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Water Use Efficiency, Irrigation Management and Nitrogen Utilization in Rice Production in the North of Iran

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Abstract

Iran with nearly 165 million hectare of land area and amount of rainfall equal to 300mm in 67% of its territorial land, is considered as a semi-dry region in the world. Rice production in Iran needs to be increased to feed a growing population, whereas water for irrigation is getting scarce. One way to decrease water consumption in paddy field is the change of irrigation regime and replacement of continuous submergence to alternate submergence. In order to investigate the effect of different regimes of irrigation and nitrogen fertilizer on yield of hybrid rice, an experiment was conducted at the Rice Research Institute of Iran during crop season 2008. The 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. Grain yield,water use efficiency,relative water content,total nitrogen,grain nitrogen and nitrogen harvest index were statistically the same under continuous submergence and irrigation interval of 5 and 8 days and were lowest in 11- day interval.total nitrogen,grain nitrogen and nitrogen harvest index decreased with the increment of nitrogen.we concluded that 8- day interval could reduce water consumption in paddy fields in the North of Iran.

Keywords: Continuous Submergence, Nitrogen, Water Use Efficiency, Nitrogen Harvest Index

1. Introduction

Rice is the most important staple in Asia, providing on average, 32% of total calorie uptake. About 75% of

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the global rice volume is produced in the irrigated lowlands (MacLean et al., 2002). Iran, with nearly 165 million hectare of land area and amount of rainfall equal to 300mm in 67% of its territorial land, is considered as a semi-dry region in the world. 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 (Guerra et al., 1998).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 no submerged conditions of several days throughout the growing season until cracks are formed through the plough sole (Bouman and Tuong, 2001). It is worth mentioning utilization, especially, usage of nitrogen fertilizer is very significant factor in the growth of rice. When nitrogen fertilizer is used in tillering, paddy yield increased (Bacon, 1989).Biomass and yield did not significantly differ between ASNS and CS, but water productivity was significantly higher under ASNS than under CS. Grain yields were 4.1–5.0 t ha^{-1} with 0 kg N ha^{-1} and 6.8–9.2 t ha^{-1} with 180 kg N ha^{-1} (Belder et al., 2004). Rice grain yield was recorded highest in case the N application ranged between 90-250 kg per ha (Bali et al., 1995). Michiel *et al*., (2010) reported that grain yield increased when nitrogen fertilizer increased from zero to 300 kg ha^{-1}. Quanbao *et al*., (2007) reported that nitrogen harvest index decreased when the consumption of nitrogen fertilizer increased from zero to 300 kg ha^{-1}.Jongdee *et al*., (2002) reported that Water restrictions during flowering increased spikelet sterility and grain yield was reduced. Be conjectured that high leaf water potential the effects of water shortages on spikelet sterility reduced. Matsuo (1995) reported that leaf water content had significant effect on photosynthesis so that when leaf water content reduced the amount of photosynthesis decreased.

2. Materials and methods

The experiment was arranged in split plot based on a completely randomized block design with 3 replications, in which water regimes were the main factors 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. Nitrogen fertilizer was splited in three important growth stages according to transplanting (50%), tillering (25%) and booting (25%). For all treatments, drainage basins have been mounted on some points, from which waste water belonging to each replicate treatment was released. Each experimental plot had 15 lines with five meters in length and the planting method was considered to be 25×25 cm. The nursery construction took place in April and transplanting to the field happened in early May. The amount of irrigation water applied was monitored at each plot from transplanting to the maturity, by using flow meters installed in the irrigation pipes. Yield was measured with $6m^2$ harvesting of every plot. Definition of relative parameters: Nitrogen harvest index (NHI) = grain N uptake / total plant N uptake × 100

Relative water content= fresh weight- dry weight / saturate weight- dry weight ×100

Water use efficiency= grain yield / water used

3. Results and discussion

The effect of irrigation regimes on total nitrogen were significant(table 1).I1, I2 ,I3 and I4 with 145, 135 ,136 and 113 kg ha^{-1} had the highest and lowest average, respectively. Irrigation interval at 5, 8 days and Continuous submergence produced the same total nitrogen but in irrigation interval at 11 days decreased (table 2).The effects of nitrogen levels on the total nitrogen were significant. N4, N3, N2 and N1 with 173, 150,125 and 85 kg ha^{-1} have the highest and lowest average, respectively (table 2). The interaction of irrigation and nitrogen on total nitrogen was significant.I1N4 and I4N1 with 190 and 60 kg ha^{-1} had the highest and lowest average, respectively (Table 3).Lower total nitrogen in 11- day intervals was due to dry soil and ammonia sublimation and more casualties by denitrification after irrigation.Rice hybrid compared