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Effect of drought stress and different levels of nitrogen fertilizer on morphological and physiological traits and total dry matter in two rice cultivars (cvs. Hashemi and Gilaneh)

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Extended abstract

Introduction

Drought stress is a limiting factor for growth in crops. Water and nitrogen relationships in the crop change in drought stress. The role of nitrogen in plant response during drought stress depends on the stress intensity and fertilizer level. Plants with relatively high nitrogen availability show better growth compared to plants with low nitrogen in drought stress. Therefore, the objectives of the present study were to investigate the effect of drought stress and different levels of nitrogen fertilizer on morphological and physiological traits in two rice cultivars.

Materials and methods

The present study was conducted in Rasht in 2017 and 2018. The experimental design was split plot plot arrangement in randomized complete block design with three replications. The experimental factors were drought stress (main factor) at three levels (continuous submergence, 7 and 14 days irrigation interval), N fertilizer (sub factor) in three levels (50, 75 and 100 kg ha^{-1}) and sub sub factor in two levels (cv. Hashemi, Gilaneh). The size of the experimental units was 9 m^{-2} (plot dimensions 3 × 3). To control weeds, butachlor herbicide (3 L ha^{-1}) was used after planting and manual weeding. To calculate the maximum leaf area index, 10 days after transplanting, 7 sampling steps were performed every 10 days until the harvest stage and in each sampling, four mounds from each floor plot and total leaf area were determined. To determine the dry matter, sampling was done in the complete ripening stage after removing the margins from the middle rows of plots and all one square meter plants were harvested. The samples were placed separately in an oven at 75 ° C for 72 hours and then weighed and recorded.

Results and discussion

Results showed that the impact of year and on shoot height, flag leaf length and width, RWC, SPAD and k were not significant but on LAImax, total dry matter were significant. Impact of drought stress × N fertilizer × cultivar on RWC, SPAD and k were significant. Impact of year × drought stress × N fertilizer

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× cultivar on LAImax and total dry matter were significant ($p<0.01$). Shoot height, LAImax, total dry matter, flag leaf length and width, RWC, SPAD were decreased by drought stress and were improved by increase of N fertilizer consumption under the three condition of drought stress. The lowest k (0.14) was obtained in continuous submergence and consumption of 100 kg ha^{-1} N fertilizer, which was same in two cultivars. The highest total dry matter accumulation (803.3 g m^{-2} in 2017 and 760.7 g m^{-2} in 2018) was obtained in Gilaneh with consumption of 100 kg ha-1 nitrogen fertilizer in continuous submergence.

The highest number of SPAD in flooding with 51.8 with 100 kg of pure nitrogen per hectare in Gilaneh cultivar and the lowest with 50 kg of nitrogen fertilizer per hectare in 14 days irrigation cycle and in Gilaneh cultivar (27.65) was obtained. Hashemi cultivar showed the highest plant height (131.1 cm) in flood irrigation and the lowest plant height in 14 day irrigation (131.6 cm). Gilaneh cultivar, similar to Hashemi cultivar, showed the highest height (110.5 cm) in flood irrigation and the lowest height (100.6 cm) in 14 day irrigation.

Conclusions

Drought stress showed adverse effects on morphological and physiological traits, while the application of 100 kg ha^{-1} of nitrogen fertilizer compared to the other levels improve these traits in both cultivars stress and not-stress, and produce more dry matter in both years of study. Therefore, when there is not enough water for irrigation, it is possible to moderate the effects of water stress by using the optimal amount of nitrogen fertilizer. It can help to produce more dry matter and achieve higher yield.

***Keywords*:** Chlorophyll meter, Gilaneh, Leaf relative water content, Light extinction coefficient

Table 1. Physical and chemical properties of soil in the experiment site

Year	K_{ava}	P_{ava}	N	pH	EC	Soil type	Sp
	----------- ppm -----------		%		dS m^{-1}		
2017	280	17.8	0.184	7.4	1.2	Si-Cl	75
2018	290	17	0.155	7.4	1.12		

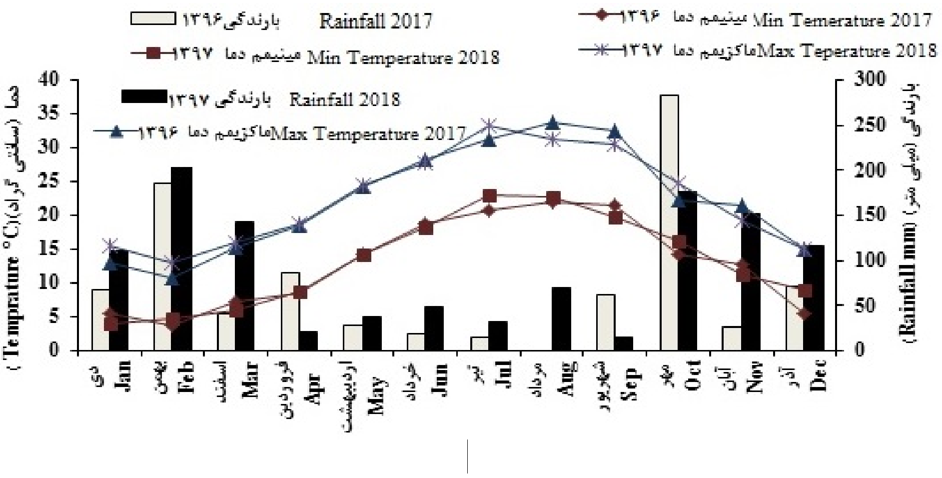


Fig. 1. Meteorological information during the growth season of rice in experimental site (2017 and 2018)

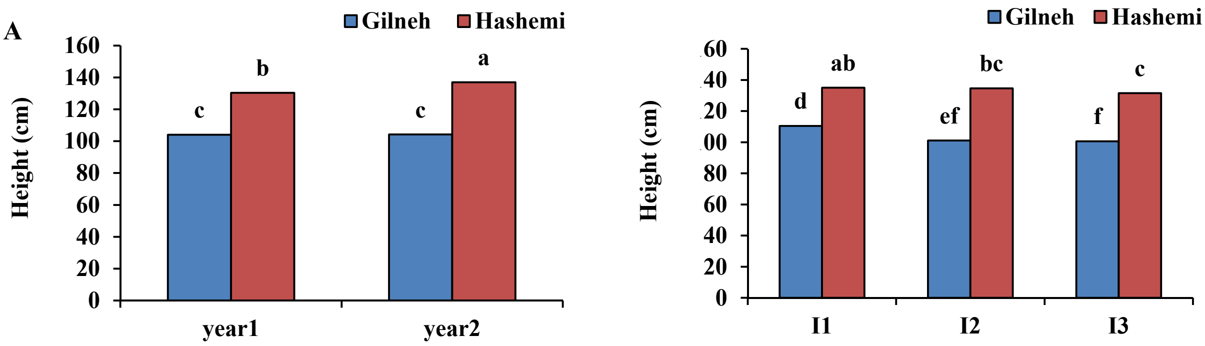
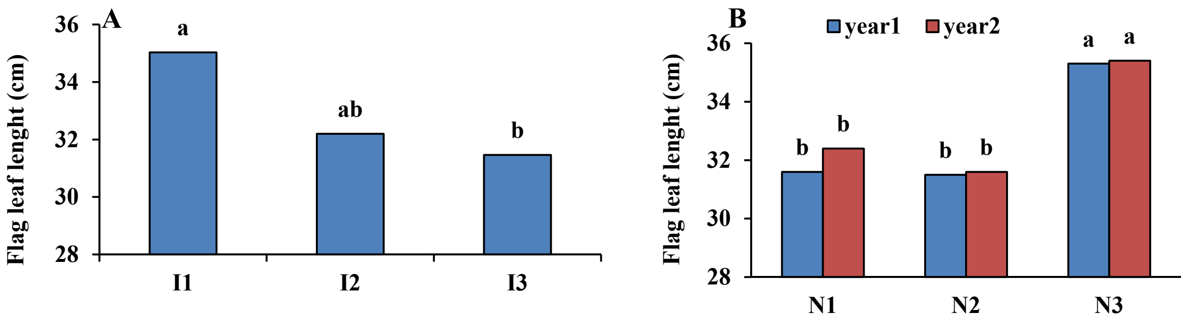


Fig. 2. A. Effect of year ×cultivar on height, B- Effect of Irrigation × cultivar on height. I1- continuous submergence; I2 and I3: 7 and 14 days irrigation interval, respectively



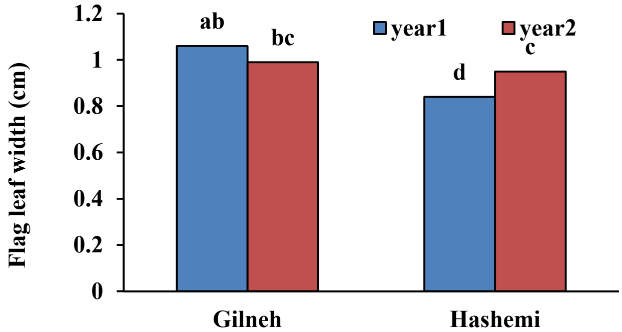


Fig. 3. A. Effect of different levels of water stress on flag leaf length; B- Effect of year × N fertilizer on flag leaf ength; C- Effect of year ×cultivar on flag leaf width; I1: continuous submergence; I2 and I3: 7 and 14 days irrigation interval respectively; N1, N2 and N3: 50, 75 and 100 kg ha^{-1} N fertilizer respectively

Table 2. Combined analysis of variance for water stress and N fertilizer on studied trait in two rice cultivars

S.O.V	df	Total dry matter	Shoot Height	LAI_{max}	RWC
Year(Y)	1	18249.5**	314.1ns	0.39**	3.6ns
R(year)	4	230.68ns	44.6ns	0.005ns	4.42ns
a	2	244140.4**	433.4ns	15.9**	116.4**
Y × a	2	1822.2**	62.18ns	0.12**	7.42ns
Erorr a	8	386.09	47.28	0.006	4.6
b	2	350386.49**	421.8ns	13.2**	2269.3**
Y × b	2	601.4ns	46.33ns	0.43**	0.15ns
a×b	4	2582.9**	60.3ns	1.98**	55.9**
Y × a ×b	4	4331.85**	11.1ns	0.129**	6.9ns
Erorr b	24	330.6	17.1	0.009	4.8
c	1	92306.1**	23592.4**	5.04**	206.7**
Y ×c	1	2.23ns	278.2**	0.132**	2.8ns
a×c	2	1371.2*	184.7*	0.489**	102.2**
Y×a×c	2	198.2ns	9.2ns	0.145**	7.3ns
b×c	2	3909.3**	279.1ns	0.540**	103.4**
Y×b×c	2	2799.6**	34.4ns	0.046**	4.4ns
a×b×c	4	8939.7**	48.2ns	0.31**	45.8**
Y ×a×b×c	4	1859.5**	29.19ns	0.089**	8.14ns
Erorr c	36	295.4	20.7	0.007	4.54
CV(%)		2.8	3.8	2.94	2.7

Table 2. Continued

S.O.V	df	k	Flag leaf width	Flag leaf length	SPAD
Year(Y)	1	0.003ns	0.01ns	9.5ns	32.56ns
R(year)	4	0.0099ns	0.019ns	49.5*	9.09ns
a	2	0.00057ns	0.02ns	128.4**	450.02**
Y×a	2	0.0018ns	0.01ns	3.1ns	148.14**
Erorr a	8	0.0039	0.013	20.4	7.12
b	2	0.023*	0.044ns	47.9*	752.11**
Y×b	2	0.0019ns	0.003ns	106.3**	16.48ns
a×b	4	0.098**	0.022ns	21.3ns	145.05**
Y× a×b	4	0.0051ns	0.01ns	5.6ns	73.7**
Erorr b	24	0.048	0.01	16.4	4.67
c	1	0.84**	0.44**	210.3	229. 1**
Y×c	1	0.0005ns	0.25**	0.82	14.01ns
a×c	2	0.006ns	0.004ns	35.1ns	13.99ns
Y×a×c	2	0.012ns	0.005ns	8ns	7.62ns
b×c	2	0.068**	0.0025ns	7.4ns	37.7**
Y×b×c	2	0.0005ns	0.008ns	10.7ns	11.13ns
a×b×c	4	0.217**	0.0041ns	19.3ns	24.5**
Y ×a×b×c	4	0.00015ns	0.014ns	30.9ns	8.64ns
Erorr c	36	0.006	0.025	14.9	5.69
CV(%)		13.23	16.44	11.8	6.57

ns, *and ** non significant and significant at 5% and 1% level, respective

Table 3. Mean comparison of some studied traits in water stress×fertilizer×cultivar

Irrigation	N fertilzer (Kg ha^{-1})	Cultivar	SPAD	RWC $_{flag\ leaf}$	k
I1	N1	Gilaneh	31.73^{d}	68.57^{ef}	0.29^{d}
I1	N1	Hashemi	33.51^{de}	74.05^{e}	0.28^{de}
I1	N2	Gilaneh	36.8^{c}	80.29^{b}	0.17^{e}
I1	N2	Hashemi	41.65^{bc}	87.82^{a}	0.136^{e}
I1	N3	Gilaneh	46.31^{ab}	86.47^{a}	0.14^{e}
I1	N3	Hashemi	51.85^{a}	88.06^{a}	0.14^{e}
I2	N1	Gilaneh	29.62^{de}	68.05^{f}	0.46^{bc}
I2	N1	Hashemi	31.28^{d}	72.49^{e}	0.48^{b}
I2	N2	Gilaneh	35.73^{d}	75.96^{c}	0.42^{c}
I2	N2	Hashemi	35.1^{d}	81.82^{b}	0.41^{cd}
I2	N3	Gilaneh	36.4^{cd}	83.05^{a}	0.39^{c}
I2	N3	Hashemi	40.1^{c}	85.89^{a}	0.291^{d}
I3	N1	Gilaneh	28.81^{e}	66.78^{f}	0.68^{a}
I3	N1	Hashemi	27.65^{e}	65.07^{f}	0.582^{b}
I3	N2	Gilaneh	32.56^{d}	74.2^{e}	0.406^{c}
I3	N2	Hashemi	33.23^{d}	78.98^{bc}	0.32^{cd}
I3	N3	Gilaneh	35.26^{d}	81.44^{b}	0.361^{c}
I3	N3	Hashemi	35.06^{d}	82.83d	0.297^{d}

In each column, means with at least one similar letter are no different at 5% level ($p \leq 0.05$)

† I1- continuous submergence I2 and I3: 7 and 14 days irrigation interval respectively; N1, N2 and N3: 50, 75 and 100 Kg ha^{-1} N fertilizer respectively

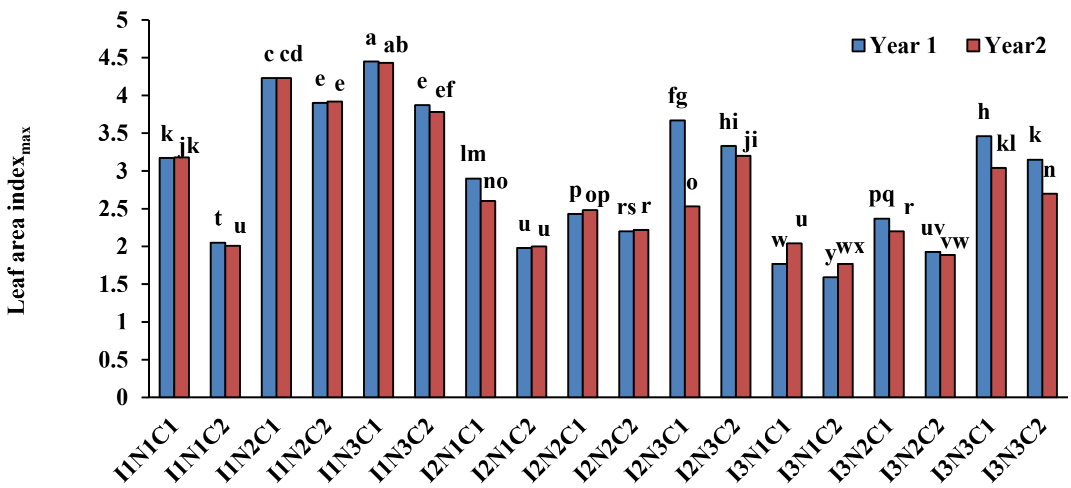


Fig. 4. Effect of year × irrigation × N fertilizer× cultivar on leaf area index$_{max}$. I1: continuous submergence, I2 and I3: 7 and 14 days irrigation interval respectively; N1, N2 and N3: 50, 75 and 100 Kg ha^{-1} N fertilizer respectively; C1: Gilaneh and C2, Hashemi

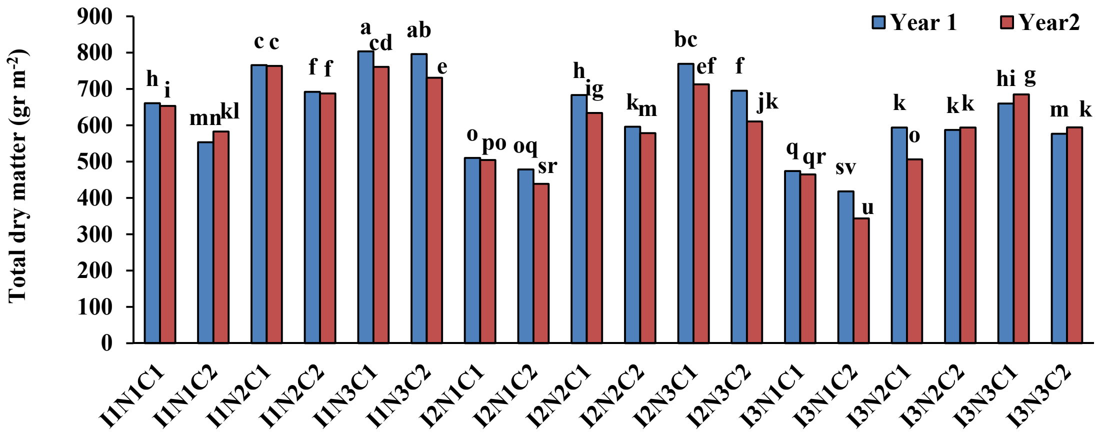


Fig. 5. Effect of year × irrigation × N fertilizer× cultivar on total day matter. I1: continuous submergence, I2 and I3: 7 and 14 days irrigation interval respectively; N1, N2 and N3: 50, 75 and 100 Kg ha^{-1} N fertilizer respectively; C1: Gilaneh and C2, Hashemi