2. Efficiency of High Speed Rotary Tiller in Soil Pulverization (1976)

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To solve the difficulty of soil pulverization for growing upland crops in paddy field of heavy clay, a high speed rotary tiller with short tilling pitches was examined in the efficiency of soil pulverization.

Materials and method

1. Rotary tiller
   High speed rotation: Kobashi rotor
   Ordinary rotation: Howard rotavator
2. Test field: Two field lots were used. Wet season rice was planted in the field lots and harvested on different dates with about 1 week interval. Thus, two field lots of different moisture conditions were provided as follows:
   Dry soil condition: 26.9% on dried soil basis at tilled layer (Ic* = 0.58)
   Wet Soil condition: 34.4% on the same basis (Ic* = 0.24)
3. Testing time: January 17 ~ 19, 1976
4. Observation: clod size distirbution was checked after the first tilling with reference to tilling pitch, tilling depth and rotation speed of rotary shaft. These factors were interrelated as follows:
   Tilling pitch was controlled by changing the combination of rotary gears and running speed of a tractor. When the test on tilling pitch was carried out, tilling depth was 3.5 to 6 cm under the dry soil condition and 4.5 to 8 cm under the wet soil condition. At the test of tilling depth, tilling pitch was 35 to 48 mm and 50 to 57 mm in cases of the high speed rotary tiller and the ordinary one, respectively.
   Rotation speed of the rotary shaft was controlled by changing the P.T.O. rotation. When the test was carried out, tilling pitch of the high speed rotary tiller was 31 to 40 mm and that of the ordinary rotary tiller was 49 to 51 mm. Tilling depth was 4 to 6 cm and 4 to 8 cm under the dry and wet soil conditions, respectively.

Result

1. Tilling pitch
   The relation between tilling pitch of rotary tiller and soil pulverization was shown in Fig. 2-1.
   There was seen a clear trend that the shorter the tilling pitch was the higher the percentage of smaller clods was irrespective of type of rotary tiller. The high speed rotary tiller is characterized by the short tilling pitch as compared with the

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*Ic (Consistency index) = $\frac{W_L - W}{W_L - W_P}$

Where, W_L : Liquid limit
W_P : Plastic limit
W : Present moisture content on dried soil basis

ordinary one. Thus, the high speed rotary tiller was more efficient to pulverize soils than the ordinary one although the soil pulverizing ratio* of the former did not exceed 40% at the highest.

On the other hand, soils under the dry condition were pulverized more easily than those under the wet condition; the soil pulverizing ratio varied with tilling pitch more widely under the dry soil condition than under the wet soil condition.

2. Tilling depth

As shown in Fig. 2-2, there was seen a trend that the soil pulverizing ratio decreased with the increase of tilling depth obviously under the dry soil condition and slightly under the wet soil condition. The high speed rotary tiller pulverized soils more efficiently than the ordinary one at any tilling depth under both the soil moisture conditions. However, the high speed one could not well pulverize soils under the wet condition even in case of shallow tilling as indicated in the large proportion of clods bigger than 4 cm in diameter.

3. Rotation speed of rotary shaft

The results obtained were shown in Fig. 2-3. There was not seen any relation between the rotation speed of rotary shaft and the soil pulverizing ratio irrespective of type of rotary tiller and soil moisture condition.

Discussion

For pulverizing soils into small particles it was found essential to cut soils finely by tilling tines of short pitches and/or till shallowly without increased crashing power through acceleration of P.T.O. rotation. Thus, the high speed rotary tiller proved to be efficient on soil pulverization in comparison with the ordinary one. However, it is generally accepted in Japan that over 60 to 70% of the soil pulverizing ratio* is desirable to ensure good emergence of upland crops, while the ratio remained below 40% in this experiment even in the case of shallow tilling by using the high speed rotary tiller. Therefore, two times of tilling is required to complete good seed beds consisting of fine clods of soils. In this connection, it was also confirmed in this experiment that the high speed rotary tiller efficiently worked at the second tilling as well.

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* Defind as the percentage of soil pulverized into pieces smaller than 2 cm in diameter.

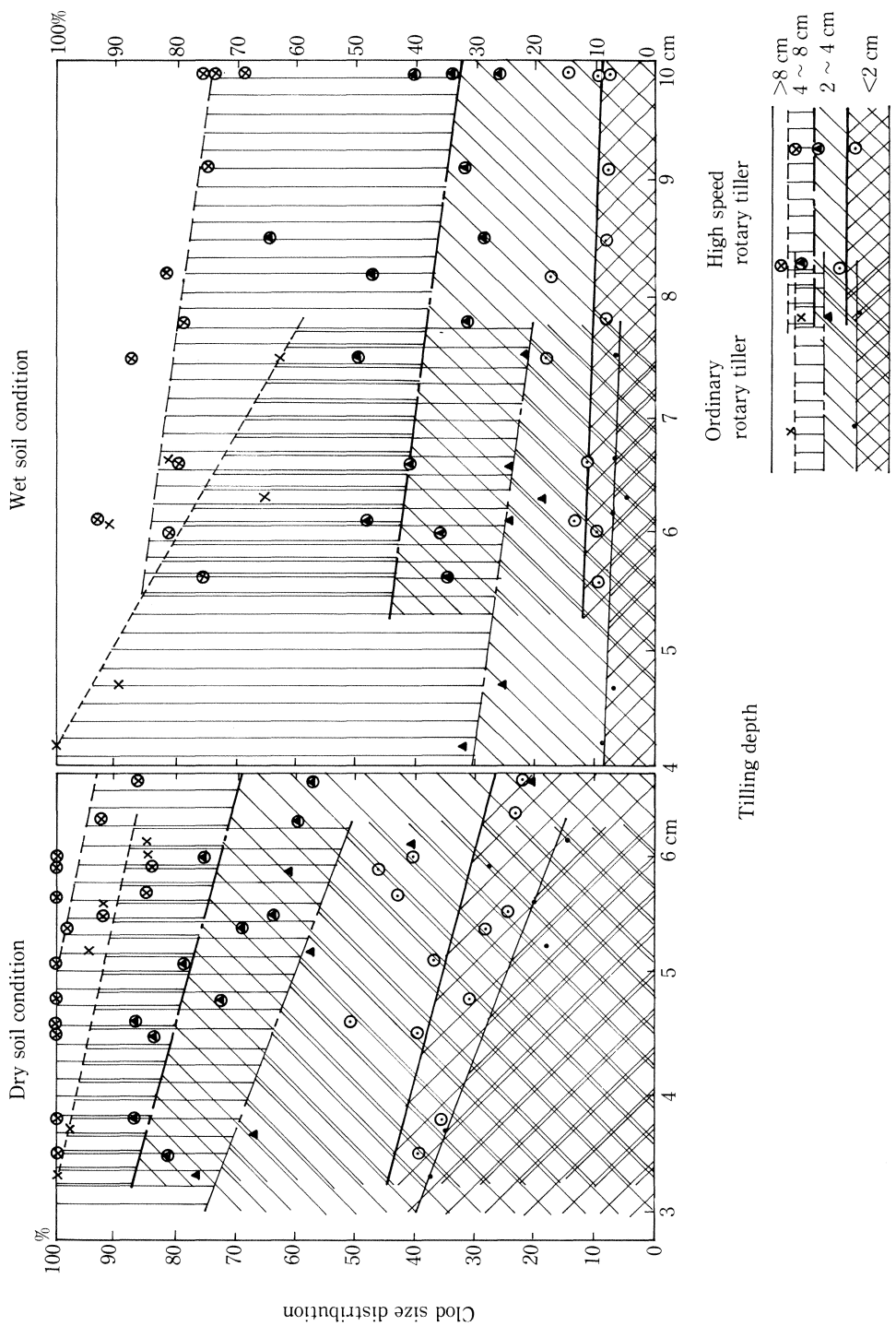

Fig. 2-1. Soil pulverization in regard to tilling pitch of rotary tiller

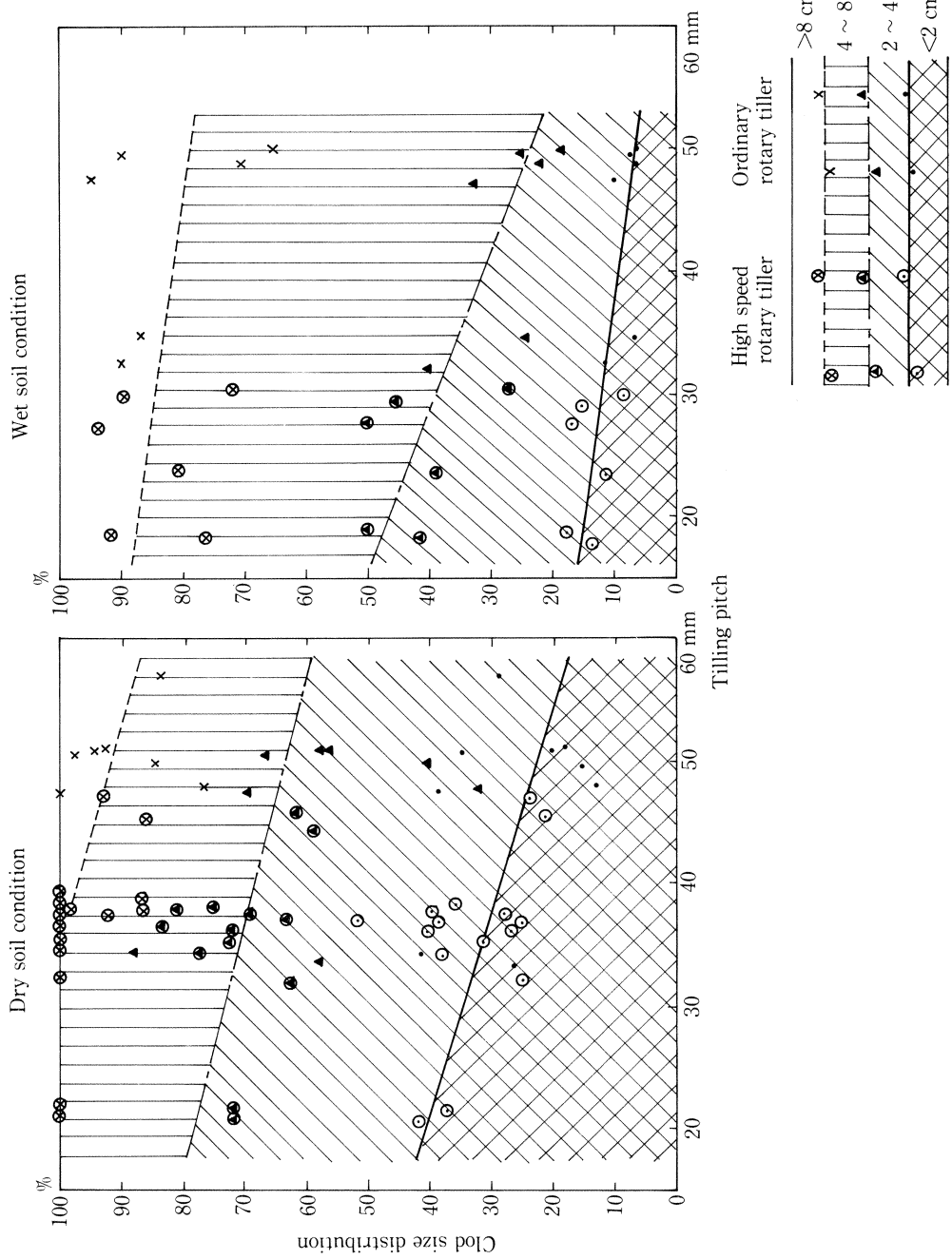

Fig. 2-2. Soil pulverization by rotary tiller in regard to tilling depth

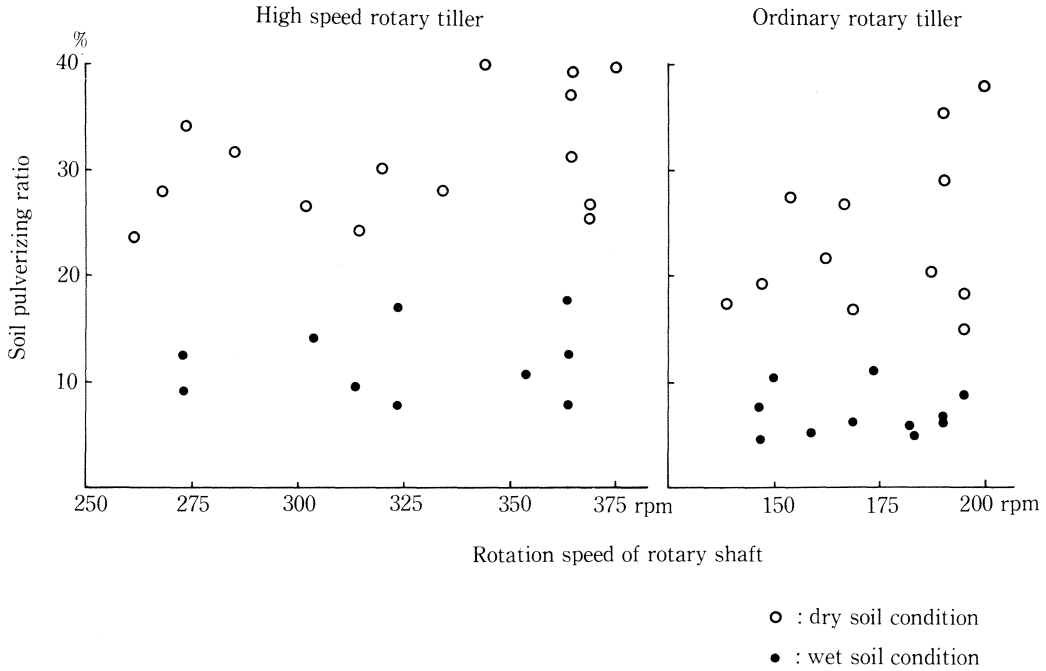

Fig. 2-3. Soil pulverization in regard to rotation speed of rotary shaft