showed that the effect interaction drought stress × cultivar on grain yield, biological yield, harvest index, chlorophyll, leaf proline, and water use efficiency were not significant, but on characteristics number of pods per plant, number of grain per plant, number of grain per pod, and 100-grain weight was significant. The results showed a decrease in the mean of characteristics in drought stress conditions compared to normal irrigation conditions. So that the highest grain yield under normal irrigation conditions with an average of 2304.17 kg/ha and the lowest belonged to severe stress with an average of 1931.25 kg/ha. The rate of decrease in chlorophyll and biological yield in the Talash cultivar compared to the Koosha cultivar was about 26 and 17%, respectively, and the increase in proline in the Talash cultivar compared to the Koosha cultivar was 60%.

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Conclusion

Talash cultivar in most plant traits, including yield and yield components, had the highest amount among other cultivars of pinto beans, in such environmental conditions, this cultivar can be introduced as drought-tolerant, and considering that cultivar Koosha in Most plant traits, including yield and yield components, had the lowest rate among other cultivars of pinto beans. In such environmental conditions, this cultivar can be introduced as drought sensitive.

***Keywords*:** Chlorophyll, Harvest index, Leaf proline, Water deficit

Table 1. Physical and chemical characteristics of soil in experimental field in depth 0-30 cm

Soil Texture	K	P	N	C	EC	S.P	True specific gravity	Appearance specific gravity
	-------mg.kg^{-1}-----------		------%-------		dS/m	%	------------g.cm^{-3}-------------	
Clay loam	635	17	0.07	0.7	0.7	57	2.17	1.254

Table 2. Climatic conditions of Yasouj region during the growing season

Month	Minimum temperature	Maximum temperature	Rainfall	Evaporation rate
	------------------^{0}C-------------------		-------------mm per month------------	
June	8.6	35.4	0	13.4
July	14.4	38.0	8.0	15.0
August	14.0	39.0	4.3	11.9
September	11.0	35.0	0.0	13.1
October	6.0	32.0	20.1	9.4

Table 3. Analysis of variance of yield components traits at four cultivar pinto bean in irrigation treatments

S.O.V	df	Pod number per plant	Seed number per plant	Seed number per pod	100-Seed weight	Water use efficiency
				Mean square		
Replication	2	45.48 ^{ns}	60.21 ^{ns}	0.34 ^{ns}	22.53 ^{ns}	18.27 ^{ns}
Interval irrigation (I)	2	123.13 ^{ns}	2315.21 ^{ns}	65.40**	88.02*	25869.63**
Error a	4	45.63	1438.40	3.56	5.01	462.82
Cultivar (C)	3	228.79**	1678.19**	5.75**	90.31**	9380.84**
C × I	6	42.30**	695.44*	2.77*	30.98*	1626.22**
Error b	18	8.8	253.09	1.03	10.73	159.03
C.V. (%)	-	*14.74*	*26.38*	*19.21*	*7.35*	*4.04*

ns, * and **: Non-significant and significant at the 5% and 1% levels of probability respectively.

Table 4. Comparison of the mean interaction of different pinto bean cultivars in each level of interval irrigation for yield components

Irrigation levels	Cultivar	Pod number per plant	Seed number per plant	Seed number per pod	100- Seed weight (g)	Water use efficiency (g.m^{-3})
Normal Irrigation (Irrigation after 4 days)	Talash	24.13^a	102.20^a	7.80^a	42.72^c	334.40^c
	Sadri	24.00^a	73.13^b	6.53^a	49.88^{ab}	352.22^{bc}
	Khomein	21.00a^b	76.60^b	7.40^a	52.17^a	391.95^a
	Koosha	16.20^b	45.80^c	6.23^a	44.44^{bc}	369.24^{ab}
Mild Stress (Irrigation after 7 days)	Talash	33.67^a	90.60^a	6.73^a	40.40^a	286.15^b
	Sadri	19.67^b	46.53^b	5.67^a	43.79^a	243.02f^c
	Khomein	23.00^b	60.13^b	6.67^a	47.00^a	340.08^a
	Koosha	13.80^c	41.93^b	5.80^a	46.62^a	348.24^a
Severe Stress (Irrigation after 10 days)	Talash	20.20^a	42.60^a	4.60^a	37.83^c	222.35^c
	Sadri	20.60^a	47.87^a	$^+$3.40	38.50^{bc}	267.81^b
	Khomein	13.53^b	46.40^a	1.00^b	43.48^{ab}	295.01^a
	Koosha	11.60^b	49.80^a	1.47^b	47.74^a	295.10^a

* In each column and Irrigation levels, the averages with at least one common letter show no statistical difference in the 5% probability level based on the L.S.Means method.

Table 5. Analysis of variance of seed yield, biological yield and harvest index along with physiological traits of pinto bean cultivars in irrigation treatments

S.O.V	df	Mean Square				
		Seed yield	Biological yield	Harvest index	Chlorophyll	Leaf proline
Replication	2	58405.44 ^{ns}	53566.26 ^{ns}	36.17 ^{ns}	4.31 ^{ns}	0.0013*
Interval irrigation (I)	2	669794.70*	12451147.11**	416.37*	36.03*	0.0014*
Error a	4	67465.24	31405.82	42.69	4.78	0.00013
Cultivar (C)	3	173785.43*	1730496.98*	138.17*	186.79**	0.004**
C × I	6	75239.32 ^{ns}	75218.98 ^{ns}	66.54 ^{ns}	12.52 ^{ns}	0.0007 ^{ns}
Error b	18	50786.42	34702.69	36.00	12.98	0.0004
C.V. (%)	-	11.41	3.97	13.91	9.38	36.38

ns, * and **: Non-significant and significant at the 5% and 1% levels of probability respectively.

Table 6. Mean comparison of main effects Interval irrigation and pinto bean cultivars for seed yield, biological yield and harvest index along with physiological traits

Treatment	Grain yield	Biological Yield	Harvest index	Chlorophyll index	Leaf proline (Micromol per gram of fresh leaf weight)
	--------- Kg.ha^{-1} --------				μmle.g^{-1} F.W
Interval irrigation					
Normal Irrigation (Irrigation after 4 days)	2245.80a	5673.17a	39.90b	39.98a	0.04b
Mild Stress (Irrigation after 7 days)	1871.80b	4757.07b	39.50b	38.65ab	0.06ab
Severe Stress (Irrigation after 10 days)	1808.80b	3639.26c	49.83a	36.55b	0.07a
Cultivar					
Talash	2166.7a	5228.99a	38.33b	43.08a	0.085a
Sadri	1902.8b	4563.10c	41.33ab	41.51a	0.052b
Khomeini	1938.60ab	4787.78b	46.89a	34.79b	0.057b
Koosha	1848.90b	4179.45d	45.78a	34.20b	0.038b

* In each column, the averages that have common letters, according to Duncan test, there is no significant difference in the level of 5% probability