EAEF Engineering in Agriculture, Environment and Food
published by AABEA
Research Paper

EAEF 5(2): 65-70, 2012

Rice Cultivation by Direct Seeding into Untilled Dry Paddy Stubble

-Proposal of a New Seeding Method and Germination Rate with That-

Yoshifumi NISHIURA*[1], Teruo WADA*[1]

Abstract

We propose direct seeding into the previous year's stubbles as a labor-saving rice cultivation method in untilled dry paddy fields. The effectiveness of this method was determined by conducting a seeding experiment. Three seeding holes at depths of 20 or 40 mm were bored per stubble, and 4 or 7 seeds were sown per stubble. Four sets of experiments were designed with different combinations of seeding depth and seeding number, and each set of conditions was replicated 3 times. Germination rate and stubble width were determined 1 month after seeding. Our results suggest that seeding in stubbles may be effective in preventing bird damage typically noted in shallow seeding but that deep seeding restricts seedling growth through shielding of sunlight.

[Keywords] direct seeding, germination rate, previous year's stubbles, rice, untilled dry paddy field, new seeding method

I Introduction

Three methods are currently used for direct seeding in rice cultivation: direct seeding in (1) flooded paddy fields, (2) tilled dry paddy fields, and (3) untilled dry paddy fields. For direct seeding in flooded paddy fields, rice seeds are directly sown in paddy fields that have been tilled, clod crushed, and soil puddled. Although this method removes the need for seedling transplantation, Calper coating of seeds is necessary to increase the germination rate (by increasing oxygen supply) (Okamura, 2001). With direct seeding in tilled dry paddy fields, the soil puddling process, which is necessary for direct seeding in flooded paddy fields, is not necessary, and rice seeds are sown directly into tilled dry fields. Because tillage is necessary when using this method, seeding or pest control is sometimes delayed due to rainfall. Over-wetted soils are often difficult to reduce into fine particles, causing poor germination and less healthy seedlings. For direct seeding of untilled dry paddy fields, rice seeds are sown into untilled dry fields. Rainwater flows easily over the untilled ground, resulting in a soil with good drainage and high bearing capacity. Because tillage, clod crushing, soil puddling, and transplanting processes are not necessary when using this method, it is considered to be the simplest and most labor-efficient method of rice cultivation. In this report, we propose a new method of seeding untilled dry paddy fields. The effectiveness of this method was determined by comparing the germination and seedling rates of rice seeds under various seeding conditions.

II The Proposed New Seeding Method

1. Custom methods of direct seeding in untilled dry paddy fields and the associated problems

In Japan, there are two standard methods for direct seeding of untilled dry paddy fields: the Okayama method and the Aichi method (Washio, 2003).

The Okayama method prescribes that seeding, fertilizing, pesticide application, and soil covering are carried out in a ditch with a depth of 20–30 mm. The ditch is prepared using a reversibly rotating ditching machine equipped with soil-covering blades. The advantages of this method include stable germination, stable seedling growth, no disturbance of the seeding process by weather changes, elimination of the need of a water supply at the time of seeding, a high lodging tolerance, reduced bird damage, high soil permeability, low methane emission, good rice yield, and a quality comparable to that obtained by standard rice cultivation (Okatake, 1998). The distribution of seeds is nearly identical to that achieved with dibbled seeding, although strip seeding sometimes occurs when the seeding machine speed is increased. Strip seeding decreases both germination rate and lodging tolerance; hence, a relatively slow seeding speed is desirable (Kimoto et al., 1995).

In the Aichi method, seeding and fertilizing are carried out in a V-shaped 50-mm deep ditch with an opening width of 30 mm. The ditch is prepared using a ditching wheel. A characteristic of this method is that paddy fields are tilled and soil puddled in the winter in order to avoid a crowded

*1 JSAM Member, Graduate School of Life and Environmental Sciences, Osaka Prefecture University, 1-1, Gakuen-cho, Naka-ku, Sakai, Osaka, 599-8531 Japan: nishiura@bioinfo.osakafu-u.ac.jp

planting season. In winter, use of this method is effective in controlling water leaks, preventing overgrowth of weeds, improving land leveling, disposing of waste straws, and promoting tillering and root development. An inter-ditch distance of approximately 200 mm is ideal for obtaining the maximum number of seedlings and tillers per unit area (Hamada et al., 1995). Koide et al. (1997) reported that the rice yield obtained using this method is nearly the same as that obtained by custom transplanting. They reported that harmful competition between rice plants sometimes occurs due to dense plantation (Koide et al., 1997). To avoid the harmful effects of such dense plantation, large amounts of agricultural chemicals must be applied, resulting in decreasing cost-effectiveness and increasing environmental stress. Therefore, rather than strip seeding, spot seeding is preferred to provide adequate ventilation and decrease the harmful effects resulting from dense plantation.

2. Direct seeding beneath stubbles

Figure 1 summarizes the proposed method of seeding directly beneath the previous year's stubbles.

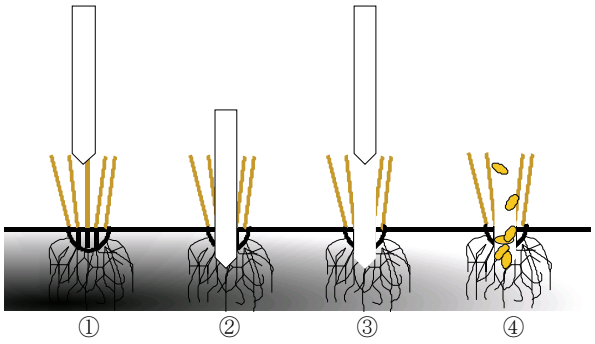

Fig. 1 Schematic diagrams of direct seeding beneath the previous year's stubbles.

This process consists of 4 steps: (1) aiming with a stick at the planting position in the stubble, (2) boring a hole with the stick at the aimed position, (3) removing the stick, and (4) seeding into the hole. Although soil hardness changes according to field water content, the soil beneath the stubble is consistently wet and soft regardless of the soil water content because the tillering portion is putrid at the time of seeding. Therefore, boring and seeding are relatively easier in stubble than in soils.

Figure 2 shows a cross-sectional view of the area beneath the stubble. The blackish area in the figure, which is shaped like an inverted triangle, is the tillering portion of the rice that was grown in the previous year, and is quite soft and porous with excellent aeration and water-holding capacity. Furthermore, the hole bored in the stubble gradually closes, providing the same effect as soil-covering.

Figure 3 shows the seeds sown in the stubble hole, which has already been closed, such that birds cannot locate the seeds.

Fig. 2 Cross-sectional view of the area underneath the stubble.

Fig. 3 Cross-sectional view of the region below the stubble after direct seeding.

The described seeding method can overcome many of the difficulties encountered in standard ditching methods, as follows. Seeding spots can be fixed depending on the stubble position. Seeding spots prevent strip seeding, which sometimes occurs when using conventional seeding methods. This can cause overgrowth of rice and increase pest damage. Seeds are embedded into stubbles, solving the problem of bird damage that may sometimes occur due to insufficient covering of the seeds by soil, particularly in hard soil fields. The porous and water-holding capacities of the tillering part of stubbles provide suitable conditions for rice germination and seedling growth, which require a continuous water supply.