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Original article

Effect of different irrigation regimes on gas exchanges and agronomy traits related to yield in bean (*Phaseolus vulgaris* L.)

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Extended abstract

Introduction

Bean (*Phaseolus vulgaris* L.) is one of the most important food sources of human. It has a high nutritional value due to its protein, vitamins and fiber supply. Abiotic stresses are most important limiting factors to crop productivity that among these, drought stress is known to be the main limiting factor of bean production in worldwide. The bean has a low tolerance to water stress, while about 60% of the bean crop is obtained in areas under low water stress. It has been reported that about 25% reduction of yield bean is due to drought stress conditions. The use of modern irrigation methods in addition raise grain yield, because saves of water consumption.

Materials and methods

In order to investigate the effect of different irrigation regimes on gas exchanges and agronomy traits related to yield in bean, a field experiment was carried out at the Research Farm of the Faculty of Agriculture, Zanjan University, Zanjan, Iran (36410N, 48290E) in spring 2012 years. The experiment was conducted at complete randomized block design with four replications. Experimental treatments included five level of irrigation (Traditional Irrigation with 100 % supply water requirement (I1), drip tape irrigation with 100 (I2), 80 (I3), 60 (I4) and 40 % (I5) supply water requirement. Each plot consisted of four rows, each measuring six meter long, distance of each rows and plants was 50 and 10 cm, respectively. Crop Evapotranspiration (ETc) of bean determined through calculation the evapotranspiration of the refrence crop (ETo) evaluated by FAO-Penman-Montith method and Crop Evapotranspiration (ETc) of plant. For of photosynthesis and other gas exchange parameters use IRGA Lci meter. At the physiological maturity stage, plants in an area of 1 m2 to measuring of length of plant, number pod in plan, number seed in pod, weight of thousand seeds, grain yield, biological yield and harvest index (HI) were harvested, then all aboveground dry matter were determined.

Results and discussion

The irrigation regimes have significant effect all traits investigate except plant length and intercellular CO_2 concentration (C_i). Reducing the amount of available water had adverse effects on the yield and yield components. The maximum of Stomatal conductance to water vapour (g_s) observed in I1 and net

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CO_2 assimilation rate (ACO_2), mesophyll conductance (g_m) in I1 and I2 treatment. The intercellular CO_2 concentration (C_i) was not affected by the irrigation regimes. The maximum of grain yield (945.6 kg/h), number of pod in plant (10.95) and harvest index (23.87 %) observed in I2 treatment and the highest of stomatal conductance to water vapour (g_s) with 0.43 $mmol.m^{-2}s^{-1}$ was in I1 treatment. There was no difference in other traits investigate between I1 and I2 treatments. The intercellular CO_2 concentration (C_i) not significant in different irrigation regimes. The grain yield, number of pod in plant and harvest index in I2 treatment was more than I1 treatment to the amount 31.29, 59 and 18.93 percent, respectively.

Conclusions

According to this study, results showed that the physiological and agronomical traits that affected the growth and development of common bean disturbed whit reducing the available water content and ultimately the yield reduced. Since the no significant difference between more eco-physiological traits, in order to reducing of water consumption, suggested that in the field of bean culture, instead of traditional (leakage) irrigation, to use from of drip irrigation method with 100 percent supply water requirement. Result showed that the use of drip tape irrigation with 100 % water requirement was better than traditional irrigation with 100 percent supply water requirement, because in addition raise grain yield, cause saves of water consumption and reduces of hardness of work in farm conditions..

***Keywords*:** Bean, Eco-physiological traits, Irrigation regimes, Photosynthesis parameters, Yield components.

Table 1. Analysis of variance of the effect of treatments of irrigation on photosynthesis parameters of bean plant

		Mean of Squares				
S.O.V	**df**	**RWC**	**Net CO_2 assimilation rate** (ACO_2)	**Stomatal conductance to water vapour** (gs)	**Mesophyll Conductance** (gm)	**Intercellular CO_2 concentration** (Ci)
Repeat	3	7.41^{ns}	28.21^{ns}	0.018^{ns}	0.008^{*}	4711.08^{**}
Treatment	4	472.34^{**}	85.15^{**}	0.12^{**}	0.01^{*}	2430.84^{ns}
Total Error	12	31.62	8.23	0.007	0.001	801.96
C.V %	-	*7.06*	*35.09*	*23.69*	*21.74*	*13.63*

*, ** and ns represent significant at of 5% and 1% probability level and not significant, respectively

Table 2. Mean comparisons of the effect of treatments of irrigation on photosynthesis parameters of bean plant

Treatment	**RWC**	**Net CO2 assimilation rate (ACO_2)**	**Stomatal conductance to water vapour (gs)**	**Mesophyll Conductance (gm)**	**Intercellular CO_2 concentration (Ci)**
	%	$\mu molco_2.m^{-2}.s^{-1}$	---------- $mmol.m^{-2}.s^{-1}$ ----------		
100% Irrigation	88.90^{a}	12.23^{a}	0.17^{b}	0.06^{a}	209.25^{a}
80% Irrigation	81.05^{ab}	7.16^{bc}	0.10^{bc}	0.04^{ab}	192.0^{a}
60% Irrigation	75.98^{b}	7.12^{bc}	0.08^{bc}	0.03^{ab}	178.88^{a}
40% Irrigation	62.82^{c}	3.72^{c}	0.03^{c}	0.01^{b}	214.87^{a}
Traditional Irrigation	90.68^{a}	15.32^{a}	0.43^{a}	0.06^{a}	243.75^{a}

In each column, there is no significant difference between treatments with common letters according to Duncan test

Table 3. Analysis of variance of yield and some traits of bean under different irrigation regimes

		Mean of Squares						
S.O.V	**d.f**	**Length of plant**	**Number pod in plant**	**Number seed in pod**	**Weight of thousand Seeds**	**Grain yield**	**Biological yield**	**Harvest Index**
Repeat	3	466.4^{**}	1.30^{ns}	0.042^{ns}	0.69^{ns}	3.10^{ns}	0.024^{ns}	17.94^{ns}
Treatment	4	57.04^{ns}	70.72^{**}	4.50^{**}	0.497^{**}	446.82^{*}	1.46^{**}	290.75^{**}
Total Error	12	24.35	2.70	0.174	0.075	10.99	0.047	20.89
C.V%	-	*7.27*	*28*	*21.16*	*5.26*	*16.94*	*2.83*	*29.37*

*, **and ns represent significant at of 5% and 1% probability level and not significant, respectively

Table 4. Mean comparisons of yield and some traits of bean under different irrigation regimes

Treatment	**Length of plant**	**Number pod in plant**	**Number seed in pod**	**Weight of thousand Seeds**	**Grain yield**	**Biological yield**	**Harvest Index**
	cm			g	---------Kg/h--------		%
100% Irrigation	69.97^{a}	10.95^{a}	3.13^{a}	229.68^{a}	945.6^{a}	3967.9^{a}	23.87^{a}
80% Irrigation	68.73^{a}	8.30^{ab}	1.93^{b}	267.02^{a}	531.7^{bc}	2822.2^{a}	19.16^{ab}
60% Irrigation	65.77^{a}	1.65^{c}	1.07^{bc}	166.80^{ab}	178.1^{c}	1465.6^{b}	12.56^{b}
40% Irrigation	62.40^{a}	1.37^{c}	0.78^{c}	108.65^{b}	21.0^{d}	978.7^{b}	2.15^{c}
Traditional Irrigation	72.07^{a}	6.87^{b}	2.93^{a}	219.58^{a}	720.2^{b}	3725.4^{a}	20.07^{ab}

In each column, there is no significant difference between treatments with common letters according to Duncan test