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Study on inundation periods of land for mechanical transplanting under minimum tillage unpuddled transplanting

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Introduction

In Bangladesh and other countries in Asia, manual transplanting of rice into puddled soil is conventional practice but relies on access to cheap readily-available labour. Besides being costly and time consuming, puddling results in degradation of soil (Chauhan et al., 2012). The use of continuous puddling results in the formation of a hard pan with a consequent increase in bulk density and lowering of hydraulic conductivity below the plow layer (Singh et al., 2009). To overcome labour and water shortages, mechanical transplanting of rice under minimum tillage is of considerable interest but little is known of the optimal inundation for soils before transplanting. In this study both farmers' participatory and research station-based experiments evaluated the performance of a mechanical rice transplanter at Bangladesh Rice Research Institute research farm, Gazipur and on farmers' fields at Kushtia and Rangpur, Bangladesh under minimum tillage options and varied inundation periods.

Materials and Methods

The Versatile Multi-crop Planter and a rotary tiller both powered by a two-wheel tractor prepared the strip and conventional plots, respectively. Two dry and one wet pass followed by one leveling operation produced conventional puddling of soil. Seedlings of cv. BRRI dhan28 were raised at 130 gram of pre-germinated seeds in each tray. Textural classes at Gazipur, Kushtia and Rangpur were clay loam, loamy and sandy loam soil, respectively. Soil resistance during transplanting was measured by a hand penetrometer at 5 cm operating depth. Tillage treatments in a split plot design with three replications were strip tillage (ST), zero tillage (ZT) and conventional tillage (CT) and the inundation periods as sub-plots before transplanting were 12, 18 and 24 hrs. The 4 row walk-behind type Daedong rice transplanter, model DP480 was used to transplant into the strip, zero and conventional tillage plots.

Results

Average tillage time for ST and CT was 11.0 and 24.8 hr/ha. Un-puddled ST saved 56% of tillage time and fuel consumption compared to CT. Conventional tillage demonstrated significantly higher soil resistance (22.4 N/cm^2) in clay loam soil whereas ZT and ST (in the furrow of the strip) demonstrated higher soil resistance (16.8 and 14.6 N/cm^2 respectively) in sandy loam soil at 0-5 cm operating depth. Soil resistance varied among the soils in the order sandy loam > loam > clay loam soil. In clay loam soil, highest field capacity (area coverage per unit time) of the transplanter was observed for ST and ZT (0.128- 0.127 ha/hr). In loamy soil¸ CT showed higher field capacity. In clay loam and loamy soil, field capacity of the rice transplanter decreased with increased of inundation periods. By contrast, in sandy loam soil higher field capacity of the rice transplanter was observed for 18 hrs inundation period. In sandy loam soil, ST and ZT saved about 20% fuel consumption over CT. Inundation period showed insignificant effect on fuel consumption in all cases.

Tillage showed significant effect on volume of water required for transplanting. Strip and ZT saved 10-20%, 15-30% and 20-30% of the water required to prepare soils for transplanting of

rice in clay loam, loam and sandy loam soil, respectively compared to CT. On the contrary, inundation periods before transplanting had no significant effect on volume of water required in three types of soil.

Tillage treatment did not affect the percentage of missing hills in clay loam and sandy loam soil conditions. In loam soil, however, lowest percentage of missing hills was observed for ST. Zero tillage provided more missing hills because of more floating plants followed by CT. On the other hand, ST provided minimum missing hills. There were fewer missing hills with 24 hrs inundation with each tillage treatment. There have no inundation effect on weed infestation. Zero and ST showed significantly height weed infestation compared to CT.

Strip tillage gave significantly higher yield in loam and sandy loam soil (Table 1). There was no significant difference in yield between ZT and CT in sandy loam soil. Inundation period showed significant effect on yield in three types of soil. In sandy loam soil, 18 hrs for ST and 24 hrs for ZT and CT gave highest yields. However, averaged across three soil types, ST with 18 hrs inundation period showed higher BCR 1.54 followed by 1.51 and 1.45 for CT and ZT, respectively, with 24 hrs inundation period.

Table 1. Grain yield at 14 % moisture content (t/ha) as affected by tillage treatment and inundation period (IP) in three soil types.

	Clay loam soil				Loam soil				Sandy loam soil			
	IP_{12}	IP_{18}	IP_{24}	Mean	IP_{12}	IP_{18}	IP_{24}	Mean	IP_{12}	IP_{18}	IP_{24}	Mean
ST	4.7	5.1	5.3	5.0	4.7	5.5	5.4	5.2 a	6.0 cd	7.0 a	6.3 bc	6.4 a
ZT	5.2	5.2	5.6	5.3	4.3	4.5	4.8	4.5 c	5.2 f	5.8 de	6.5 ab	5.8 b
CT	4.8	5.4	5.7	5.3	4.7	4.8	5.3	4.9 b	5.5 ef	5.8 ef	6.3 bc	5.8 b
Mean	4.9 b	5.2 ab	5.5 a	-	4.6 b	5.0 a	5.2 a	-	5.6 c	6.1 b	6.4 a	-
$LSD_{0.05}$	T= NS, IP=0.40 and T × IP = NS				T= 0.22, IP =0.23 and T × IP = NS				T= 0.24, IP =0.25 and T × IP = 0.4240			

Note: ST=Strip tillage, ZT=Zero tillage, CT=Conventional tillage, NS-Not significant, *-significant at 5%, **-significant at 1%, Data followed by different letters differ significantly.

Conclusions

Rice transplanter operation and rice production under minimum tillage was satisfactory irrespective of soil especially under ST. Averaged across three soil types, 18 hrs inundation for ST and 24 hrs inundation for ZT and CT showed more benefit for rice production.

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