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Original article

Effect of deficit irrigation methods on physiological characteristics of maize (*Zea mays* L.)

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Extended abstract

Introduction

Maize (*Zea mays* L.) is an annual crop belonging to poaceae family that compared to other cereals has high yield. After wheat and rice, maize dedicated largest cultivation area in the world. Drought stress is one of the most important abiotic stress that often affects many aspects of plant growth and it's the main limitation factor for crop production especially in arid and semiarid regions. Low irrigation lead to drought stress, which affects the plant growth and development. Drought stress leads to growth reduction, delayed maturity and crop yield loss. The use of modern irrigation methods to increase water use efficiency could help solve the problem of water resources shortage that needed for agriculture. Partial root zone drying irrigation is one of the innovative techniques that enhance water use efficiency without a significant reduction in throughput product. The part of the plant root watering and the other part remains dry; this part of the roots that remained dry by sending a signal to aboveground respond to dry and causes Stomatal closure and reduction of plant water consumption. This study aimed to evaluate the effect of different traditional irrigation and partial root zone drying focuses on physiological characteristics of maize.

Materials and methods

In order to evaluate the effect of different traditional irrigation and partial root zone drying on physiological characteristics of corn, an experiment in complete randomized block design with 18 treatments and 3 replication was conducted in Birjand University Agricultural Research Station at 59 degree and 13 minutes of eastern longitudes and 32 degree and 56 minutes altitudes. Irrigation treatment concluding from over irrigation (at 125% water requirement), full irrigation (at 100% water requirement) and combined from traditional low irrigation, low irrigation with fixed furrows and variable furrows after one or two irrigation, that started one month after emergence and continued until the end of vegetative or growth period of plant. Low irrigation treatments were applied at 50 and 75% of water requirement. For measuring the volume of irrigation water per plot first net irrigation requirement was measured and then to fine-tune the distribution of water between plots and distribution of water the pumps and water counter were used. Finally, plant height, ear length, leaf area index, Stomatal conductance and relative water content were measured.

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Results

The results showed that the effect of irrigation treatment on all treats was significant. The highest averages were observed in irrigation at 125% of water requirement and applying various methods of irrigation lead to reduced plant height, ear length, leaf area index, stomatal conductance and relative water content in all of low irrigation treatments were observed in maize plants, although this different was not statistically significant in some treatments. Although water stress was reduced in maize plants traits, but the difference caused by the stress at the partial root zone drying was less than traditional low irrigation compared to full irrigation. Partial root zone drying also increased the physiological characteristics compared to traditional low irrigation treatments. It has been reported that the use of partial root zone drying in cotton resulted in significant savings in water consumption, earliness and increase the quality of the product, this technique reduces water consumption by 50% and increase water use efficiency by 21 percent compared to conventional irrigation to full irrigation was 43 percent.

Conclusion

According to the results of this study can be recommended partial root zone irrigation at 75 percentages of maize plant water requirement by variable irrigated furrows after twice irrigation as the best treatment for water use reduction in maize seed production. This treatment is appropriate for solving the water crisis.

Keywords: Environmental Stress, Partial Root Zone Drying, Relative water Content, Stomatal Conductance.

Table 1. Quality of irrigation water

SAR	Cl	Ca	Mg	K	Na	SO_4	HCO_3	CO_3	TDS	TH	EC	pH
	----------eq/l----------								mg/l		µs/cm	
6.02	16.8	4.2	12.4	0.05	17.35	13.25	3.95	0	1496	0.83	2890	7.5

Table 2. The volume of water required for each treatment during the growing season

Treatment	FI125	FI100	DI75T	DI50T	DI75V	DI50V	CI75T	CI50T	CI75V
Water volume (m^3)	18.95	15.16	11.37	7.58	13.64	9.09	11.37	7.58	13.64

Treatment	CI50V	1PRD75T	1PRD50T	1PRD75V	1PRD50V	2PRD75T	2PRD50T	2PRD75V	2PRD50V
Water volume (m^3)	9.09	11.37	7.58	13.64	9.09	11.37	7.58	13.64	9.09

FI100 and FI125 full irrigation with 100 and 125% water requirement of the crop, DI traditional deficit and CI conventional irrigation with fixed furrow irrigation, PRD partial root drying by changing furrows after one (1PRD) or two irrigations (2PRD); 50 and 75, irrigation based on the percentage of crop water requirement, V and T show the application of deficit irrigation period to the end of vegetative growth and the whole growth period, respectively.

Table 3. Analysis of variance of the effect of irrigation treatments on some of physiological characteristics in maize.

S.O.V	dF		Relative water content stage 2	Ear length stage2	Stomatal conductance	Plant height		Leaf area index	
	Stage 1	Stage2				Stage1	Stage2	Stage1	Stage2
Block	2	2	51.32 ^{ns}	8.74**	736.46 ^{ns}	472**	58.4^{ns}	2.17**	0.3^{ns}
Treatment	9	17	116.17**	2.48*	1015.65**	173*	222.5*	1.12**	0.32**
Error	18	34	25	1.23	294.5	66.3	111.69	0.2	0.11
CV (%)	-	-	*17.26*	*8*	*29.52*	*6.8*	*6.46*	*22.6*	*15.29*

ns, * and ** shows non significant, significant at 5% and 1% probability levels respectively.

Table 4. Effect of irrigation treatments on plant height, ear length, leaf area index and stomatal conductance in maize.

Irrigation treatments	Stomatal conductance ($mmol.m^{-2}.S^{1}$)	Leaf area index LAI		Ear length (cm)	Plant height (cm)	
		Stage 1	Stage 2		Stage 1	Stage 2
FI125	96 ^{a}	3.50 ^{a}	3.01 ^{a}	16.43 ^{a}	134.2 ^{a}	176. 7 ^{a}
FI100	81.3 $^{a-c}$	2.58 ^{b}	2.4 $^{b-e}$	14.37 ^{bc}	126.5 ^{ab}	171.7 $^{a-c}$
1PRD75V	48.6 $^{d-f}$	1.77 ^{c}	2.31 $^{b-e}$	13.88 $^{b-d}$	116.4 ^{bc}	171.5 $^{a-c}$
2PRD75V	49 $^{d-f}$	1.75 ^{c}	2.62 ^{ab}	14.19 $^{b-d}$	123.8 ^{ab}	174 ^{a}
CI75V	63.3 $^{b-e}$	1.93 ^{c}	2.08 $^{b-f}$	13.77 $^{b-d}$	116.7 ^{bc}	173.8 ^{ab}
DI75V	76.3 $^{a-d}$	1.72 ^{c}	1.93 $^{d-f}$	13.37 $^{b-d}$	120.9 $^{a-c}$	161.7 $^{a-f}$
1PRD75T	41.3 ^{ef}	-	2.48 $^{a-d}$	14.35 ^{bc}	-	167.3 $^{a-e}$
2PRD75T	34 f	-	2.50 $^{a-c}$	14.358 ^{bc}	-	172.3 $^{a-c}$
CI75T	47.3 ^{ef}	-	2.06 $^{b-f}$	14.7 ^{ab}	-	162.3 $^{a-f}$
DI75T	76 $^{a-d}$	-	1.86 ^{ef}	13.84 $^{b-d}$	-	160.7 $^{a-f}$
1PRD50 V	66 $^{b-e}$	1.59 ^{c}	2.12 $^{b-f}$	13.54 $^{b-d}$	115.6 ^{bc}	162.4 $^{a-f}$
2PRD50V	53.3 $^{c-f}$	1.45 ^{c}	2.08 $^{b-f}$	13.57 $^{b-d}$	108.2 ^{c}	155 $^{c-f}$
CI50V	38 ^{ef}	1.86 ^{c}	2.29 $^{b-e}$	13.42 $^{b-d}$	113.7 ^{bc}	156.2 $^{b-f}$
DI50V	86 ^{ab}	1.69 ^{c}	1.98 $^{c-f}$	13.06 $^{b-d}$	113.1 ^{bc}	154.1 $^{d-f}$
1PRD50 T	44.3 ^{ef}	-	2.22 $^{b-e}$	12.72 ^{cd}	-	153.9 ^{ef}
2PRD50T	42 ^{ef}	-	1.92 ^{ef}	12.38 ^{d}	-	152.4 ^{ef}
CI50T	43 ^{ef}	-	2.07 $^{b-f}$	12.76 ^{cd}	-	166.6 $^{a-f}$
DI50T	60.3 $^{b-f}$	-	1.6 ^{f}	13.87 $^{b-d}$	-	149.4 ^{f}
LSD	28.47	0.54	0.55	1.84	13.96	17.53

Means with at least one similar letter do not have a significant difference based on the least significant difference test at the 5% probability level. FI100 and FI125 full irrigation with 100 and 125% water requirement of the crop, DI traditional deficit and CI conventional irrigation with fixed furrow irrigation, PRD partial root drying by changing furrows after one (1PRD) or two irrigations (2PRD); 50 and 75, irrigation based on the percentage of crop water requirement, V and T show the application of deficit irrigation period to the end of vegetative growth and the whole growth period, respectively.

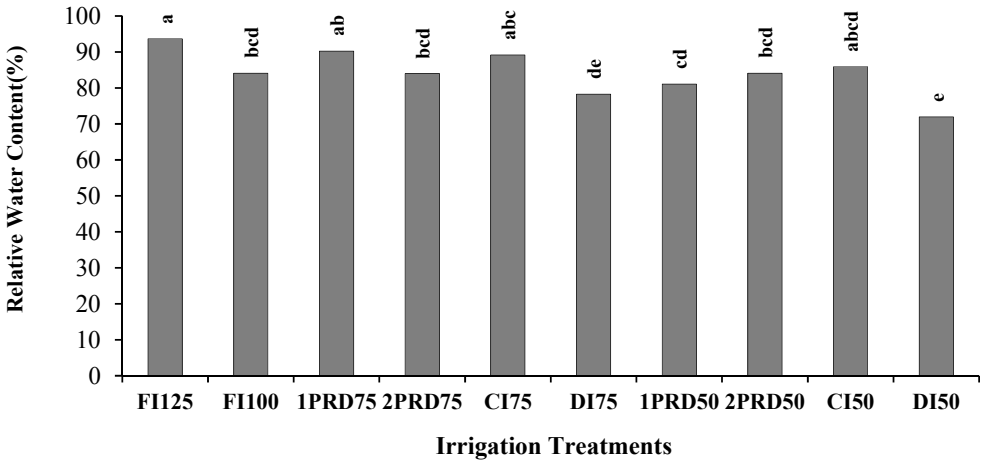

Fig. 1. Effect of irrigation treatments on leaf relative water content at the end of the vegetative growth of maize. FI100 and FI125 are irrigation at 100 and 125 percentage of plant water requirement, PRD is localized irrigation furrow variable, after an irrigation (1PRD) and after two irrigation (2PRD), CI is Fixed Furrow irrigation and DI shows traditional low irrigation. The numbers 50% and 75% shows the time of irrigation based on a part of plant water requirement, all to the end of vegetative growth.