The Effect of Water Saving Irrigation and Nitrogen Fertilizer on Rice Production in Paddy Fields of Iran

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Abstract—**Rice production in Iran needs to increase to feed a growing population whereas water for irrigation is getting scarce. There are 230000 ha paddy fields in Guilan province in north of Iran. About 73% of paddy fields irrigated by Sepeedrood dam. Shortage of water for rice production will be a problem in near future. In order to investigate the best irrigation regime and nitrogen level an experiment was conducted in split plot based on completely randomized block design with 3 replications at the rice research institute of Iran in 2008. Four levels of nitrogen (N_1= 0, N_2 = 90, N_3 = 120 and N_4 = 150 kg ha-1) were splited on 4 different irrigation managements (I_1= continuous submergence (CS), I_2 = 5, I_3 = 8 and I_4 = 11 days interval). The results clearly indicate that nitrogen levels and irrigation management in most of studied characteristics had very significant differences. Not only grain yield was statistically the same under CS and 8 days interval but also water consumption decreased 18%. Thus, concluded that water limited irrigation can lead to reduce water consumption in paddy fields and minimum 150 million m3 water of Sepeedrood dam saved annually.**

Index Terms—**Limited irrigation, grain yield, sepeedrood dam, paddy field, Iran.**

I INTRODUCTION

The construction of Sepeedrood dam was started in 1956 and ended in 1961. Operation of the dam began in 1962. Initial volume of dam was a billion and 765 million cubic meters. At present time there are 230000 ha paddy fields in north of Iran and 73% of paddy fields irrigated by Sepeedrood dam, see Fig. 1.

Fig. 1. A picture of Sepeedrood dam.

In a research compared continuous submerge method and interval irrigation methods in China and the Philippines through different nitrogen levels, water saving in interval irrigation methods was 18-15 % higher than submerge method, they also found the water productivity amount in the Philippines and China, 0.73- 1.48 and 0.5 – 1.3 kg yield for $1m^3$ of input water [1].

Conventional water management in lowland rice aims at keeping the fields continuously submerged. Water inputs can be reduced and water productivity increased by introducing periods of none submerged conditions of several days [2].

It reported that consumption of water in alternate irrigation compare to continuous irrigation reduced 92mm [3].

Reported that over 80% of freshwater resources in Asia used for irrigation and about half the amount consumed for rice [4].

Decreasing water availability for agriculture threatens the productivity of the irrigated rice ecosystem and ways must be sought to save water and increase the water productivity of rice [5].

Nitrogen, among nutrients, is the most important and the most limiting element in rice growth [6].

After water stress, nutrients are recognized as the second most limiting factor in many rain fed lowlands of Asia. Low soil fertility and the limited use of fertilizers contribute considerably to the low productivity of rain fed rice-based systems [7].

10 percentage reductions in water consumption of rice irrigation system save 150 million cubic meters of water in the world [8].

Because rice receives more irrigation water than other grain crops, water saving irrigation technologies for rice is seen as a key component in any strategy to deal with water scarcity [9] , [10].

Worldwide, freshwater availability for irrigation is decreasing because of Increasing competition from urban and industrial development, degrading Irrigation infra-structure and degrading water quality [11].

Water resources are declining rapidly due to the competition between water users [12], [13].

Although in recent years the growth of consumption rate of fertilizers in Iran has increased sharply and a large amount of fertilizer in addition to domestic productions has been imported from abroad nevertheless unfortunately during this period not only yield of crops has not increased in accordance with the consumption growth rate of fertilizers but also yield in hectare of crops has declined to many reasons such as water shortage, different irrigation methods, lack of scientific knowledge by farmers and method of fertilizer usage. It is worth mentioning utilization especially usage of nitrogen fertilizer is very significant factor in growth of rice.

II MATERIALS AND METHODS

In order to investigating the effect of different regimes of

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irrigation and nitrogen fertilizer on yield of hybrid rice an experiment was conducted at rice research institute of Iran during crop season 2008. experiment was arranged in split plot based on completely randomized block design with 3 replications in which water regimes were main factor included continuous submergence and alternately submergence (irrigation intervals of 5, 8 and 11days) and nitrogen fertilizer levels were sub factor included 0, 90, 120 and 150 kg/ha. For all treatments, drainage basins have been mounted from which waste water belonging to each replicate treatments were exited. Each experimental plot had 15 lines with five meter in length and Transplanting spacing was 25 x 25 cm with one seedling per hill.

The nursery construction took place in April and transplanting to the field happened in early may. In order to use fertilizer, based on the soil test and instructions of the technicians the rice investigation organization the amount of P and K was calculated and applied to every plot. The amount of irrigation water applied was monitored at each plot from transplanting till maturity, by using flow meters installed in the irrigation pipes. Pests, diseases, and Weeds were intensively controlled to avoid yield loss. Yield was measured with 6m^2 harvesting of every plot. The yield and yield components were analyzed by using MSTATC software. The Duncan's multiple range tests used to compare the means at 5% of significant.

TABLE I: ANALYSIS OF GRAIN YIELD, AMOUNT OF IRRIGATION AND WUE.

S.O.V	df	Yield	Biomass	Harvest index	amount of irrigation	Water use efficiency
I	3	12452331**	5364477*	334**	33888.8**	0.374**
N	3	11838173**	44436179**	ns	580.5 ns	0.669**
I*N	9	1211276*	4554914*	ns	4127.3**	0.125**
CV (%)		10.59	10.93	9.48	6.25	9.98

** and * respectively significant in 1% and 5%; ns: no significant

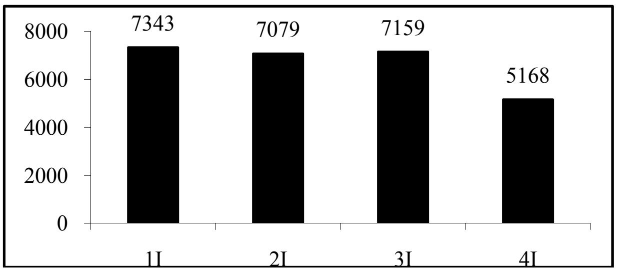

Fig. 2. The effect of irrigation regime on grain yield.

III RESULTS AND DISCUSSION

The effect of irrigation regime on grain yield was significant (TABLE I).

I_1 to I_4 produced 7342, 7079, 7159 and 5168 kg/ha respectively.I_1, I_2 and I_3 were in a class and produce same grain yield but in I_4 grain yield decreased 28% because there was drought stress in 11 days irrigation intervals, see Fig. 2.

Interaction of irrigation regime and nitrogen level on grain yield was significant (TABLE I). I_1N_3, I_3N_4, I_1N_4, I_2N_3, I_3N_3 and I_2N_4 produced same grain yield with 8912,8284,8247,7730,7679 and 7542 kg/ha respectively and I4NI had minimum value with 4804 kg/ha, see Fig. 4.

The effect of nitrogen level on grain yield was significant (TABLE I). N_1 to N_4 produced 5303, 6628, 7399 and 7419 kg/ha respectively. N_4 and N_3 were in a class and produced same grain yield but N_1 had minimum value, see Fig. 3.

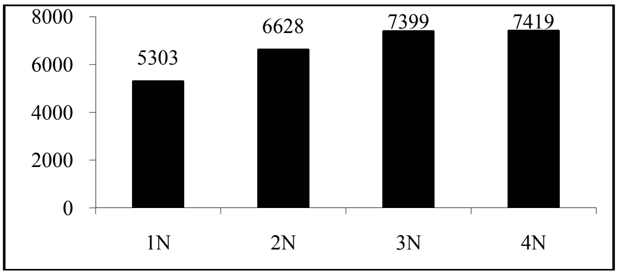

Fig. 3. The effect of nitrogen level on grain yield.

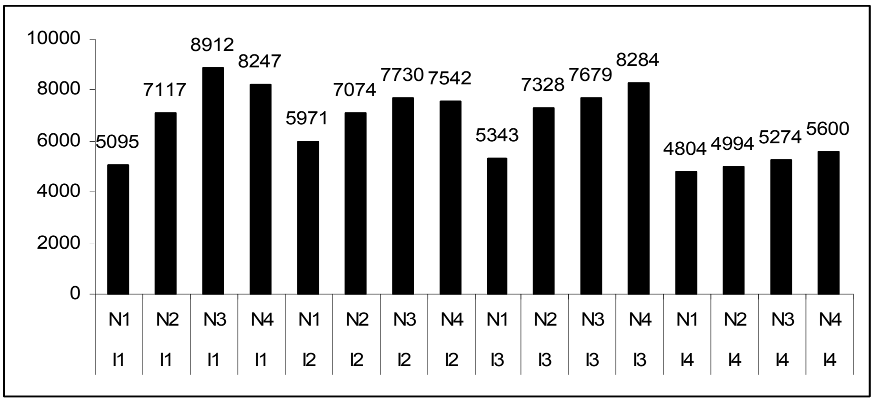

Fig. 4. The Interaction of irrigation regime and nitrogen level on grain yield.

The effect of irrigation regime on amount of irrigation was significant (TABLE I). I_1 to I_4 produced 5190, 4636, 4275 and 3950 m3 respectively, see Fig. 5.

Amount of irrigation in 8 days interval compare to continuous submergence decreased 18%.Reported that ASNS can reduce water use up to 15% without affecting yield when the shallow groundwater stays within about 0–30 cm [1].

The effect of nitrogen level on amount of irrigation was no significant (TABLE I).

Interaction of irrigation regime and nitrogen level on amount of irrigation was significant (TABLE). I_1N_4 and I_1N_1 consumed maximum water with 5480 and 5440 m3 and I_3N_4, I_3N_3 and I_4N_1 with 3590,3580 and 3550 m3 consumed minimum water, see Fig. 6.

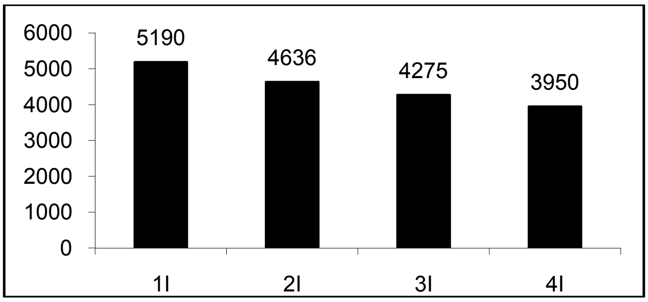

Fig. 5. The effect of irrigation regime on amount of irrigation.

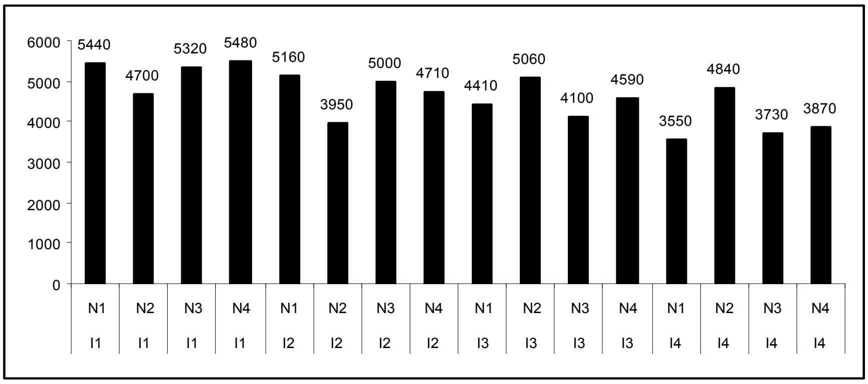

Fig. 6. The Interaction of irrigation regime and nitrogen level on amount of irrigation.

The effect of irrigation regime on water use efficiency was significant (TABLE I).WUE in I_1 to I_4 were 1.44, 1.53, 1.68 and 1.33 kg/m3 respectively. Irrigation interval 8 days had maximum mean value but 11days interval had minimum mean value , see Fig. 7.

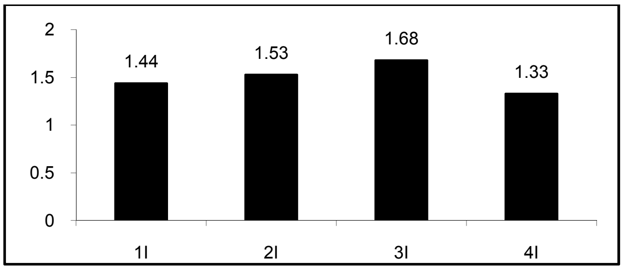

Fig. 7. The effect of irrigation regime on water use efficiency.

The effect of nitrogen level on water use efficiency was significant (TABLE I).WUE in N_1 to N_4 were 1.17, 1.48, 1.70 and 1.74 kg/m3 respectively. Consumption of 150 and 120 kg/ha nitrogen fertilizer had maximum mean value in WUE but NI had minimum mean value, see Fig. 8.

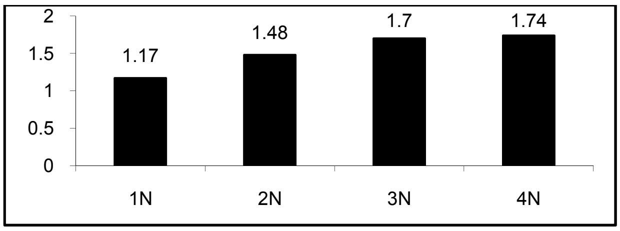

Fig. 8. The effect of nitrogen level on water use efficiency.

Interaction of irrigation regime and nitrogen level on water use efficiency was significant (TABLE I). WUE in I_3N_3 and I_3N_4 were maximum with 1.87 and 1.85 kg/m3 and I_1N_1 had minimum mean value with 0.94, see Fig. 9.

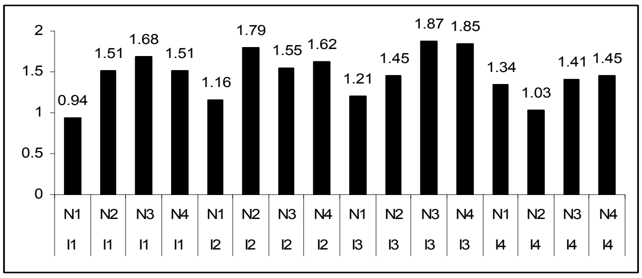

Fig. 9. The Interaction of irrigation regime and nitrogen level on water use efficiency.

The effect of irrigation regime on biomass was significant (TABLE I).

I_1 to I_4 produced 14273, 13657, 13707 and 12364 kg/ha respectively.I_1, I_2 and I_3 were in a class and produce same biomass but in I_4 biomass decreased because there was drought stress in 11days irrigation intervals, see Fig. 10.

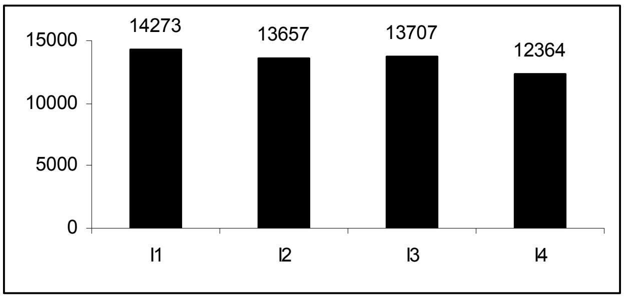

Fig. 10. The effect of irrigation regime on biomass.

The effect of nitrogen level on biomass was significant (TABLE I). N_1 to N_4 produced 10615, 13638, 14320 and 15428 kg/ha respectively. N_4 and N_3 were in a class and produced same biomass but N_1 had minimum value, see Fig 11.

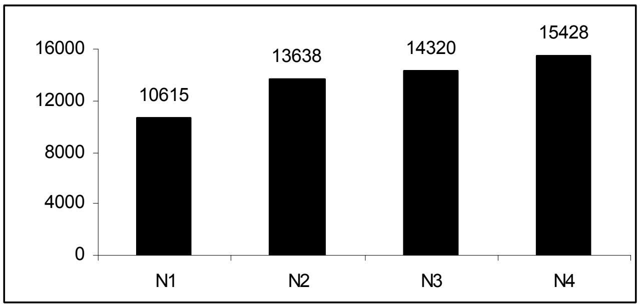

Fig. 11. The effect of nitrogen level on biomass.

Interaction of irrigation regime and nitrogen level on biomass was significant (TABLE I). I_1N_4, I_2N_4 and I_3N_4, produced same biomass with 15832, 15520 and 15557 kg/ha respectively and I4NI had minimum value with 9846 kg/ha, see Fig. 12.

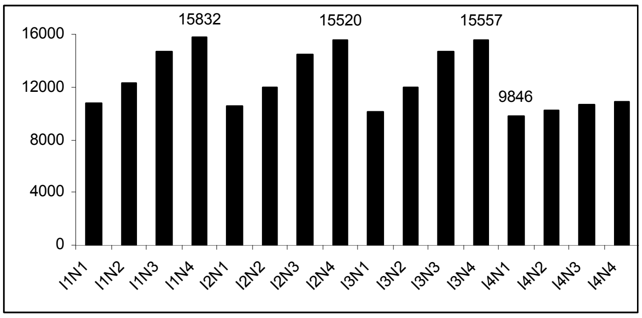

Fig. 12. The Interaction of irrigation regime and nitrogen level on biomass.

The effect of irrigation regime on harvest index was significant (TABLE I).

I_1 to I_4 produced 51, 52, 52 and 42 percentage respectively.I_1, I_2 and I_3 were in a class but in I_4 harvest index decreased because there was drought stress in 11 days irrigation intervals, see Fig. 13.

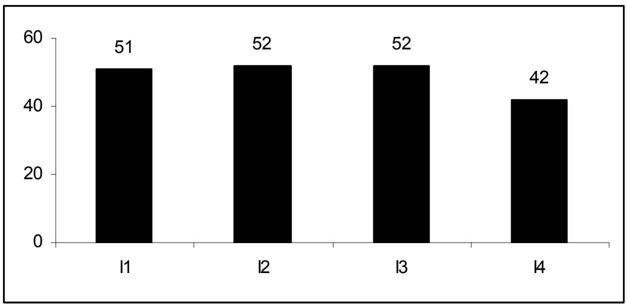

Fig. 13. The effect of irrigation regime on harvest index.

The effect of nitrogen level and Interaction of irrigation regime and nitrogen level on harvest index was no significant (TABLE I).

We can conclude that continuous submergence irrigation is not essential for rice production in paddy fields of north of Iran and we advise irrigation interval 8 days without grain yield decreased.

As we showed Irrigation interval 8 days (I_3) compare to continuous submergence irrigation (I_1) saved 920 m3 in a hectare, see Fig. 5. there are 230000 ha paddy fields in north of Iran and 73% of paddy fields irrigated by sepeedrood dam therefore minimum 150 million m^3 water of sepeedrood dam saved annually.

Water saving irrigation can lead to reduce water consumption in paddy fields and conservation of natural water resources of which is important goal of achieving sustainable development in agriculture**.**

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