Performanace of Rice Transplanters as Evaluated by National Test in Japan

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According to 1978 statistics, the number of rice transplanters practically used in Japan was 1,601,000 and the area served accounted for about 2,150,000 ha,88.5% of the total area planted to lowland rice. National test of rice transplanters (hereafter simply referred to planter) was initiated in 1974, when the planters began to be used widely. By 1979, a total of 114 types, including 15 riding types, have passed the test. In this paper, structures and performances of planters which have passed the test, and methods of testing in the national test will be briefly presented.

Kinds of planters

Most of the planters in Japan belong to a type designed for the use of rice seedlings with roots from which soil is not washed away (referred to seedlings with soil), and hence planters applied for the test are of this type. They are classified into three sub-types: seedling-mat type, seedling-band type and seedling-pot type. Of them, the seedling-mat type is most popularly used.

The seedling-mat is prepared by raising seedlings in rectangular box (58×28 cm with 3 cm of depth) containing fine soil to which rice seeds are broadcast. The seedling-band is prepared by drilling seeds to soil-bands contained in ditches (2.3 cm depth and 8 mm width) of rectangular seedling box. The seedling-pot is prepared by sowing 3–5 seeds to a pot (1.5×1.5 cm with 3 cm of depth) containing soil. Seedlings grown to 9–10 cm high (2–4 leaf-stage) are generally used for transplanting.

General description of structure

1) Constitution of principal parts

Walking type planters are composed of engine, main transmission, running part, planting part and operating part. Power is transmitted from the engine to the main transmission by V-belt, or directly to the main transmission, and from which to the running part by chain. Power to the planting part is transmitted from the main transmission by chain or propeller shaft.

As to riding type planters, there are two kinds: mounted type (mounted on tractor) and self-propelled type (with its own engine). Structure of planting part is almost the same as that of the walking type.

2) Dimension of planters

As shown in Table 1, dimension and weight increase in proportion to the number of rows to be planted. Weight of 6-row planter of walking type reaches 200 kg without loading seedlings, so that considerably large power is

Table 1. Overall dimensions

	Row	Length (cm)	Width (cm)	Height (cm)	Weight (kg)
Walking type	2	212	87	93	102
	3	221	118	88	113
	4	237	145	99	172
	6	244	207	106	209
Riding type	4	354	141	152	402
	5	276	202	133	362
	6	311	218	184	550
	8	332	289	184	600
	12*	486	386	273	1906

* With tractor

needed for turning and taking in and out of the planter in fields. However, 2–4 row planters can easily be handled.

As for riding type planters, the mounted type is slightly heavier than self-propelled type, and overall width is 2–2.4 m for 6-row planters, 2.9 m for 8-row planters, and as wide as 3.9 m for 12-row planters. Therefore planting part, including seedling board is designed to be removable.

3) Engine

Except for the mounted type of riding type planters, air-cooled gasoline engines are exclusively used, with rated output less than 2.5 ps for walking type, and 4–6 ps for self-propelled riding type. As the power consumption is small during the work of planters, the engine is used in the range of an increased torque by reducing revolution/min in many cases.

4) Structure of running device and running method

All the walking type planters have wheels and floats (wheel and float type), both supporting the body, and run by wheels. The float has a role to stabilize the body and level the planting surface of soil. In most cases, adjustment of wheel depth against rugged hard pan depth is made automatically by hydraulic pump and cylinder. Typical radius of wheel is 30 cm. As the planters are unable to run in areas where their wheel axis comes to contact soil surface, paddy fields on which the planters can be used are determined by the structure of planters.

Planters presently available are considered to be usable in fields with hard pan depth of about 7–25 cm. In such fields, planting depth can be kept at constant by automatic vertical movement of wheels, although hard pan depth is rugged.

With riding type planters, raising and lowering of planting part are made by hydraulic system. Raising and lowering of planting part during the working time are automatically adjusted by hydraulic or spring system. The mechanism of the systems is similar to that of walking type planters. In case of the hydraulic system, a sensor on the float worked on a lifting device to lower or raise the planting part in response to the conditions of float, either floating or sinking. With many-row planters, a rolling mechanism or other device by which each planting part moves independently is equipped.

Talking into consideration the running on roads, solid rubber wheels are mostly used. Range of speed is mostly foreward 2 stages and reverse 1 stage for walking type, and forward 3 stages for riding type.

5) Planting part

Locus of planting paw is related to the size of seedlings to be planted. Planters which have passed the national test show 20–25 cm of vertical movement of paw, and can handle seedlings about 20% longer than that, with some variations according to the conditions of seedlings and fields.

For seedling-mats, bar paw (rod-shaped paw) attached with a claw, which pushes out seedlings, or plate paw (plate-shaped paw with a sharp tip) are used. As seedling-bands are made of continuous belt of seedlings, they are cut by hatchet paw, and then pressed into soil along guide plate. In any case, transplanting is made by a forced planting system.

Inter-row space is usually designed to be 30 cm, but there are also 28 or 33 cm space. Number of seedlings/hill can be adjusted within a range of 3–8. It can be done by changing amount of seedlings (0.9–2.7 cm^2 of seedling-mat) to be picked up by a planting paw in case of seedling-mats, or by changing the length of cut seedling-bands, that depends on the rate of sending seedling-bands to the hatchet paw in case of seedling-bands. With seedling-pots, the number of seedlings/hill is adjusted by changing seed rate per pot.

Hill density (hills/m^2) is adjusted to 18–30 by changing planting distance (hills/m of row).

Planting depth can be adjusted to 4–5 stages within a range of 1–5 cm depth. In all cases, paw upper stop device and torque limiter are equipped as the safety device of

planting part.

Field performance

1) Working speed, effective field capacity

Working speed and working rate as classified by number of rows of planters are shown in Figs. 1 and 2. The working speed is faster with less number of rows, and working rate increased with the increase of row number. However, working rate/row is decreased with increased row numbers.

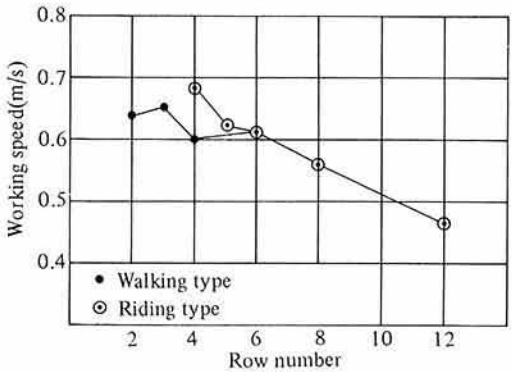

Fig. 1. Working speed

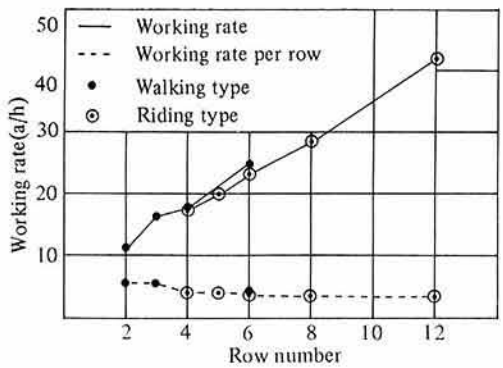

Fig. 2. Working rate

As the paddy field used for the tests is of relatively good condition, showing hard pan depth of 16 cm, cone penetration depth of 10 cm (cone penetrometer: 3.6 cm of maximum diameter, 4.4 cm height, 115 g of weight, dropped from a height of 1 m) and clay loam of soil texture, it should be considered that performance lower than the above may occur under unfavorable conditions.

Percentage of each part of work in a total working time is shown in Table 2.

Table 2. Percent of working time

	Row	Planting %	Turning %	Supplying seedlings %	Adjustment %
Walking type	2	80.1	9.8	8.8	1.3
	3	82.2	10.8	5.5	1.5
	4	70.9	10.7	15.8	2.6
	6	68.4	12.4	16.9	2.3
Riding type	4	65.4	12.9	15.4	6.3
	5	62.0	15.3	12.2	10.5
	6	60.7	16.7	17.5	5.1
	8	59.4	15.5	22.4	2.7
	12	73.3	14.7	10.6*	1.4

* With supplier

2) Percentage of missing plants

Rate of missing plants is calculated with the sum of missing plants caused by mechanical reasons, and those caused by buried seedlings (1/2 of seedling height + 2 cm and more is buried) and floating seedlings (floating on irrigated water). All the planters which passed the national test showed only about 1% for the rate of missing plants, as compared to the standard allowance of less than 5% of the test.

Procedures of inspection and standards

Application for the national test is limited only to power rice-transplanters to be used for seedlings with soil. The test is composed of inspections of structure and parts after disassembling, and the following examinations:

1) Field performance test

Prior to the test, growth of seedlings to

Plate 1. Field performance test of riding type rice transplanter

be used and field conditions are examined. Then, the transplanting test is carried out at the standard working condition (depth of planting: 2–3 cm, 3–5 seedlings/hill, and planting rate: about 22 hills/m^2) on an area of about 10 a for planters with less than 4-row planting and of 2.5 a per each row for the planters with more than 5-row planting. Measurements are made on working time, working speed, wheel slips, time required for turning, for seedling supply, and for adjustment of machines, and planting accuracy such as inter-row space, intra-row space (planting distance), planting depth, number of seedlings/hill, and missing plants, etc.

The test code defines that planting work should be done smoothly, and rate of missing plants should be less than 5%.

2) Handling test

In addition to the test on the easiness of handling, which is determined by actually operating the test planters in field by inspectors, the adaptability test is also included in the handling test. The latter test is carried out by operating the test planters under varied conditions of seedlings and paddy fields.

The test code defines that any defect which causes severe fatigue to operators, makes operators feel dangerous, or causes operational troubles such as extreme difficulties in adjusting each part of the planters should be avoided.

3) Continuous running test in muddy water

To examine whether any trouble or abnormality occurs or not by continuous operation for long time, and to know water and dust proof performance of test planters, the continuous running test is carried out for 15 hrs in a muddy water tank.

The test code defines that there should not be any damage, intrusion of muddy water and others into the machine, sticking by overheat, abnormal abrasion and oil leakage.

Investigation after disassembling is made after the completion of all other tests.

References

1) The national test code of the rice-transplanter to be used for seedlings with soil. Established on April 18, 1974, noticed on the Official Gazette issued on the same date. Revised on April 7, 1977 and April 18, 1979 [In Japanese].

2) Institute of Agricultural Machinery: Test reports of rice-transplanters (49 machines) passed the national test. (1977–1979) [In Japanese].