Determination of the Best Irrigation withholding Time in Four Rice Varieties

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Abstract: In order to determine the best Irrigation withholding time in four variety of Rice an experiment in Factorial statistical format based on complete Randomized block design was conducted. This experiment took place in national Rice Research Institute situated in Rasht township (Guilan province, north Iran) in 2008. First factor included four rice variety (v_1=Khazar variety, v_2=Sepeed Roud variety, v_3= Hassani variety, and v_4= Binaam variety). The second factor included three drought period (d_1 =One week after flowering, d_2=Two weeks after flowering, d_3= Three weeks after flowering). The Statistical analysis results almost in most measured traits was showed significant difference in 1% and 5% probability level. The highest grain yield with 5635.8 kg/ha was obtained of Sepeed Roud variety. Also the interaction effect of V_2d_3 with 6000 kg/ha was recorded the maximum grain yield. But since one of the goals for conducting this project is to determine a variety with short- water-necessity period in water deficiency years for cultivation, it is recommended that V_2d_1 level with Grain yield of 5325 Kg/ha is used even though for cultivation it has a lower yield.
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1. Introduction

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 (Khush, 2005). More than 75% of the annual rice supply comes from 79 million ha 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 3,000–5,000 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 (Bouman et al., 2002). Irrigation water is an important production factor in rice systems but is no longer available unlimited in rice-growing areas (Bindraban, 2001). In recent years; due to unprecedented growth of demand for water consumption both in domestic and industrial sectors and because of lower and lower water content in underground reservoirs due to human consumption, the volume of water for irrigation of paddy fields has significantly declined. According to climate conditions Iran lies among semi-dry to dry belts of the world, the Guilan province has a high annual rainfall but experiencing water shortage problems in resent years. Rice, a major farming product of Guilan is a hydrophilic plant. Therefore, any water shortage means a rapid decline in its growth and yield as an agricultural product. Thus; by cultivation of varieties with high yields, this experiment aims to determine their water needs and requirements. This has several benefits. First, it prohibits addition of excess water to paddy fields after rice physiological water satisfaction. Second, it reduces production expenses and determines those varieties that are drought resistant with high qualitative and quantitative yield for cultivation in years to come. The future of rice production will depend heavily on developing and adopting strategies and practices that will use water efficiently in irrigation system. Numerous studies conducted on the manipulation of depth and interval of irrigation to save on water use without any yield loss have demonstrated that continuous submergence is not essential for obtaining high rice yield (Guerra et al., 1998). One method for reduce water consumption in rice planting is irrigation withholding at optimum time and blockage of flooding field for all duration of irrigation withholding. Drought stress of irrigation withholding causing to yield decrease and stress in flowering stage cause to increases unfilled grain percentage and decreases in rice yield. According to several researches there is a 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, in the other hand moisture stress at late vegetative and reproductive stage resulted a reduction in number of panicles per plant, percentage of filled grains and 1000-grain weight. Also the reduction in grain yield was occurred when plants were exposed to water stress at panicle initiation stage, while the moisture stress at the milk ripe or dough ripe had significant effects on grain

yield (Bahattacharjee et al., 1973; De Datta et al., 1973; Krupp et al., 1971). Nour et al (1994) 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. (Boonjung and Fukai, 1996) reported that drought stress at duration of filling grains period with acceleration in ripening time, casing to growth period duration and filling grains decreased. (Abou Khalifa, 2010) with study three levels of irrigation withholding time included: (w1) Irrigation withholding at complete heading. (w2) Irrigation withholding after 10 days from complete heading. (w3) Irrigation withholding after 20 days from complete heading on two variety of rice included: H1 hybrid rice and Giza 177 inbred rice, found that the highest amounts of traits grain yield, panicle length and number of grains per panicle obtained of w3 treatment respectively with 10.59 t/ha, 18.80cm and 144 number.

This study has been conducted to find the best Irrigation withholding Time for rice cultivars rice in Guilan province, Iran.

2. Material and Methods

In order to study and determination of best irrigation withholding time in four variety of rice in paddy fields of Guilan province (north Iran), an experiment in factorial statistical format based on complete randomized block design on a land parcel of 1000 square meter area in national rice research institute situated in Rasht township (Guilan province) with 37˚12'5" N latitude and 49˚38'30" E longitude in 2008 was conducted. The soil texture was silty loam, PH:7.1,, N: 0.18%, P: 37.4 ppm, K: 29.1. First factor included four rice varieties namely Khazar (v_1), Sepeed roud (v_2), Hassani (v_3) and Binaam (v_4). The second factor included three drought periods namely; irrigation withholding one week after flowering (d_1), irrigation withholding two weeks after flowering (d_2), and irrigation withholding three weeks after flowering (d_3). Each replicate was designed from 48 experimental units and each unit with a distance of 30 cm away from one another. These units included twelve treatments and 7 lines with each line about 6 meter long and 20 cm apart from each other. According to soil analysis, amount of fertilizers N, K and P were implemented. Sowing in nursery was done April 15 and transplanted to field May 22. All options consist of Irrigation, weeding, fighting with pests and diseases up to harvest stage have been done. Characteristics to be evaluated are: Grain yield, straw yield, harvest index, panicle length, number of grains per panicle, unfilled grain percentage, number of bearer tiller, number of non bearer tiller, 1000 grain weight and height of plant. The yield and yield components were analyzed by using SAS software. The Duncan's multiple range tests was used to compare the means at %5 of significant analyzed by using SAS software. The Duncan's multiple range tests was used to compare the means at %5 of significant.

Results and Discussion:

Results of variation analysis show that (Table 2); in more studied traits, effect of variety and irrigation withholding time have a significant difference in 1 % probability level. the effect of variety on traits such as grain yield, straw yield, harvest index, panicle length, number of grains per panicle, number of bearer tillers, percentage of unfilled grain per panicle, 1000 grain weight and plant height showed a significant different in 1 % probability level. the highest amounts of traits grain yield, straw yield, harvest index and number of bearer tillers per square meter respectively with 5635.8 kg/ha, 7870.4 kg/ha, 41.7% and 323 per square meter was obtained of V_2 (Sepeed roud). The lowest grain yield, straw yield and harvest index was recorded by V_4 (Binaam) respectively with 2609.2 kg/ha, 4506.8 kg/ha and 36.6 %. The V_1 (khazar) with 164 tillers per square meter was recorded the lowest number of tillers per square meter (table 3). Yield is a factor that it's importance respectively dependence on number of tillers per square meter, panicle length, number of grains per panicle and 1000 grain weight, the seeped roud variety due to maximum number of bearer tillers per square meter obtained the highest grain yield. Whiles the khazar variety due to lowest amounts of mentioned factors showed minimum grain yield. Since the number of tillers per square meter and plant height are two affective factors on straw yield, reach to highest straw yield in v_2 treatment is due to the maximum number of tillers per square meter and high size of plant height. 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. One of the breeding rice varieties characteristics for maximum yield is more tillers production to compare with local rice varieties. This characteristic observed in sepeed roud variety. Only the khazar is alone breeding rice variety that its tillers are lowest of others, even from local varieties (mojtahedi, 1989). With attention to table 3, the V_3 (Hassani) was resulted the highest amounts of panicle length with 25.9 cm and 1000 grain weight with 31.4 g. The lowest panicle length and 1000 grain weight was recorded from V_1 (Kazar) with 23.7 cm and 23.8 g respectively. The grains distance on panicle in Hassani variety genetically is high. As a result the longest panicle was showed in this treatment. Due to less grain in panicle of Hassani variety, the

photosynthetic matters division per each grain becomes more and as a result 1000 grain weight was increased. The maximum number of grains per panicle with 111 was recorded from v_1 (Khazar) and the minimum with 89 was recorded from v_3 (Hassani). The highest percentage of unfilled grains per panicle with 27.3 % and the lowest percentage of unfilled grains per panicle with 14.4 % respectively were obtained of v_1 and v_3. It seems that high percentage of unfilled grains per panicle in khazar variety is due to, first; for genetically problems in this variety and second; further number of grains in this variety. As a result the proportion of unfilled grains to filled grains in this level is high. In the Hassani variety due to less number of grains, materials transition well division to all grains. In the other side, the proportion of unfilled grains to filled grains in this treatment because of less grain is down. The tallest plant height was recorded from v_4 (Binaam) with 146 cm and the shortest with 99 cm was recorded from v_2 (Sepeed roud). One of the clear characteristics of local rice varieties are that's taller plant height which this trait was showed in Binaam variety. In the other hand plant height usually is shorter in the breeding varieties.

Rice grain filling and ripening are affected by many environmental factors, including water, temperature, radiation, and soil nutritional conditions (Yoshida, 1981). With attention to table 2, the effect of irrigation withholding time on traits straw yield and 1000 grain weight in 1 % probability level and on percentage of unfilled grains per panicle in 5 % probability level showed a significant difference, And on other traits was non significance. Comparison of Mean between irrigation withholding times show that (Table 3), The straw yield, harvest index, panicle length, percentage of unfilled grains per panicle and plant height was recorded from d_1 (irrigation withholding one week after flowering) respectively with 6310kg/ha, 38.9 %, 25.3 cm, 19.9 % and 127.8 cm. d_3 treatment (irrigation withholding three weeks after flowering) the lowest amounts of harvest index, percentage of unfilled grains per panicle and plant height respectively with 38.6 %, 17.5 % and 127.5 cm give resulted. The minimum amounts of straw yield and panicle length respectively with 5808 kg/ha and 25.1 cm was recorded from d_2 (irrigation withholding two weeks after flowering). In the first 10 day after flowering, cell division and expansion in the endosperm of most grains ends and starch deposition begins (Hoshikawa, 1967; Egli, 1998). With soon irrigation withholding in d_1 level due to decrease of photosynthesis process and photosynthetic matters production, transition of this matters to grains reduced and causing to percentage of unfilled grains in this level increased. Whereas in d_3 level this case wasn't showed. Vegetative growth in rice with flowering start become end, therefore not added anymore to plant height and tillering process come to maximum stage. Thus with irrigation withholding one week after flowering (d_1) since that production of generative organs decreased, the materials resulting of photosynthesis, more transition to vegetative organs and in addition to tillers preservation, leaf area index increased, and as a result the maximum straw yield was obtained. But in d_2 treatment (irrigation withholding two weeks after flowering) since that more generative organs in compare with d_1 level was produced, further photosynthetic matters give to grains and in harvest time less straw yield was showed. The highest 1000 grain weight with 27.1 g was obtained of d_3. In the other hand the lowest 1000 grain weight was found from d_2 with 26.3 g and d_1 with 25.6. The 1000 grain weight is one of factors in plant that it is less under influences by environment and more is under genetically factors. Water is one of the important soil and environmental factors that have a major influence on 1000 grain weight. If water exists sufficient and complete and in all stages of plant growth under bush, nutrients transition to plant and grains filling was better carried. As a result, 1000 grain weight increased. This case was found from d_3 level. The maximum number of grains per panicle with 99 was found from d_2 and the minimum amount of this trait with 95 grain per panicle was found from d_1.

Results of variation analysis show that (Table 2), the interaction effect of variety and irrigation withholding time on traits grain yield and straw yield in 1% probability level and on percentage of unfilled grains per panicle in 5% probability level have significant different, And on other traits was non significance. The highest grain yield with 6000 kg/ha was recorded from v_2d_3 and the lowest one with 2307.5 was in v_4d_2 (Table 4). Since that the sepeed roud variety genetically have high yield factors in the other hand, irrigation withholding three weeks after flowering give sufficient time to plant for suitable photosynthesis and high photosynthetic materials production casing to all flowers inoculation and transition of materials to grains was high then grains materials receive to maximum amounts that casing to high yield in v_2d_3 level compare with v_4d_2. In v_4d_2 treatment due to lower yield factors and also with irrigation withholding two weeks after flowering, haven't sufficient time for transition of photosynthetic matters to all grains and as a result yield was decreased. The maximum yield of straw with 8315 kg/ha was found from v_2d_3 and the minimum of this trait was found from v_4d_2 with 4144 kg/ha (Table 4). Water existence under rice bush is one of the factors that casing to better vegetative growth in this plant. As a result in sepeed roud variety because of more tiller

and partly taller plant height and also leaf area duration was increased and the highest straw yield obtained of v_2d_3 level. But in v_4d_2 in addition to low tiller in Binnan variety, irrigation withholding two weeks after flowering in this variety casing to increases of generative organs, As a result more photosynthetic matters send to generative organs and straw yield in harvest time at this level decreased. V_1d_1 treatment produced the highest percentage of unfilled grains per panicle with 30.1 % and the lowest one with 12.2 % was found from v_3d_1 (Table 4). Irrigation withholding one week after flowering in khazar variety (v_1d_1) due to high number of grains per panicle in this variety, prevent from filling all grains. As a result percentage of unfilled grains in this level was increased. But in v_3d_1 level (Hassani variety along with irrigation withholding one week after flowering) water withholding have low influence on percentage of unfilled grains because of sufficient photosynthetic matters production for filling the grains per panicle. Although the v_2d_3 treatment with 6000 kg/ha was obtained the highest grain yield, but since one of the goals for conducting this project is to determine a variety with short- water- necessity period in water deficiency years for cultivation, it is recommended that v_2d_1 level with Grain yield of 5325 Kg/ha be used even though for cultivation it has a lower yield.

Table 2: the variance analysis of studied traits

S.O.V	df	grain yield (kg/ha)	straw yield (kg/ha)	Harvest index (%)	panicle length (cm)	The number of grains per panicle	The number of bearer tillers	percentage of unfilled grains	1000 grain weight (g)	Plant height (cm)
Block	3	39547.2223	59266.25	3.4858	0.027	198.92	1742.25	24.06	0.48	147.74**
Effect of variety	3	18989497.22**	25524936.25**	65.6612**	12.59**	1132.19**	53378.73**	402.48**	147.67**	5364.53**
Effect of irrigation withholding time	2	295581.25	1320700.725**	0.40305	0.195	74.94	516.51	24.37*	8.83**	0.34
Interaction effect	6	1350570.138**	1623841.258**	6.7308	1.92	140.88	865.87	17.25*	0.31	21.09
Error	33	125879.0404	83075.136	4.1092	0.89	73.96	1234.25	5.31	0.39	32.84
CV(%)		8.96	4.69	5.23	3.74	8.83	1234.25	12.25	2.37	4.48

** and * respectively significant in 1% and 5% area

Table 3: Yield and yield components of four rice varieties under three irrigation withholding time in north of Iran

treatment	grain yield (kg/ha)	straw yield (kg/ha)	Harvest index (%)	panicle length (cm)	The number of grain per panicle	The number of bearer tillers	percentage of unfilled grains	1000 grain weight (g)	Plant height (cm)
variety									
V_1	3977.5b	6688.3ab	37.1b	23.7b	111a	164c	27.3a	23.8ab	123ab
V_2	5635.8a	7870.4a	41.7a	25.2ab	95a	323a	18.1ab	24.1ab	99b
V_3	3622.5b	5492.9bc	39.6a	25.9a	89b	210ab	14.4b	31.4a	143a
V_4	2609.2c	4506.8c	36.6ab	25.7a	92a	222ab	15.4b	26.1a	146a
Irrigation withholding time									
d_1	4043.8a	6310a	38.9a	25.3a	95a	235a	19.9a	25.6b	127.8a
d_2	4035.6a	5808ab	38.8a	25.1a	99a	213a	19.2a	26.3b	127.8a
d_3	3804.4a	6301a	38.6a	25.2a	98a	240a	17.5ab	27.1a	127.5a

Within each column, treatments that carry the same superscript letter are not significantly different at P<0.05

Table 4: the interaction effects of varieties and irrigation withholding times yield and yield components

treatment	grain yield(kg/ha)	straw yield(kg/ha)	percentage of unfilled grains
V_1d_1	4492.5b	7293b	30.1a
V_1d_2	3102.5cde	5523cd	25.4a
V_1d_3	4337.5b	7250b	26.2a
V_2d_1	5325a	7763ab	15.9bcd
V_2d_2	5582.5a	7534b	19.6b
V_2d_3	6000a	8315a	18.3bc
V_3d_1	3412.5c	5275de	15.8bcd
V_3d_2	4225b	6030c	16.4bdc
V_3d_3	3230cd	5174de	12.2d
V_4d_1	2945cde	4910ef	17.2bc
V_4d_2	2307.5e	4144g	15.3bcd
V_4d_3	2575de	4467fg	13.5cd

Within each column, treatments that carry the same superscript letter are not significantly different at P<0.05

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