Effect of Shallow Water Management on Growth and Yield of Rice

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Rice, the most staple food crop of the world has been cultivated about 157 million hectares of land (FAO, 2008). Irrigated rice ecosystem contributes 75% of global rice production. Growing rice using conventional irrigation (continuous flooding) requires a tremendous amount of water. The high water demand of irrigated lowland rice mainly arises from keeping the field continuously submerged. There is decreasing trend in water resource availability year by year due to various reasons. The shortage of water resources for rice production has now become an important issue worldwide. It indicates that a reduction in water input without compromising yield and optimization of scarce water in rice production are required. Shallow water management can be one of the alternatives to use water efficiently, achieve good yield and minimize the methane emission from the rice fields. However, information about growth and yield of rice grown under shallow water management are limited. Therefore, this study was conducted to investigate whether shallow water could influence plant growth and yield of irrigated rice under field conditions.

Materials and Methods

A field experiment was conducted at Yamagata University Experimental Farm, Takasaka, Tsuruoka, Japan in 2009. Two plant spacings – [30*30cm (wider) and 30*15cm (narrow)] and water managements shallow and conventional were practiced .The four treatments were set up as conventional wider (CW), conventional narrow (CN), shallow wider (SW) and shallow narrow (SN). In conventional method, five to six cm water ponding depth was maintained throughout the growing period except for mid season drainage and totally drained out 15 days before the harvest. For shallow water ,ponding water depth of 1-2cm with wetting and drying was done till panicle initiation stage and then 1-2 cm was maintained and totally drained out 30 days before harvesting. Transplanting of 28 days old (3.5leaf age) seedlings of Sasanishiki variety was done on12th May and harvested on 1stOctober 2009. The total dry matter & nitrogen (N) uptake by plant was measured at 37, 44, 51, 58, 65, 77, 91 and 122 days after transplanting (DAT). The yield was estimated by both yield components (10hills) and yield examination (50hills).This preliminary experiment was carried without replication.

Results and Discussion

Comparing with water management practices, aboveground biomass was higher in shallow than conventional. Interestingly, wider spacing of shallow water management showed almost same as to conventional narrow spacing (fig.1).

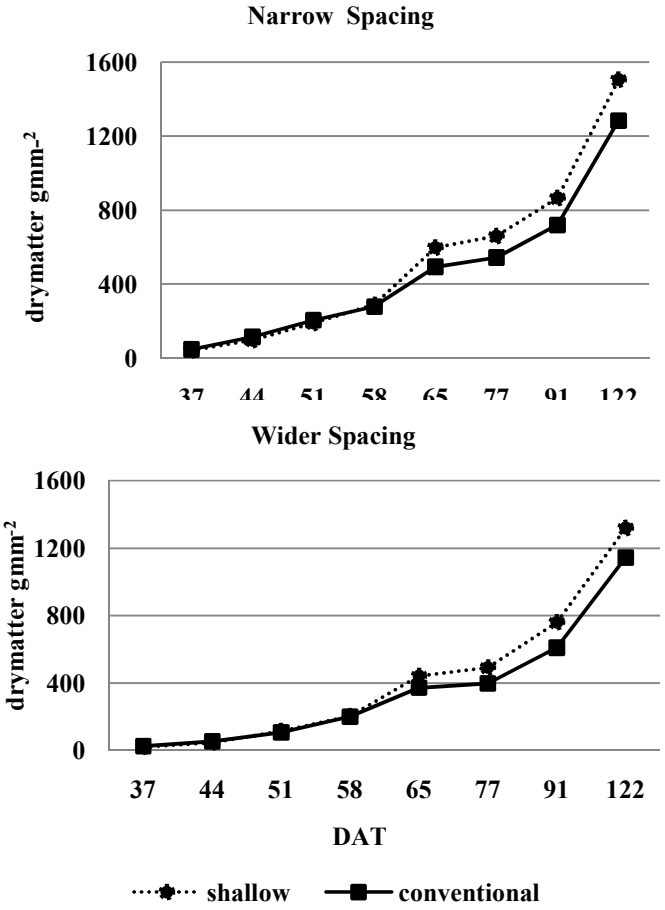

Fig 1 Aboveground biomass of rice plants as affected by different water management in two plant spacings.

The N uptake by plant was higher in shallow water management treatments starting from the mid tillering stage (fig. 2).The uptake of N was found higher in shallow water than conventional water management, irrespective of plant spacing. The wetting and drying during vegetative period may have favored the better root activities and enhancing for N uptake by the plant.

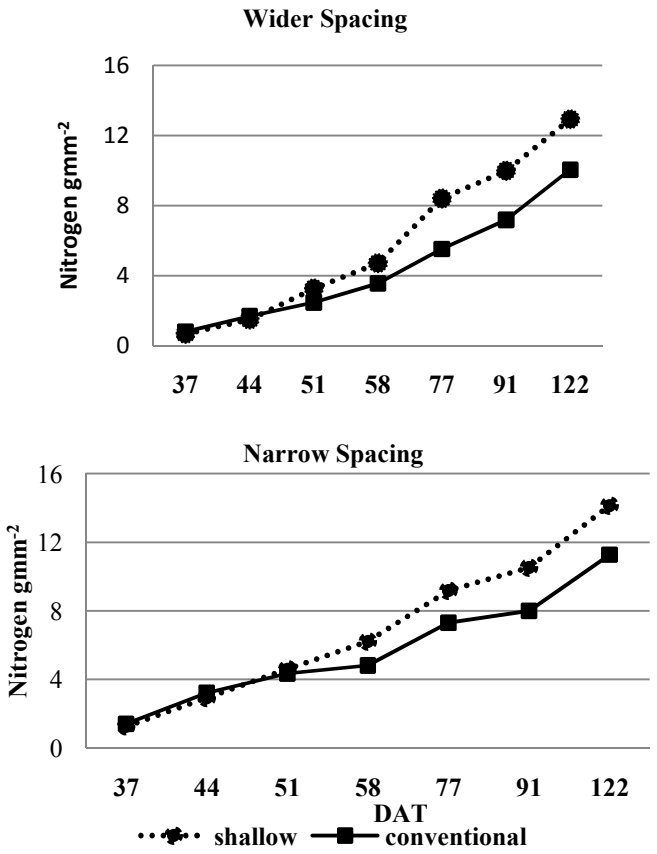

Fig 2 Nitrogen uptake by rice plant in different water management in two spacing.

Paddy and brown rice yield were found higher in shallow water management practices on yield component and yield examination basis than conventional (table 1). The panicle length was highest 18.5cm in SW and lowest was measured in CN 16.5cm.It was 17.8 cm in CW and 16.9 cm in SN. Although there was 24% less panicles in SW, the grains m^{-2} and yield were only 2% less than CN The SN had 11%,16% more panicles and grains m^{-2} which resulted about 13% more yield as compared to CN. The higher yield in shallow water management was mainly due to panicle numbers in narrow spacing whereas both panicle numbers and no of grains per panicle contributed in wider spacing. The results indicated that the benefit of shallow water management with wetting and drying during vegetative growth period over continuously flooding.

Conclusion

The preliminary experiment which was carried out with no replication showed the following trend; the N uptake by the rice plant which is considered as one of the most influencing factors of tillering and photosynthesis was higher in shallow than conventional water management. Higher number of tillers (panicles) as well as the panicle length and number of grains $panicle^{-1}$ also contributed to higher yield in shallow water irrigation. Good yield can be obtained by reducing the considerable amount of irrigation water for rice.

Table 1: Yield and yield components in different water management practices.

Treatments	No of Paniclesm^{-2}	Grains per Panicle	Total Grainsm^{-2}	Filled grain%	1000 grain weight (14% moisture)		Yield (kgha^{-1})	
					Paddy	Brown rice	Yield Components	Yield Examination
							Brown Rice	Brown Rice
Conventional Wider	326	74	24001	94	28.82	23.76	5360	4987
Shallow Wider	367	87	32417	90	28.65	23.54	6792	6385
Conventional Narrow	484	68	33119	91	28.11	23.08	6868	6599
Shallow Narrow	539	71	38516	87	28.33	23.51	7786	7528