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Comparative Performance of the Rice Transplanters in Thailand's Field Conditions

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ABSTRACT

Field performance and planting accuracy of three different transplanters : 4-row riding type transplanter, 2-row walking type transplanter and 6-row manually operated IRRI transplanter, were evaluated and compared in actual paddy field conditions. The fields were prepared by conventional land preparation method. The 4-row riding type Japanese transplanter had a field capacity of 0.148 ha/hr or 0.926 rai/hr with the field efficiency of 68.88 % when operated at 1.79 km/hr forward speed. The percentages of missing hills, buried hills and floating hills were observed to be 1.5%, 1.5% and 0.5% respectively without damaged hills.

The 2-row walking type transplanter had a field capacity of 0.114 ha/hr or 0.712 rai/hr when operated at 2.14 km/hr forward speed. It had a field efficiency of 88.64%. The pencentages of missing hills, buried hills and floating hills were measured to be 0.5%, 1.5% and 1.0% respectively without damaged hills. The IRRI transplanter gave the field capacity of 0.050 ha/hr or 0.312 rai/hr at 0.73 km/hr operating speed. The field efficiency was measured to be 57.66%. The percentages of missing hills, buried hills and floating hills were observed to be 11.25%, 0.83% and 0.83% respectively without damaged hills.

INTRODUCTION

Rice transplanters have been introduced to Thailand for more than a decade. Around 1978-1980, self-propelled walking type Japanese transplanters were introduced to Thailand and the 12-row riding type transplanter from China appeared in the market. The Japanese type transplanters used mat type seedlings or soil bearing seedlings and the Chinese transplanter used conventional seedlings or root washed seedings (Eam-o-pas, 1981). A 4-row manually operated, pulled type, was also introduced to Thailand by the International Rice Research Institute (IRRI), during the same period. The soil bearing seedlings having different mat sizes from that of Japanese seedlings was used for the IRRI transplanter. These transplanters were not popular in Thailand due to unsuitable field conditions, new seedling methods were required and high initial cost.

At present the transplanting cost in Thailand increases rapidly and the labour is scarce during the growing season. Therefore there is a need to utilize the mechanical transplanters as well as to identify the proper land preparation methods for those transplanters. The KU-JAPAN PHASE II project, the Co-operative project between Kasetsart University and JICA, has been initiated and one of its activities under the research topic "Land Preparation for Rice Transplanters" is to identify the suitable transplanters for Thailand and to improve the Land preparation methods for paddy fields. This paper demonstrates the field performance and picking performance of three different transplanters in the actual Thailand's field conditions.

METERIAL AND METHODS

The tested transplanters

Three types of transplanters were tested in the actual field conditions. These transplanters were 4-row riding type transplanter (KUBOTA Model S1-400D), 2-row walking type transplanter (KUBOTA Model NS-150-D), and 6-row manually operated, pulled type, IRRI transplanter. The first two were the Japanese type transplanters which used the soil bearing seedlings having the mat size of 28x58 cm. The IRRI transplanter used the soil bearing seedlings having the mat size of 20x40 cm. The Japanese transplanters had a row spacing of 30 cm and the IRRI

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transplanter had 20 cm row spacing.

Seedlings

The RD-21 rice variety was used to prepare the mat type seedlings. For the Japanese seedlings, the box type seedling method was performed (Kubota Tractor Company). The IRRI seedlings were prepared by a frame type method. The conditions of seedlings used in the experiment are shown in Table 1 :

It should be noted that the box type seedling for Japanese transplanters were prepared in Laboratory and the IRRI frame type seedlings ware raised in the field. It was observed that raising the seedlings in the field required a good management. To prevent damages from insects and diseases, insecticides and fungicides were applied to the IRRI seedlings but the box type seedlings in laboratory did not require any chemical application.

Land Preparation

The tested fields were prepared using conventional land preparation method that is first plowing using moldboard plow (Eam-o-pas *et al.*, 1988), attached to the two wheel walking type tractor in flooded conditions. The plowing depth was measured to be 15-20 cm. Puddlings and levelling were done using a rake attached to the same tractor. Two passes by the rake were performed, then the fields were kept flooded to allow the sedimentation of the soil until the transplanting date which was at 7 days after puddlings. Before the tests, the soil properties affecting the performance of the transplanters (Eam-o-pas *et al.* 1988), were monitored. Those properties were falling cone depth, Cone Index Value (CI) and wet bulk density (specific weight). The field conditions such as water depth and levelness were also recorded.

RESULTS AND DISCUSSIONS

The 4-row and 2-row Japanese transplanters were tested in plot No.1 and the IRRI transplanter was tested in Plot No.2. These two plots were separated by the levee but the soil in both plots was prepared by the same method. The field conditions and soil properties of these experimental plots are shown in Table 2:

Picking Performance of the tested transplanters

Table 3 shows the comparative picking performance of the transplanters in actual field conditions. It can be seen that the 4-row riding type transplanter had the percentage of missing hills, buried hills and floating hills of 1.5%, 1.5% and 0.5% respectively without damaged hills. The average number of seedlings per

Table 1 Seeding conditions used in the experiment.

Description	Box type Seedings	IRRI Seedings
Mat size (cm x cm)	28 x 58	20 x 40
Seedling rate/box (gm)	327	not recorded
Age of Seedling (day-old)	27	27
Leaf stage	2	2-3
Height of Seedling (cm)	20 (average)	20 (average)
Mat thickness (cm)	2.5	1.5

Table 2 Field conditions of experimental plots

Field Conditions/Soil Properties	Plot No.1	Plot No.2
Water depth (cm)	3-5	3-6
Average Falling Cone Depth (cm)	8.4	8.7
Cone Index Value (kPa)		
- 0-21 cm range	294	305
- 0-31.5 cm range	488	498
Wet bulk density (kN/m^3)	17.06	17.81

hill was measured to be 6.12 and the average planting depth was at 6.20 cm. The 2-row walking type transplanter had the percentage of missing hills, buried hills and floating hills of 0.5%, 1.5% and 1.0% raspectively without damaged hills. The average number of seedlings per hill was measured to be 8.67 and the average planting depth was at 5.17 cm.

The IRRI transplanter showed a very high percentage of missing hills which was measured to be 11.25%. This was due to improper working of the picking forks as well as the seedling conditions. The percentage of buried hills and floating hills were both equal to 0.83% without damaged hills. It was observed that the operator had to repeat his push stroke frequently when he observed the missing hills. Clogging of the picking fork was also the problem during operation. The average number of seedling per hill of IRRI transplanter was measured to be 4.36 and the planting depth was at 3.18 cm.

The numbers of seedling boxes required for each transplanter were also recorded. It was found that the 4-row riding type transplanter required 163 boxes/ha (26 boxes/rai) for the mat size of 28x58 cm. The IRRI transplanter having the mat size of 20x40 cm required 406 boxes/ha or 65 boxes/rai. These figures correspond to that recommended by the manufacturers or machine producers.

Field Performance

The field performance test of the transplanters was conducted in the actual field conditions described in the previous section to observe the machine maneuverability, field capacity, field efficiency, fuel consumption, slippage and ease of operation. In each test the planting time, turning time, seedling supply time, adjustment time and idle time were recorded (Eam-o-pas 1981). The working time of those transplanters, in percentage of the total time, are shown in Table 4:

Table 4 showed that the planting time of the 4-row riding type and 2-row walking type transplanters accounted for 61.26% and 81.74% of the total time respectively. The turning time of the 2-row walking type transplanters was observed to be 7.25% of the total time compared to 14.16% that of the 4-row riding type transplanter. This indicated that the 2-row walking type transplanter was more maneuverable on the headland than the 4-row riding type. The 4-row riding

Table 3 Picking Performance of the transplanters

Performance	4-row riding type	2-row walking type	IRRI-type
% missing hill	1.5	0.5	11.25
% buried hills	1.5	1.5	0.83
% floating hills	0.5	1.0	0.83
% damaged hills	0	0	0
Av.No. of seedling/hill	6.12	8.67	4.36
Planting depth (cm)	6.20	5.17	3.18

Table 4 Working time of the transplanters

Operations	Working time in percentage of total time		
	4-row riding type	2-row walking type	IRRI type
Planting	61.26%	81.74%	61.20%
Turning	14.16%	7.25%	2.70%
Supply Seedlings	19.58%	10.47%	7.34%
Adjustment	-	0.54%	4.82%
Idle	-	-	23.94%
Total	100%	100%	100%

type transplanter required 19.58% of the total time to supply seedlings which was much higher than that of the 2-r ow walking type which required 10.47% of the total time. The adjustment time of the 2-row walking type transplanter was measured to be 0.54% of the total time. This time was spent mainly for cleaning the picking forks. For the IRRI transplanter, the planting time was observed to be 61.20% of the total time. It spent only 2.7% of the total time to turn on the headland. The idle time was observed to be 23.94% of the total time because the operator needed to rest at the end of each pass (34 m field length)

The field capacity, field efficiency, slippage and fuel consumption of those transplanters are shown in Table 5:

The 4-row riding type transplanter had a field capacity of 0.1485 ha/hr or 1.188 ha/day compared to 0.1139 ha/hr or 0.9112 ha/day that of the 2 row walking type transplanter. The field efficiencies of the 4-row riding type and 2-row walking type transplanter were measured to be 68.88% and 88.64% respectively. It can be seen that the 2-row walking type transplanter had a higher field efficiency which resulted from less turning and seedling supply time. The slippages of the machine in the field during operation were measured to be 19.12% and 23.22% for the 4-row riding type and 2-row walking type respectively. The 4-row riding type transplanter consumed 1.032 L/hr of gasoline at half throttle setting with the in-field actual speed of 0.499 m/s (1.796 km/hr). The fuel consumption of the 2-row walking type transplanter was measured to be 0.391 L/hr when operating at half-throttle setting or the field speed of 0.595 m/s (2.143 km/hr).

The IRRI transplanter had a field capacity of 0.0508 ha/hr or 0.4064 ha/day with the field efficiency of 57.66%. The IRRI machine gave a higher percentage of missing hills as described in the previous section. The operator required frequent resting time during operation which decreased the field efficiency significantly.

CONCLUSIONS

The performance of the 4-row riding type and 2-row walking type Japanese transplanter in actual paddy fields prepared by traditional method that is one plowing in flooded conditions and two puddlings and levelling by a rake were satisfactory. They gave the good planting accuracy or picking performance. When operated at half throttle setting speed the 4-row riding type transplanter had a field capacity of 0.1485 ha/hr compared to 0.01 ha/hr that of hand transplanting, assuming 800 m^2/day can be completed by hand transplanting. The 2-row walking type self-propelled transplanter and manually-operated IRRI transplanter had a field capacity of 0.1139 ha/hr and 0.0508 ha/hr respectively. It can be seen that the IRRI transplanter worked five times faster than hand planting.

It is necessary to test these transplanters in different field conditions prepared by different methods before the conclusion on the suitable transplanters and the proper land preparation techniques for each transplanter can be drawn. Economical aspect as well as field conditions should be considered carefully before introducing the rice transplanters to farmers in different regions having different farm sizes and tillage implement.

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Table 5 Field performance of the transplanters

Performance	4-row riding type	2-row walking type	IRRI type
Forward speed (m/s)	0.499	0.595	0.204
(km/hr)	1.796	2.143	0.734
Field Capacity (ha/hr)	0.1485	0.1139	0.0508
Field Efficiency (%)	68.88	88.64	57.66
Slippage (%)	19.12	23.22	N.A.
Fuel Consumption (L/hr)	1.032	0.391	N.A.
(L/ha)	6.948	3.433	N.A.

Note N.A. = not applicable

participated in the field experiments

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