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The Study Effect of Drought Stress on Four Native Rice Varieties in Iran

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Abstract: To investigate the effects of drought stress on yield and yield components of four native rice in Iran, an experiment in split plot format based on randomized complete block design in three replication in a field situated in Lahijan township (Guilan province in north of Iran) in farming year 2007 was conducted. First factor of experiment consist of three irrigation management (I_1: always flooded, I_2: 6 days interval irrigation and I_3: 9 days interval irrigation) and second factor consist of four native rice varieties namely (V_1: Hashemi, V_2: Ali Kazemi, V_3: Hasani and V_4: Binam). Studied traits was include of grain yield, number of grains per panicle, 1000 grain weight, plant height, total biomass, amount of irrigation, percentage of unfilled grains, number of bearer tillers per hill unit and Harvest index. It was observed that more studied traits were significantly influenced by both irrigation methods and variety in 1 % probability level. Among irrigation methods levels the flooded irrigation was obtained highest grain yield. Also, the 6 days interval irrigation statistically placed in same level with always flooded method. Also among varieties the Ali Kazemi was record highest grain yield.

Key words: Rice · Irrigation · Native Variety · Yield · Iran

INTRODUCTION

Irrigation is an important practice in agriculture. Nowadays, the competition for fresh water in the development of urbanization, industry, leisure, and agriculture causes the decline of fresh water for irrigation [1-3]. Water scarcity is a severe environmental limitation to plant productivity. Drought induced loss in crop yield may exceeds loses from all other causes, since both the severity and duration of the stress are critical [4]. Rice (Oryza sativa L.) is the most important cereal crop in the world and it is the primary source of food and calories for about half of mankind [5]. More than 75% of the annual rice supply comes from 79 million hectares of irrigated paddy land. Thus, the present and future food security of Asia depends largely on the irrigated rice production system. However, rice is a profligate user of water. It takes 3000–5000 liters to produce 1 kilogram of rice, which is about 2 to 3 times more than to produce 1 kilogram of other cereals such as wheat or maize [6]. Irrigation water is an important production factor in rice systems but is no longer available unlimited in rice-growing areas [7]. Nour *et al*. reported that exposing rice plant to water stress for 36 days without flush irrigation during both tillering and panicle initiation significantly reduce plant height, number of tillers per plant, total dry matter, crop growth rate and grain yield [8]. Boonjung and Fukai. reported that drought stress at duration of filling grains period with acceleration in ripening time, casing to growth period duration and filling grains decreased [9]. One method for reduce water consumption in rice planting is interval irrigation and blockage of flooding field for all duration of rice growth cycle. The obtained results of Razavi pour *et al*. [10] and Arab Zade. [11] in Iran and Belder *et al*. [12] and Bouman *et al*. [6] in the world show that, it is not necessary that rice plant in all stages of growth be continuous flooding, but it can be done rice cultivation by reducing of water depth with changing of irrigation methods from flooded to non-flooded. Also, some reports show that, by a favorable water management and use of optimum interval irrigation, without yield and yield components decreases or with an acceptable decrease of it, can do highly thrift in water consumption [13, 14, 15]. The aim of this study was to determine the effect of flooded and non-flooded irrigation method on yield and yield components of four native rice varieties in Iran.

MATERIALS AND METHODS

For comparison of flooded and non-flooded irrigation methods in rice culture an experiment.

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Table 1: Soil analysis results of the experimental sites

Depth (cm)	0-30	Texture	Silty loam
Organic matter %	7.1	PH	7.1
Clay%	17.81	E.c.d. s/m	6.82
Sand%	22	N%	0.18
Silt%	60.19	P ppm	37.4
SP%	69.7	K ppm	29.1

In split plot format based on randomized complete block design (RCBD) with 3 replications in 2007, in a field situated in Lahijan township (Guilan province of Iran), with 37°11' N latitude and 50°0' E longitude and 20 m above sea level was conducted. The climate of the area is mild and Mediterranean. Soil analysis results show that (Table 1), the soil texture was Silty Loam and pH 7.1. First factor of experiment included three irrigation management (I_1: always flooded, I_2: 6 days interval irrigation and I_3: 9 days interval irrigation) and second factor included four native rice varieties namely (V_1: Hashemi, V_2: Ali Kazemi, V_3: Hasani and V_4: Binam).The operations of preparing land includes first plough in winter and secondary plough along with giving phosphorus and potash was done. The area of plots was 15 m^2 and for prevent of water, fertilizer and herbicides escape plots border covered with plastic cover. Sowing in nursery was done April 15 and transplanted to field May 22. According to soil analysis amount of fertilizers N, K and P were implemented. During growth period, cultivate cares were done ordinarily. In maturity time, according measurement instruction, grain yield, number of grains per panicle, 1000 grain weight, plant height, total biomass, amount of irrigation, percentage of unfilled grains, number of bearer tillers per hill unit and Harvest index were measured. The yield and yield components were analyzed by using MSTAT-C software. The Duncan's multiple range tests was used to compare the means at %5 of significant.

RESULTS AND DISCUSSION

With attention to results of variance analysis (Table 2), the effect of different irrigation methods in more studied traits such as grain yield, number of bearer tillers per hill, number of grains per panicle, percentage of unfilled grain per panicle, amounts of irrigation and total biomass have a significant difference in 1 % probability level. Also, plant height and 1000 grain weight significantly affected by irrigation methods in 5 % probability level. But don't show significant effect on harvest index. Comparison of mean between methods of irrigation show that (Table 3), The highest amounts of grain yield with 4060 kg/ha, total biomass with 7471 kg/ha, number of bearer tillers per hill with 28.50, number of grain per panicle with 92.18, 1000 grain weight with 25.23 gr, plant height with 145.2 and irrigation with 623.8 (mm) was related to always flooding irrigation. The 6 day interval irrigation level statistically placed on same group with flooding irrigation from viewpoint of these traits. Similar results were obtained by Rezaei and Nahvi [16]. The lowest amount of grain yield, total biomass, number of bearer tillers, number of grain per panicle, 1000 grain weight, plant height and amount of irrigation respectively with 3325 kg/ha, 6109 kg/ha, 17.75, 82.05, 24.40 gr, 132.5 cm and 485.9 mm was recorded from 9 day interval irrigation. Almost all rice varieties show better growth and higher productivity under continuous flooding conditions than

Table 2: Analysis of variance for studied traits

S.O.V	DF	Grain yield (kg/ha)	No. of grain per panicle	1000 grain weight(g)	Plant height (cm)	Total biomass (Kg/ha)	Amount of irrigation (mm)	Unfilled grain percentage	No.of bearer tillers (per hill)	Harvest index (%)
						MS				
Irrigation (A)	2	1681935.583**	326.397**	2.498**	505.919*	5676649.731**	58247.528**	188.083**	347.250**	0.872^{ns}
Error A	4	87357.417	15.235	0.325	58.191	223285.551	2728.236	6.833	2.583	45.387
Variety (B)	3	1262968.769**	494.494**	91.474**	11.482^{ns}	548699.878*	220.333^{ns}	149.361**	47.778**	124.307*
A×B	6	164041.435^{ns}	101.870^{ns}	0.505^{ns}	15.117^{ns}	155991.700^{ns}	423.750^{ns}	24.306*	2.694*	40.230^{ns}
Error B	18	204574.324	59.186	0.267	17.127	172829.305	201.750	7.380	0.972	30.311
CV%		12.11	8.76	2.09	3	6.07	2.53	22.80	4.29	10.10

ns,* and **: non significant, significant at the 5 and 1 % level of probability respectively

Table 3: Comparison of Mean Effect of irrigation and variety on measured traits

Treatment	Grain yield (kg/ha)	No. of grain per panicle	1000 grain weight (g)	Plant height (cm)	Total biomass (Kg/ha)	Amount of irrigation (mm)	Unfilled grain percentage	No.of bearer tillers (per hill)	Harvest index (%)
Irrigation									
Flooded	4060a	92.18a	25.23a	145.2a	7471a	623.8a	7.66b	28.50a	54.31a
6 days interval	3817a	89.28a	24.48b	136.6ab	6956a	572.1a	12.58a	22.75b	54.83a
9 days interval	3325b	82.05b	24.40b	132.5b	6109b	485.9b	15.50a	17.75c	54.43a
Variety									
Hashemi	3680b	86.23a	23.84c	138.1a	6648b	562.4a	8.88c	24.33b	55.17ab
Ali Kazemi	4222a	78b	28.02a	136.5a	7202a	558.2a	8.55c	21.22c	58.64a
Hasani	3726b	93.77a	26.27b	138.7a	6808ab	555.2a	13.00b	20.89c	54.66ab
Binam	3309b	93.34a	20.67d	139.1a	6723b	566.6a	17.22a	25.56a	49.62b

Difference of means having similar letter in each column is not significantly different at the 5 % of probability (Duncan)

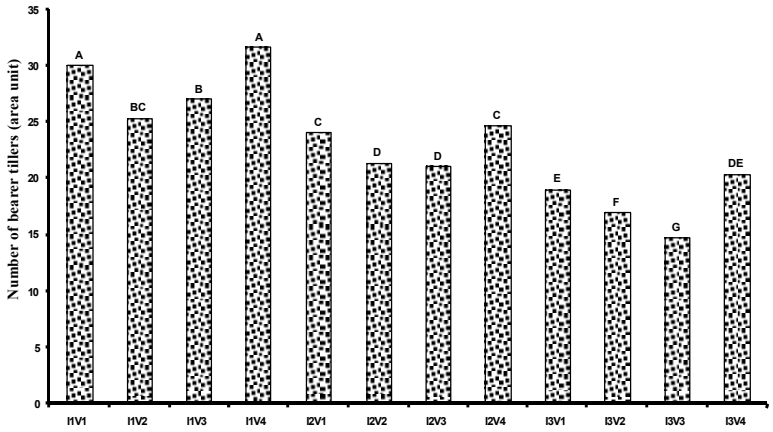

Fig. 1: Interaction effect of irrigation and variety on bearer tillers

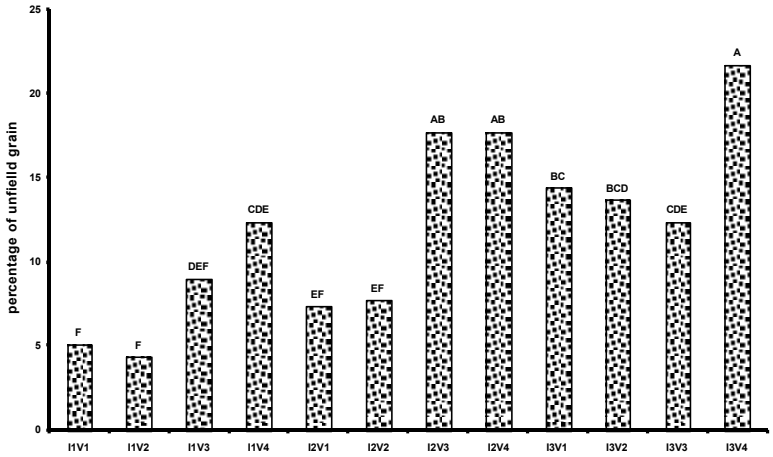

Fig. 2: Interaction effect of irrigation and variety on unfilled grain percentage

ones exposed to water deficit at certain growth stages [17]. Bhattacharjee *et al*. [18]. and De Datta [19]. Found that significant reductions in tillers and panicles numbers as well as plant height and grain yield were found when water stress was imposed at tillering stage. The maximum percentage of unfilled grain per panicle with 15.50 % was obtained from I_3 irrigation level in the other hand the lowest amount of this trait with 7.66 % was recorded from I_1 irrigation level. The similar result was obtained by Pirmoradian *et al*. [20]. Although the irrigation effect on harvest index was no significant the highest harvest index was recorded from 6 day interval irrigation.

Results of variance analysis show that (Table 2). the effect of variety levels have significant influence in 1% probability level on more traits such as grain yield, 1000 grain weight, number of bearer tillers, number of grains per panicle and percentage of unfilled grains per panicle. Also, on total biomass and harvest index was significant in 5% probability level. But don't show significant effect on plant height and amount of irrigation. Comparison of mean between varieties show that (Table 3). With regard to this table between varieties, the Ali Kazemi variety with 4222 kg/ha grain yield, 28.02 gr 1000 grain weight, 7202 kg/ha biomass and 58.64% harvest index , the highest amounts of this traits was record. Because of higher grain yield and better transfer of photosynthetic matters to grains in v_2 treatment, the highest harvest index was showed in this level. Also due to lowest grain yield in V4 level the minimum amount of harvest index was recorded. The maximum number of bearer tillers per hill, unfilled grains per panicle, plant height and amount of irrigation respectively with 25.56, 17.22%, 139.1 cm and 566.6 mm was related to Binam variety. The hasani variety with 93.77 grains per panicle obtains the highest amount of this trait and the lowest was record from Ali Kazemi variety with 78 grains per panicle. Similar result was recorded from mohammadian Roshan *et al*. [21] and Amiri *et al*. [22] With regard to variance analysis (Table 2), the interaction effect on grain yield, number of grains per panicle, 1000 grain weight, plant height, total biomass, amount of irrigation and harvest index was non significant. The number of bearer tillers and percentage of unfilled grain per panicle was significantly affected by interaction effect of irrigation and variety in 5% probability level. The highest number of bearer tillers with 31.67 tillers per hill was obtained from I_1V_4 interaction level and the lowest was recorded from I_3V_3 with 14.67 (Figure 1). The interaction level of I_3V_4 with 21.67% and I_1V_2 with 4.33% was recorded the highest and lowest percentage of unfilled grain respectively (Figure 2). Although the always flooded irrigation treatment with 4060 kg/ha was obtained the highest grain yield, but since one of the goals for conducting this project is replacement of flooding irrigation with interval irrigation in water deficiency years for cultivation, it is recommended that due to same statistically level of 6 day interval irrigation with flooding irrigation use of I_2 level for rice cultivation.

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