Research article

Efficiency of Two-Row Chinese Rice Transplanter Experimented at Royal University of Agriculture

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Abstract As a number of agricultural labors have shifted to urban industry, rice production is now experiencing labor shortages. Thus making transplanting is deeply unpopular. Despite producing higher yields, transplanting has dramatically been replaced by direct seeding. Therefore, this research paper aims to introduce the rice transplanter model TMRT 2 and to determine its working performance and efficiency by conducting an on-station experiment, starting from June to August, 2015, at the Royal University of Agriculture (RUA), Cambodia. The experiment was divided into 9 treatments with the size of 2 m x 7 m, and two main factors—plant age and water level—were studied and analyzed on different periods of 12 days, 18 days, and 25 days in age; an water depths of 2 cm, 5 cm, and 10 cm for water level. The findings indicate that in the treatment (25 days and + 2 cm), the hills contained a density of 4-5 plants and suffered low damage during planting operation. Though transplanted at various water depths, old rice seedlings tended to stand upright at the average of 650 to 750 degrees, whereas slow transplanting speed might greatly reduce seedling losses to 1-2 plants per hill. Additionally, hill-to-hill spacing varied from 21 to 23 cm when the rice seedlings age 18 and 25 days were mechanically transplanted. However, transplanting of younger seedlings produced many missing hills that ranged from 3 to 7 hills in the 2 m x 7 m plot, and this might substantially decrease the future yields. Planting depths varied from 4 to 5 cm when transplanting of seedlings age 18 and 25 days was performed at a water level of 2 cm. It might be concluded that rice seedlings, age 18 and 25 days, should be transplanted at 2 cm water level, in combination with slow enough operational speed, while transplanting of 12-day seedlings at varied water depths produced greater damage and losses.

Keywords rice transplanter, water level, root growth, hill spacing, operational speed

INTRODUCTION

Rice cultivation is known as traditional income-generating work practiced by 60% of rural Cambodian people and as a staple crop consumed in the country. Rice is also rich in vitamin B, which is important to keep the body running (MAFF, 2012). Recently, rice has been prioritized as a strategic crop to boost exports (FAO, 2014). Therefore, rice yields have increased, while workload has decreased. Despite its tremendous significance, rice cultivation is laborious and takes a long time to yield. In general, the cultivation time ranges from three to six months, depending upon the selected rice varieties and the seasons when crops are cultivated. Rice growth and yields are highly sensitive to variability of land preparation, climatic conditions, proper care, and water supplies. So, improper farming techniques may obviously lead to a waste of invested capital and low outcomes. Since rice cultivation requires a great deal of available labor, lack of man-power may lead to late farming or little care which signifies a pressing need for machine aid to boost crop production (ADB, 2014).

At the present time, mechanization has started to appear as a useful farming method that accelerates agricultural work and cut down unnecessary labor use, as well as increasing crop yields per year. After years of globalization, Cambodia has imported hundreds of power tillers to quicken land preparation proportionally in the wake of youth out-migration for work abroad. This really demonstrates a noticeable trend in the Cambodian agricultural evolution, while labor shortages pose a serious challenge towards the existence of agriculture (Lay, 2009). Seldom introduced into the Cambodian domestic market, hand-powered rice transplanters have been widely marketed and utilized in the Asian regions to compensate for labor shortages and facilitate farming work. Such rice transplanters are of great importance to the rural economies as fewer people are needed to transplant rice crops than ever, seedlings are uniformly transplanted for the purpose of better field irrigation and weeding at a later stage. Apart from that, seedling uniformity results in proper nutrient intakes from the ground and enough solar absorption between rows, which means higher yields. Therefore, this research aims to introduce the rice transplanter model TMRT 2 and to determine its working performance and efficiency.

METHODOLOGY

The experiments were carried out at the Royal University of Agriculture during the period of June-August to test the performance of a hand-operated rice transplanter by selecting the mini hand cranked rice transplanter (2 row, 20 cm width), which was imported from China. Moreover, understanding different water levels in rice fields before, during, and after transplanting is crucial for the firm stance and survival of newly transplanted seedlings. Adequate water presence in the field also contributes to the ability of seedlings to take in nutrient dissolved in water, absorb oxygen from the air, and consume sufficient amounts of water to promote growth. Thus, the study was performed by selecting plots with three water levels above the ground: 2 cm, 5 cm, and 10 cm, which are similar to the real water levels observed in rice paddy field in Cambodia.

As the time frame of the practical experiment was about three months, the short-duration rice variety Sen Pidoa was chosen. The rice was germinated at the nursery prepared at RUA campus, and planted for the experiment. The age of seedlings strongly affects proper growth leading to low losses of transplanted seedlings and higher yields at the harvest time. So, experimenting with different seedling age categories can prove a premium seedling age that can assure high yields for the benefit of farmers. The tested rice seedlings were categorized into three different ages: 12 days, 18 days recommended in system of rice intensification (GDA, 2013); and 25 days to meet the optimum rice age for the rice transplanter. Both water level and seedling age affect rice growth. The 9 treatments were created with the size of 2 m x 7 m. Root growth, number of plants per hill, missing hills, damaged hills, inter-row spacing and stem angle were measured and analyzed using ONE-WAY and TWO-WAY ANOVA from Minitab-17.0 software packages. Transplanting speed was measured whereas machine depreciation cost and labor efficiency were calculated.

The seed rate for one square meter nursery was about 250 grams. During seedling preparation, organic matter was one ox-card for 100 m^2 nursery to obtain firm seedling stems, additionally 0.5 kg of Urea fertilizer was diluted into water to make seedling healthy. Rice needs to be fertilized three times, 2-3, 15, and 50 days after seeding, and weeding is needed after transplanting at 15, 30 and 45 days to prevent grass growth (GDA, 2013).

RESULTS AND DISCUSSION

Optimal Transplanting Speed Operational in Each Treatment

The seedling age and water level were tested to find the optimum transplanting speed necessary to streamline a whole transplanting process with little damage to seedlings. The seedlings transplanted at the age of 12 days tend to be associated with higher operational speed, which significantly variant from 0.24 $m.s^{-1}$ in 10-cm depth to 0.36 $m.s^{-1}$ in 2-cm depth, while the transplanting of 18-day seedlings might retard the machine mobility estimated at around 0.25 $m.s^{-1}$ in depths of 2 and 5 cm and at 0.30 $m.s^{-1}$ in 10-cm depth. It is clear that young seedlings were easy to be picked up and dug into the soil, hastening the operational speed. With 25-day seedlings, the transplanter was operated at slow speed of 0.20 $m.s^{-1}$ in each water depth. This shows slowness of the machine. As a result, the operational speed varies in uniformity to subsequent seedling ages, but may fluctuate due to soil conditions and constant mechanical pulling force.

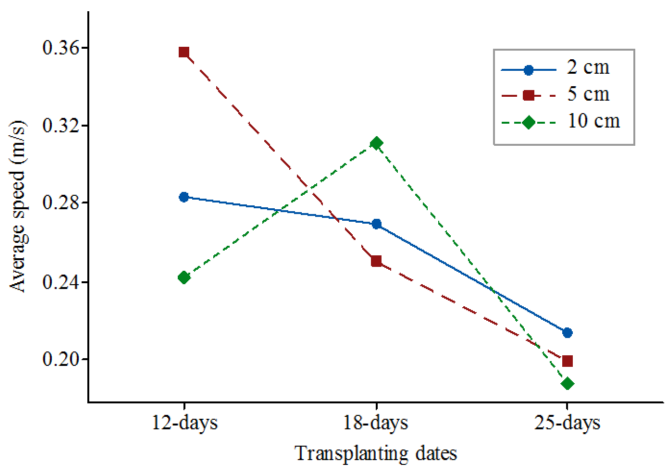

Fig. 1 Comparison in transplanting speeds operated in different seedling ages and water levels, with different speed means significant ($p < 0.001$) in transplanting date factor, non-significant ($p = 0.055$), and with significant interaction ($p = 0.019$)

Transplanting Speed Operational in Each Treatment

Missing hills and floating rates of transplanted seedlings were examined and counted in each treatment. This was to discover how significantly the age factor and the water-level factor affected the transplanter performance. As shown in Table 1, the difference in seedling damage in each hill is highly significant ($p < 0.001$), while the variation in an average floating rate of seedlings is also statistically significant ($p < 0.001$). As a result, the findings show that seedling damage in a density of 4 m^2 tend to be greater at high depth and young age, with the averages of 3 seedlings in the treatment (12 days + 5 cm), 4.5 seedlings in the treatment (18 days + 5 cm) and 7.5 seedlings in the treatment (18 days + 10 cm). The damage rate was non-significant in case older seedlings were transplanted, though at various depths. Water depth had a huge effect on a floating rate of seedlings in the vicinity of 4 m^2. High water level presented on the experimental plot signified a higher rate of seedlings afloat, and transplanting young seedlings was also influential in this rate. The seedlings age 25 days suffered a low floating rate at which very few drained seedlings were gathered in 4 m^2, which other treatments with younger seedlings had a floating rate of 4-7 seedlings.