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Mechanized Direct Seeding of Rice in Muda, Malaysia

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Abstract
With an objective of establishing a mechanization system suitable for direct seeding if rice under wet field conditions in the Muda area, some machinery tests were undertaken during the period of 1988 to 1990. Tillage and puddling operations with tractors under wet soil conditions showed a working rate of 0.5-0.7 ha/hr. The pudding operations with a wide rotary tiller considerably raised field work efficiency. Surface water drainage through the ditches opened by an auger trencher reduced incidences of vacant spots to the level of 4.4%, which was comparable to 9.3% under the ordinary method. Working rate of that trencher was estimated at approximately 0.7-0.8 ha/hr. A prototype of drill seeder was developed to explore the feasibility of a drilling method for direct seeding of rice under wet conditions. The stand establishment with a row space of 30 cm was inferior to that with broadcasting, but coefficient of variation (CV) values were improved. Drilling operation was accomplished as a working rate of 0.8 ha/hr.

Discipline: Agricultural machinery
Additional key words: broadcast, drainage, drill, seeder, paddy, seedbed, preparation

Introduction

Rice farming system in the Muda area in Peninsula Malaysia made great changes in the 1980s, which were represented by a rapid shift from transplanting to direct seeding[5].

Since 1980, the rice area seeded under a wet condition had increased in the main cropping season, and reached approximately 76% of the total rice area in Muda in 1989[2,3]. Approximately 50% of the paddy fields with direct seeding in the off-season are also seeded under a wet condition in recent years. With an increase in the planting area under direct seeding, various problems have come out during the decade. In regards to mechanization of field operations, those problems were associated specifically with the methods of tilling, weed control and seeding. The authors were assigned to the task for designing suitable systems with special emphasis placed on mechanized direct seeding for rice cultivation in the Muda area.

Results and discussions

In the Muda area, tilling and puddling operations are generally undertaken with farm machinery, while rice seeds are broadcast by hand. Pre-germinated seeds are broadcast under wet field conditions. Submerged fields are drained through run-off operations of surface water before seeding. The present studies dealt with the following subjects to design

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mechanized operations for tilling and puddling, surface water draining, and drill seeding: (1) use of a laser beam transmitter and a rotary tiller; (2) use of an auger trencher; and (3) use of a drill seeder.

1) Tilling and puddling operation

First tillage is carried out by farmers under dry field conditions before submerging. However, in the main cropping season, paddy fields are often wet due to monsoon rains. The second tillage and puddling operations are undertaken under water submergence.

The field topography was surveyed before flooding with a laser beam transmitter, i.e. Laser Beacon 5030AG having a precision index of ±1.5 mm and a capacity of working radius of 91.5 m[4]. The test field was slightly over 200 m in length with a topography variation of less than ±5 cm.

The first tillage was carried out with a farm tractor 18 days after straw burning. The performance of straw burning was about 83%. The traveling speed was 4.1 km/hr with a working rate of about 0.5 ha/hr. The second tillage was practiced under a flooded condition, applying the conventional procedures and equipment generally used in the Muda area. The tilling depth showed a wide range of variations with an average depth of 18.5 cm, which was 10 cm deeper than that under the dry field condition, where the traveling speed was 4.3 km/hr with a working rate of about 0.55 ha/hr.

In regard to the machinery for puddling operations, a wide rotary tiller was tested. This type of tiller, called "paddy harrow", has been widely used in Japan. Its working rate in the test was 0.70 ha/hr with a running unit of 2.5 m width. Rotary tillers with a tilling unit of about 1.6 m width are generally used for tilling and puddling operations in Muda. However, the wide rotary tiller as was used in the present test had never been used there. Since the working rate by a rotary tiller with tilling width of 1.6 m was 0.50 ha/hr, it may be concluded that the puddling operation using a wide rotary tiller is more efficient.

2) Surface water drainage

Surface water drainage is one of the major factors for stabilizing yields of rice directly seeded on wet paddy fields, since establishment of seedling stands under that condition is not rarely very poor. In securing an adequate level of drainage, the surface water has to be well drained before seeding. In the Muda area, small ditches are usually made through pulling bags, called "gunny sack" or "burlap bag", filled with soils. Effectiveness of this method on drainage is, however, rather low, because the ditches are too shallow, i.e. approximately 5–10 cm in depth. In addition, this method requires a great deal of labor.

In the present study, a mechanized method for digging ditches with an auger trencher was examined. This method is to drain off the surface water through the ditches, which are installed close to the field levees. The ditches are called "batas" by local farmers.

The ditches were opened under dry soil conditions. The test field had a texture of clayey soil which was of poor draining properties. The ditch-digging operation was carried out satisfactorily because the field soils were kept dry enough to operate. The test field was 520 m in distance between the irrigation canal and the drainage canal. Variation of topography of the original field was within ±5 cm, and depth of the ditches from the field surface varied between 26 and 33 cm. Width of the ditches was about 40 cm.

It was recognized that this order of the depth of ditches was sufficient for primary drainage of surface water. In order to lead the surface water to those ditches more effectively and efficiently, additional ditches under manual operations with a gunny sack are required. Soil moisture contents of the field suitable for making ditches were estimated at less than 50% on a dry matter base.

Fig. 1 shows status of seedling stands under the field tests 30 days after seeding. The area of spots without seedlings was approximately 9.3% in total under the ordinary method, i.e. gunny sack drainage method, while approximately 4.4% under the tested method with an auger trencher. The latter was clearly smaller than the former method. However, the germination was poor in such a case where additional small ditches with manual operations were not provided. The working rate was estimated at around 0.65 to 0.79 ha/hr, on the basis that the field width was 50 m and the ditches were dug by a trencher only on one side along the long levee. Durability of those ditches made by an auger trencher was estimated to last for approximately 3 years, though it would depend on the subsequent maintenance. It would therefore be justifiable to conclude that a

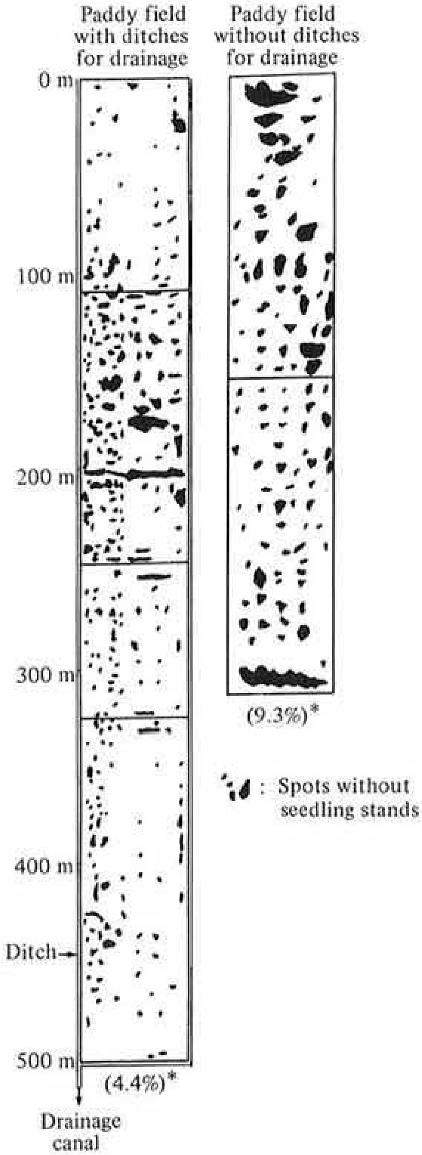

Fig. 1. Status of seedling stands of rice under the field conditions with and without ditches for drainage
* Rate of non-germinated spots as against total area.

higher working rate than the above-noted one could be expected in terms of an average achievement per year.

3) Drill seeding by a drill seeder

In most cases in Muda, seeding has been carried out in the form of manual broadcastig, but some advanced farmers have employed a mechanized method for seeding. Studies on mechanization of rice seeding have also been implemented on an experimental scale with emphasis placed on seeding efficiency and accuracy for practical use under wet soil conditions[1]. Various forms of mechanization have been tested in those experiments. However, no machines have been satisfactorily applicable for a practical use, with the exception of a knapsack type of power duster, which was identified suitable for seeding, though not highly efficient. It was therefore required to develop a more efficient technology for seeding.

A power-driven drill seeder with a trailing type was subjected to tests in the present study (Plate 1). The experimental machine had 12 seeding rows, being pulled by a power tiller, which are widely used at present in the Muda area. The row interval of the drill seeder was 30 cm each with a total working width of 360 cm. A special device for seed feeding was installed so that the damages of pre-germinated seeds could be minimized in operations. The roll unit for seed feeding was driven by a DC motor. A special type of wheels were attached to the drill seeder to hold the machine on a wet paddy field. These wheels are the same with those for a riding-type transplanter generally used in Japan. In this experiment, a power tiller equipped with iron wheels of a 1.0 m diameter was used for traction. These large wheels are widely used in the Muda area to prevent the machine from sinking into wet soils.

Fig. 2 shows comparisons of the establishment of seedling stands between the drilling and the broadcasting in the three tests. The establishment of stands in drill seeding is smaller in number as compared with broadcasting. The seeds under drill seeding were closely located with each other in rows with a smaller seeding rate of 5 to 8 g/m^2 than that under broadcasting. Smaller CV values and less spots under non-germination were observed in the drilled plot than in the broadcast one. In field operation, the working rates were estimated at 0.7–1.0 ha/hr. They were about 2–3 times higher than those with manual broadcasting.

The paddy yields of the drilled plots were slightly higher in general as compared to those of the broadcasted plots. The paddy yield in the first cropping season in 1990 was particularly high, i.e. 12% as

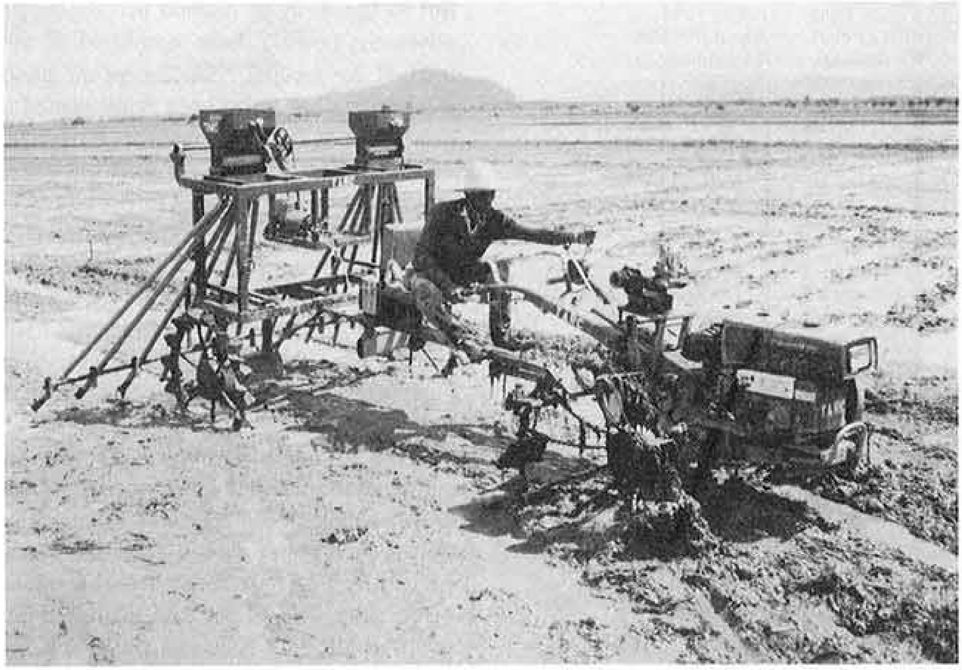

Plate 1. Seeding operation with the 12-row drill seeder under wet soil conditions

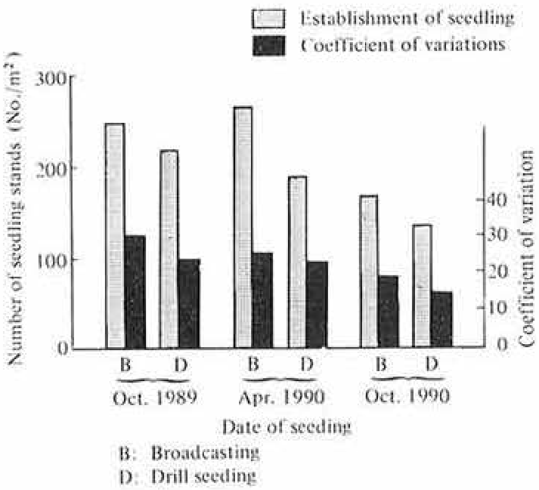

Fig. 2. Establishment of seedling stands in the drill seeded plots and the manual broadcast plots under wet soil conditions

much higher than that of the broadcasting. Further tests would be required, however, in concluding that the drill seeding method with a 30 cm row-spacing would ensure higher yields. On the other hand, regarding the lodging resistance of rice plants, the drilled plots showed greater résistance than the broadcasted ones. Considering that rice plants are harvested with combine harvesters in the Muda area, the drill seeding method would be effective in reducing harvesting losses.

Discussions and conclusions

The paddy fields for the present study were puddled with the same type of rotary and power tillers as those of the farmers. It was recognized, however, that the puddling operation with such a rotary tiller of 1.6 m width was not adequate in preparing a suitable seedbed for seeding under a wet condition. The wide rotary tiller of 2.5 m width tested in this study proved to be more effective and efficient, maintaining needed accuracy of operations. This type of rotary tiller, however, has never been adopted by farmers and contractors in the Muda area. It may be practical and economical to accomplish all the tilling operations with a single machine. Therefore, in justifying adoption of wide rotary tiller, it would be very necessary to carefully examine the possibility of establishing a new tilling system as an important part of the improved technology for direct seeding under a wet soil condition.

Another major factor is surface water drainage, which is vital for establishing good stands of seedlings. In the Muda area, mechanized operation for surface water drainage has never been practiced by farmers, while the manual method of gunny pulling yields only poor effects for drainage, which result in a great number of spots without rice stands. These spots have to be filled in by re-seeding or transplanting of seedlings. However, such a supplementary treatment is often faced with difficult problems for plant growth, in particular with greater competition with weeds. The surface water drainage by using an auger trencher provides an advantage of ensuring better drainage and, as a consequence, reducing the area of non-germinated spots. This method may also be recommendable to adopt under such a field condition as was the case in the Muda area, where irrigation canals are far distant from drainage ditches.

The drill seeding method as proposed above would provide an easier field management after seeding and a uniform seedling stand. The drill seeder tested in the present study would ensure higher operational accuracy and efficiency. In addition, simplicity in handling this machine would facilitate field operations. There remain some critical issues for practical use of the above machines, which relate particularly to their high costs for adoption. There is another issue in practice, which relates to inter-row space for seeding. This subject is generally analysed from an agronomic viewpoint. In this study, the drilling row space was set at 30 cm to meet the requirement for the use of an existing weeder available. However, it seems that the inter-row space of 30 cm is excessively large for rice cultivation in the Muda area, since the weed growth is so rapid and vigorous after seeding under such a wide space. The most appropriate space of rows would be in the range of 20 to 25 cm for direct seeding in that area.

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