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# Performance of a Self-propelled Riding Type Rice Transplanter

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## ABSTRACT

The picking performance of a 4-row self-propelled riding type rice transplanter was evaluated in the experimental fields at Kasetsart University, Kampangsaen campus under two different field conditions. The first fields was prepared using a rotavator attached to the 22 kW four wheel tractor for both first plowing and puddling operation. The second field was plowed using a conventional moldboard plow and the puddling was done using a raker attached to the two wheel walking type tractor. Planting accuracy of the transplanter was measured in these fields. The missing hills and floating hills in the first field were measured to be 6.33% and 1.33% respectively with no observed buried hills. In the second field the missing hills and buried hills were measured to be 2.33% and 2.00% respectivelly with no observed floating hills. The soil mechanical properties affected the transplanter performance were also measured and discussed.

## INTRODUCTION

Thailand has long been the major rice exporter to the world. Rice exporting value rose to 20,314.8 million baht in 1986. The total planting area for major and second rice was 61.57 million rai in 1987 which is about 48% of the total cultivated area. Therefore it is necessary to improve rice production technology in order to increase yield and reduce production cost. This can be achieved by mechanization either with full or partial application. Improving rice variety as well as minimizing damages by insects and diseases are widely conducted by many researchers. However transplanting which is the most time and energy consuming operation in the production process is mainly done by hand. At present many types of the rice transplanters have been successfully used in Japan, Korea and China. They have been introduced in Thailand many years ago but still there is no practical use in the rice farming. Therefore the performance of the rice transplanters has been evaluated under the KU-JAPAN PHASE II PROJECT in order to study the suitability under Thailand's field conditions. Consequencely, the proper land preparation methods could be formed and recommended. This paper reports the picking performance of a riding type rice transplanter.

## MATERIALS AND METHODS

### The tested transplanter

A self propelled 4 row riding type rice transplanter (Japanese Type) was tested in two different field conditions. Figure 1 shows the tested transplanter and the machine specifications are shown in Table 1.

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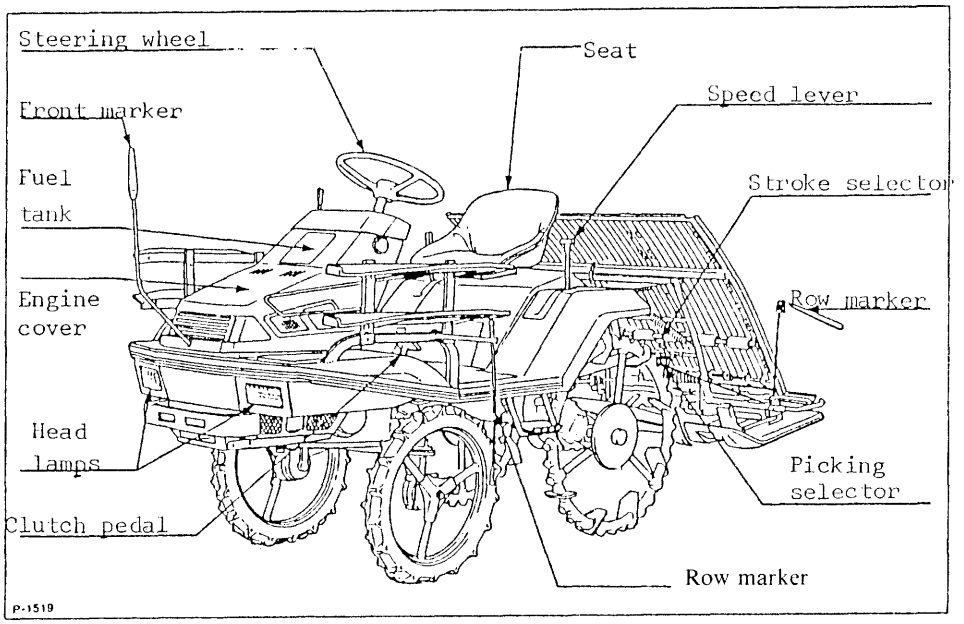


**Figure 1 The 4-row riding type rice transplanter**

**Table 1 Machine Specifications**

| | |
|---|---|
| Model | S1-400D (KUBOTA) |
| No of row | 4 |
| Row spacing | 30 cm. |
| Hill spacing | 18, 16, 13 cm. (adjustable) |
| Engine | gasoline 4PS/1800 rpm (max 5.8 PS) |
| Dimension (W*L*H) | 1540*2740*1375 mm. |
| Ground clearance | 375 mm. |
| Total weight | 315 kg. |
| Speed | 4FW (2TR) 2R |
| Speed range | 0.53-0.80 m/s |

**Land preparation methods**

The field was prepared by two different land preparation methods. The first field (field No. 1) was first tilled using a rotavator attached to the 22 kW four wheel tractor in flooded conditions. Two puddlings were performed using the same implement at 15 days after the primary tillage as shown (Figure 2). The field was then levelled using a simple steel pipe pulled by a tractor. It was kept flooded for 7 days before transplanting to allow sedimentation of the soil.

The second field was first plowed using a conventional one bottom moldboard plow attached to the two wheel walking type tractor (Figure 3). A conventional raker attached to the two wheel tractor was used for puddling with two passes at 15 days after the first plowing. The soil was allowed to settle down for 7 days before transplanting.

**Figure 2 Puddling operation using a rotavator in field No. 1**

**Figure 3 First plowing using a conventional moldboard plow in field No. 2**

**Measurement of soil properties**

It is generally known that soil conditions can significantly affect the performance of the transplanters therefore important soil mechanical properties were measured throughout the land preparation periods. In these experiments the following soil properties were measured :

a) Cone penetrometer resistance
b) Falling cone depth
c) Degree of puddle
d) Soil specific weight
e) Soil moisture content

These soil properties were measured at four different periods as follows :

a) Before first plowing
b) After first plowing
c) After puddlings
d) Before transplanting

**Data collection and methods**

## 1. Transplanting performance

After transplanting in each field the percentage of missing hills, damaged hills, buried hills, floating hills were measured from one hundred hills with three replications (Awadhwal and Singh 1985). Average number of seedlings per hill, row spacing and inter-row spacing were also recorded.

## 2. Measurement of soil properties

For measuring the soil properties, the recording type cone penetrometer was used to measure cone penetrometer resistances over the range of 0-31.5 cm. with 3.5 cm. interval. The cone index values over different ranges of depths were calculated. The cone was 20.27 mm. in diameter with 30 degrees apex angle (ASAE 1977) as recommended by ASAE (ASAE R313.1).

The standard falling cone having 36 mm. base diameter, 44 mm. height with 115 grams of weight and 45 degrees apex angle was used to measure the penetrating depth. The cone was dropped from a height of 1 m. (Kauoksak 1981) using the measured stand.

The shear vane and the 20 kg. digital force gauge were used to measure the degree of puddle (3) which was defined as

$$DP = 1 - \frac{Tp}{Tup}$$

Where DP = degree of puddle
Tp = shear yield strength of puddled soil
Tup = shear yield strength of unpuddled soil

The soil sampling kit was used to measure the soil specific weight or wet bulk density. Soil moisture content (dry basis) was determined using the oven dry method. It should be noted that in some conditions these properties could not be measured because the soil was pulverized into different states such as furrow slice and muddy soil.

## RESULTS AND DISCUSSIONS

**Picking performance**

The picking performance or planting accuracy of the 4-row riding type rice transplanter was evaluated with 20 days old seedlings (soil bearing seedlings) having the average height of

**Figure 4 Picking performance test in experimental fields**

20 cm. in 2-4 cm. depth of water. Table 2 shows the picking performance of the transplanter.

In field No. 1 the percentage of missing hills and floating hills was measured to be 6.33% and 1.33% respectively. It can be seen that there was no buried hills and damaged hills in the experiment. In field No. 2 the percentage of missing hills and buried hills were measured to be 2.33% and 2.00% respectively with no observed floating hills and damaged hills.

**Table 2 Picking performance of the transplanter**

| Field No. | Missing hills | Floating hills (percentage) | Buried hills | Damaged hills |
|---|---|---|---|---|
| 1 | 6.33 | 1.33 | 0.00 | 0.00 |
| 2 | 2.33 | 0.00 | 2.00 | 0.00 |

**Table 3 Number of seedlings/hill, row spacing and hill spacing**

| Field No. | Av. Number of seedlings/hill | Row spacing, cm. | Hill spacing, cm. | % Hill containing 3-5 seedlings |
|---|---|---|---|---|
| 1 | 3.25 | 29.13 | 19.07 | 61.67 |
| 2 | 5.15 | 29.97 | 19.77 | 51.67 |

Table 3 shows the average number of seedlings per hill, row spacing, hill spacing and percent of hill containing 3-5 seedlings. The average number of seedlings per hills in field No. 1 and 2 were equal to 3.25 and 5.15 respectively. The observed row spacing and hill spacing were measured to be 29.13 cm. and 19.07 cm. in field No. 1 and 29.97 cm. and 19.77 cm. in field No. 2 respectively compared to the theoretical spacings of 30 cm. and 18 cm.

It was observed that the percentage of missing hills, buried hills, floating hills, number of seedlings per hills were affected by seedling conditions, soil conditions and machine adjustment.

**Soil properties affected the transplanting performance**

Soil mechanical properties were measured at four different periods. This was done in order to study the changes of soil properties due to different land preparation methods. Soil properties at transplanting directly affected the performance of the transplanter eg. floating hills and buried hills. Seedling conditions and machine adjustment influenced the number of seedlings per hill, missing hills and damaged hills. The soil mechanical properties at different periods in field No. 1 were shown in Table 4. Table 5. shows the cone penetrometer resistances in field No. 1 at the different depths from 0-31.5 cm.

The falling cone depths after first tilling, after puddling and before transplanting were measured to be 8.65 cm., 11.85 cm. and 9.75 cm. respectively. The cone index values over the range of 0-31.5 cm. at those different periods were equal to 544 kPa, 624 kPa and 527 kPa respectively. Table 5 shows that the cone penetrometer resistances at 0.0 cm. and 7.0 cm. were equal to 18 kPa and 91 kPa which are considered to be a very soft condition. This soft top layer gave the floating hills of 1.33% as mentioned earlier.

**Table 4 Soil Properties in field No. 1**

| Properties | Period | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Falling cone, cm. | N.A. | 8.65 | 11.85 | 9.75 |
| C.I. (0-31.5), kPa | 649.70 | 544.35 | 624.81 | 527.35 |
| Degree of puddle | N.A. | 0.74 | 0.86 | 0.83 |
| Specific weight | 15.66 | 14.73 | 17.86 | 15.36 |
| Moisture content, % | 35.04 | 33.15 | muddy | muddy |

N.A. = Not Applicable
1 = Before First Plowing
2 = After First Plowing
3 = After Puddling
4 = Before Transplanting

**Table 5 Cone Penetrometer Resistance at different depths in field No. 1**

| Depth (cm.) | Cone Penetrometer Resistance (kPa) | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| 0.0 | 88.04 | 36.43 | 9.11 | 18.22 |
| 7.0 | 318.78 | 115.37 | 112.33 | 91.08 |
| 14.0 | 543.44 | 340.03 | 473.62 | 382.54 |
| 21.0 | 922.24 | 844.01 | 986.70 | 919.53 |
| 31.5 | 1096.00 | 1062.60 | 1196.18 | 1181.00 |

N.A. = Not Applicable
1 = Before First Plowing
2 = After First Plowing
3 = After Puddling
4 = Before Transplanting

Table 6. shows the soil properties at different periods in field No. 2 and Table 7 shows the cone penetrometer resistance at the depth of 0-31.5 cm. The falling cone depths before first plowing, after first plowing, after puddling and before transplanting in field No. 2 were measured to be 5.75 cm, 7.40 cm, 10.95 cm. and 10.15 cm. respectively. The cone index values over the range of 0-31.5 cm. at those periods were measured to be 576 kPa, 524 kPa, 621 kPa and 561 kPa, respectively. The cone penetrometer resistances before transplanting at 0.0 cm. and 7.0 cm. were equal to 15 kPa and 157 kPa respectively. It was observed that there was no floating hills in this field which may result from the relatively high value of the penetrometer resistance at 7.0 cm. which was equal to 157 kPa compared to 91 kPa in field No. 1. However it can not be clearly concluded for the effect of soil properties on the transplanter performance at this stage because there are many factors affecting its performance. The evaluation of the 4-row riding type rice transplanter must be performed in other soil conditions until the reliable conclusion can be drawn. Then the proper land preparation method can be recommended and field performance of the transplanter (Kanoksak 1981) including field capacity, field efficiency can be performed.

Preliminary test of the field capacity was conducted during the test. It was found that the field capacity ranges from 0.5-1.0 rai[1]/hr. depending on the forward speed. The field capacity reported by the manufacturer ranges from 0.94-1.34 rai[1]/hr. It should be kept in mind that this capacity is presumably obtained from the tests using high forward speed and the operator is skillfall. In addition the soil conditions and seedling conditions should be relatively excellent. Therefore the actual work rate in Thailand's field conditions will be performed in the next stage of the research.

[1] 6.25 rai = 1 hectare

**Table 6 Soil Properties in field No. 2**

| Properties | Period | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Falling cone, cm. | 5.75 | 7.40 | 10.95 | 10.15 |
| C.I. (0-31.5), kPa | 576.87 | 524.30 | 621.47 | 561.36 |
| Degree of puddle | N.A. | N.A. | 0.79 | 0.86 |
| Specific weight | 17.99 | N.A. | 15.49 | 18.55 |
| Moisture content,% | 43.15 | 41.76 | muddy | muddy |

N.A. = Not Applicable
1 = Before First Plowing
2 = After First Plowing
3 = After Puddling
4 = Before Transplanting

**Table 7 Cone Penetrometer Resistance at different depths in field No. 2**

| Depth (cm.) | Cone Penetrometer Resistance (kPa) | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| 0.0 | 100.19 | 18.22 | 27.32 | 15.18 |
| 7.0 | 294.49 | 118.40 | 194.30 | 157.87 |
| 14.0 | 446.29 | 443.26 | 707.39 | 552.55 |
| 21.0 | 825.79 | 792.40 | 910.80 | 819.72 |
| 31.5 | 1007.95 | 1017.06 | 1062.60 | 944.20 |

N.A. = Not Applicable
1 = Before First Plowing
2 = After First Plowing
3 = After Puddling
4 = Before Transplanting

## CONCLUSIONS

The performance of the 4-row riding type rice transplanter in the field which was prepared using a rotavator gave the percentage of missing hills and floating hills of 6.33% and 1.33% respectively with no observed buried hills and damaged hills. In the second field which used conventional land preparation implement gave the percentage of missing hills and buried hill of 2.33% and 2.00% respectively with no observed floating hills and damaged hills. Seedling conditions and

machine adjustment as well as soil conditions directly affected the tranplanter performance. It can be concluded that the transplanter gave a satisfactory picking performance in the tested conditions. However more tests in different conditions are needed until the descriptive conclusions on the effect of the soil conditions on the transplanter performance can be summarized. Finally field performance, eg. field capacity and field efficiency can be performed in the recommended field conditions.

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