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Short Communication

RESPONSE OF RICE AND WEEDS TO EARLY SUBMERGENCE IN DIRECT SEEDED RICE IN SRI LANKA

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INTRODUCTION

Weeds are the major biological constraint to successful rice cultivation and high weed density causes high risk of yield loss in direct-seeded rice (DSR) (Herath *et al.*, 1998; Rao *et al.*, 2007). Herbicides are intensively used to reduce the high weed pressure (Rao*et al.*, 2007; Weerakoon *et al.*, 2011) but dependency on herbicides increases the risk of development of herbicide resistance in weeds (Rao *et al.*, 2007).Poor weed control efficacy of herbicide dominant system is accompanied with the incorrect use, lack of requisite knowledge and skill to use herbicides in Sri Lanka. This has increased interest in the use of alternative weed management approaches to achieve successful weed control in DSR system. Appropriate water management at crop establishment plays a key role in weed management in DSR (Rao *et al.*, 2007).Although flooding is known as a viable tool for weed management in rice, it aggravates the poor crop establishment. One viable strategy to avoid conflict among crop stand establishment and early water management in DSR is to use of submergence tolerant rice varieties. Screening of submergence tolerant rice varieties could offer an opportunity for using them as a component of integrated weed management strategy in DSR. Therefore, this study was conducted to evaluate the submergence tolerant ability and yield potential of popular rice varieties for use in integrated weed management strategies in DSR and to determine weed control percentage under submerged condition.

MATERIALS AND METHODS

Field experiment was conducted in Rice Research Station, Ambalantota during 2015/16 *Maha* season. The experiment was established in a split-plot design with three replicates. The main plot included two level of submergence depth (0 cm and 5 cm) and sub plot (3m x 3m) withfifteen rice varieties; At 307, At 308, At 354, At 362, Bg 300, Bg 94/1, Bg 379/2, Bg 4[illegible], H4, Bg 352, Bg 360, Bw 367, Bw 372, Ld 368 and Ld

371.Seeds soaked for 48 hours and incubated for 24 hours were sown either to plots with puddled saturated soil without standing water or on to plots with 5 cm water depth and the water depth was maintained for 21 days (submergence treatment). Two quadrates of $0.25m^2$ size were placed at random in each plot to determine rice seedling density, weed density and biomass content at 4 weeks after sowing (WAS) and at 6WAS. Weeds were counted and classified into species and grouped into grasses, broad leaves and sedges and oven dried to determine weed biomass. Grain yield was measured from an area of 9 m^2 per plot.

Data were subjected to analysis of variance (ANOVA) using STAR for Windows version 2.1 (IRRI, 2014). Differences among treatments were compared using least significant differences (LSD). Relationships between grain yield (t/ha) and different attributes were determined using linear regression.

RESULTS AND DISCUSSION

Weed density and biomass

Grass and sedge weed densities (Figure 1A) and biomass (Figure 1B) were significantly lower in the submerged treatment compared to the saturated treatment at 6 WAS. Biomass reduction of grasses and sedges under submerged conditions at 6 WAS were 84% and 72%, respectively. But, broad leaf weed density and biomass were significantly higher under submerged condition. The reduction of grasses and sedge density might be due to suppressed germination ability under anaerobic conditions. Results showed that submergence to 5 cm flooding is effective to control grasses and emerging problematic sedgessuch as *Cyperus difformis* and *Cyperus irri.* Venkataraman and Gopalan (2005) showed that, continuous submergence to 5 cm flooding minimizes the grass weed density in rice field. Further, David (1992) reported that 8 cm water depth declined many grass and sedge weeds densities and 16 cm water depth totally reduced the emergence of above weed groups. Results revealed that saturated condition has favoured the germination and growth of three groups of weeds. Meanwhile submerged condition has significantly reduced the density and growth of grasses and sedges. Therefore, submergence could be suggested as the eco- friendly weed control method which can be included in the integrated weed management package to enhance the weed management in DSR while reducing herbicide dependency.

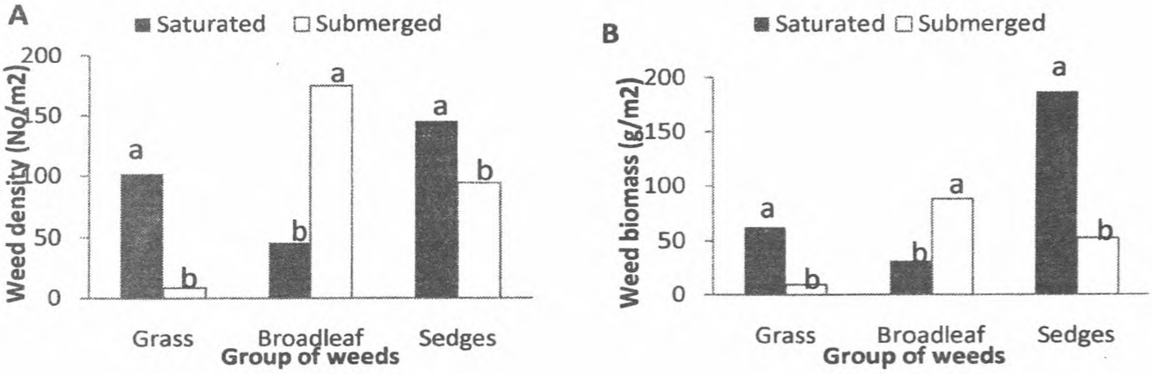

Figure.1: Variation of grasses, broad leaf and sedges density (A) and biomass (B) under submerged and saturated condition across varieties at 6 WAS. Different letters indicate significant differences ($P< 0.05$) according to $LSD_{.05}$.

Rice seedling density and yield: Seedling count of all rice varieties had reduced under submergence treatment compared to the saturated condition at 4 WAS (Figure 2). Among them, Bw 367, At 362 and Bg 455 recorded lowest reduction in seedling count of 5, 17 and 27%, respectively. Higher grain yield was recorded under the submerged condition compared to saturated condition (Figure 3).

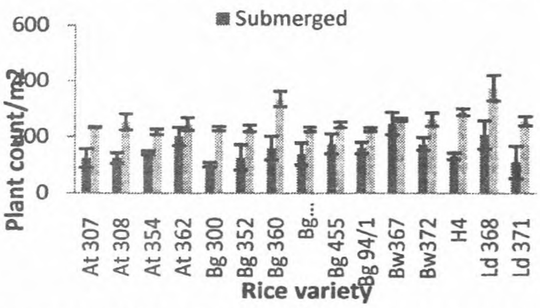

Figure 2: Plant count/m^{2}of different rice varieties under the two different submerged depths. Vertical bars represent the ±SE.

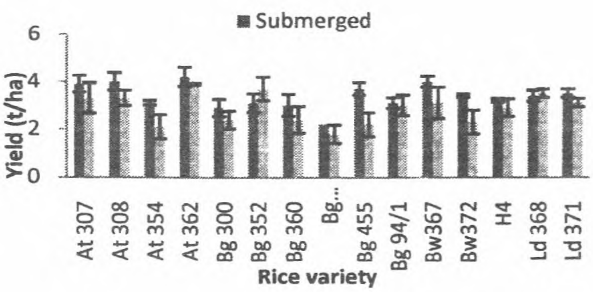

Figure 3: Grain yield (t/ha)of different rice varieties under the two different submerged depths. Vertical bars represent the ±SE.

At 362 attained the highest gain yield followed by Bw 367, At 308 and At 307 and Bg 455 under submerged condition. The reduction of grain yield under saturated condition might be due to high weed pressure compared to that under submerged condition. These results were further supported by the significant negative correlations with grain yield and sedges count and dry weight and grass dry weight at 6 WAS under saturated condition (Table 1). These results are in agreement with the results of Ismaila *et al.* (2015) who reported that significantly higher yield of rice was observed under submerged condition than saturated condition due to less weed competition. In submerged condition, grain yield was positively correlated with rice plant count, whereas, negatively correlated with the broadleaf weed count. These results show that rice plant count is the main important parameter to increase yield under submerged condition.

Table 1. Correlation among different traits in saturated condition.

Traits	GY	GDW	BLDW	SEDW	GC	BC
GDW	-0.086	1				
BLDW	0.245	0.262	1			
SEDW	-0.365*	-0.079	-0.362*	1		
	-					
GC	0.629***	0.173	-0.282	0.1641	1	
BC	0.064	-0.093	0.294*	0.0446	0.011	1
	-					
SC	0.556***	-0.006	-0.279	0.385**	0.521***	-0.074

***, **, * significant at $P \leq 0.001$, $P \leq 0.01$ and $P \leq 0.05$ respectively.

GY, grain yield; GDW, grass dry weight at 6 WAS; BLDW, broad leaf dry weight at 6 WAS; SEDW, sedges dry weight at 6WAS; GC, grass count at 6 WAS; BC, broad leaf count at 6 WAS and SC, sedges count at 6 WAS.

CONCLUSION

Study shows that rice varieties, At 362, Bw 367, At 308 and At 307 and Bg 455 had higher seedling count and higher yield under submerged condition and those rice varieties are more suitable for submerged condition. Submergence to 5 cm water depth reduces grasses and sedges biomass by 84% and 72%.Therefore, this study highlighted the use of tolerant rice genotypes to ensure the crop establishment under submerged conditions and management of grassy and sedges weed using the early submergence in DSR.

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