Effective Microorganisms in Nature Farming: Weeding Effect of EM 4 in Paddy Fields

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Abstract

The control of weeds in paddy rice has remained an unresolved problem in nature farming until now. Effective microorganisms (EM) have shown promise as a solution by accelerating the germination of weeds. Experiments were conducted to determine the best timing, frequency, and rate of application of EM 4 for controlling weeds in paddy rice. EM 4 reduced the amount and species of weeds. EM 4 was wore active in a wet field, and its application at spring plowing and at paddling and leveling was sufficient to control annual weeds. Additional research is needed to determine the effect of EM 4 on perennial weeds.

Introduction

Although more than 50 years have passed since Kyusei Nature Farming was first advocated in Japan in 1936, the farming method still has three types of problems: the supply of adequate plant nutrients, the prevention of disease and insect infestation, and the control of weeds. The problem of weeds in growing or standing paddy rice was the main obstacle in extending the nature farming concept and methodology.

Various experiments and trials have been conducted to solve this problem. Some of these are deep water cultivation, crop rotations, the interrow hand weeding machine, the intrarow and interrow motorized weeding machine, and 2 to 3 puddlings and levelings. None of these, however, has been entirely satisfactory in solving the problem.

Effective microorganisms (EM) were introduced to nature farming during 1985, and have shown good prospects for solving the weed problem. Accelerated germination due to EM 4, in conjunction with the usual weeding method of 2 to 3 puddlings and levelings, have shown promise as a solution to the weed problem in paddy rice cultivation. Additional research is expected to establish this method as a highly acceptable means of weeding for paddy rice cultivation.

Kyusei Nature Farming is a farming method which uses no chemical fertilizers or pesticides. It emphasizes the use of natural systems to provide adequate nutrients for plant growth, and to enhance the health and protection of plants.

Materials and Methods

Field experiments were conducted to determine the effect of EM 4 in accelerating the germination of weed seeds in paddy rice cultivation, and the feasibility of using EM 4, in combination with puddling and leveling operations, as an improved weeding practice.

The sequence of cultivation practices and the results of the experiments are shown in Tables 1 and 2. The tables provide information on two comparative experiments and two practical experiments.

The difference in cultivation practices between the comparative experiments was because the time, rate, and frequency of EM 4 application, and the frequency of puddling and leveling were not firmly established when these studies were conducted. Furthermore, in the practical experiments no reference field was established and the simplest method for preventing weeds was used.

Composition and Function of EM 4

EM 4 is mainly composed of *lactobacillus spp.*, with smaller numbers of photosynthetic bacteria, ray fungi, and yeasts.

Table 1. The Effect of Application Procedure of EM4 on Rice Growth and Weeds in Paddy Fields with Two Puddlings and Levelings: Comparative Experiments.

Grower Experiment lot		COMPARATIVE EXPERIMENT 1: H. Baba		COMPARATIVE EXPERIMENT 2: T. Tanabe	
		EM 4 applied	EM 4 not applied	EM 4 applied	EM 4 not applied
Variety		Koshihikari		Nihobare	
Cultivation area		10 a	1 a	10 a	3 a
Fall plowing		Twice	Once	Once	Once
Spring plowing		Twice	Twice	Once	Once
Spray of EM4 Saturated solution (1 liter/10a)	1st	Late Oct		Apr 29	
	2nd	Early Feb		May 7	
	3rd	Early Mar			
Paddling and leveling	1st	Apr 17	Mar 20	May 2	May 2
	2nd	Apr 27	Apr 13	May 7	May 7
	3rd	May 4	Apr 24		
Paddling interval		15 days	33 days	4 days	4 days
Rice planting		May 6	May 3	May 10	May 9
Weeding	1st	Late May (machine)	May 15 (machine)	May 25 (machine)	May 25 (machine)
	2nd	Mid Jun (machine)	May 25 (hand)	May 30 (hand) Jun 13 (machine) Jun 20 (hand)	Jun 13 (machine)
	3rd	Preharvest picking	Jun 10 (hand)		Jul 6 (hand)
Result	Weeding hours	Approx, 9 hrs/10a	Approx, 30 hrs/10a	Approx. 12 hrs/10a	Approx. 30 hrs/10a
	Weed growth*	1	4	2	4
Reference	Yield	433 kg/10a	290 kg/10a	554 kg/10a	377 kg/10a
	EM2 and EM3	Used	Not used	Used	Not used
	Weeding in previous year	Herbicides were used		Machine weeding: twice Hand weeding: twice	
	Location	Shiga Prefecture, JAPAN		Shiga Prefecture, JAPAN	

* Weed growth : 4(very much), 3(much), 2 (a little), 1(very little), 0(none).

Table 2. The Effect of Application Procedure of EM4 on Rice Growth and Weeds in Paddy Fields with Two Puddlings and Levelings: Practical Experiments.

Grower Experiment lot		COMPARATIVE EXPERIMENT 1 K. Nakazawa	COMPARATIVE EXPERIMENT 2 R. Yamazaki
Variety		Nihobare	Nihobare
Cultivation area		6 a	7 a
Fall plowing		None	Once
Spring plowing		Once	Twice
Spray of EM4 Saturated solution (1 liter/10a)	1st	Jun 13	Dec 14
	2nd		Mar 9
	3rd		Jun 10
Paddling and leveling	1st	Jun 13	Jun 10
	2nd	Jun 19	Jun 17
	3rd		
Paddling interval		5 days	6 days
Rice planting		Jun 20	Jun 20
Weeding	1st		
	2nd		
	3rd		
Result	Weeding hours	0 hr/10a	0 hr/10a
	Weed growth*	0	0
Reference	Yield	568 kg/10a	495 kg/10a
	EM2 and EM3	Used	Used
	Weeding in previous year	Machine: twice Hand: once	Herbicides were used
	Location	Kyoto, JAPAN	Nara Prefecture, JAPAN

* Weed growth : 4(very much), 3(much), 2 (a little), 1(very little), 0(none).

Lactobacilli in EM 4 are capable of fermenting the husks of seeds, and in so doing can accelerate seed germination. EM 4 also has strong germicidal properties, and can directly suppress soil borne plant pathogens, including *Fusarium spp.* and *Sclerotinia sclerotium*. In addition, if green grass is plowed into soil and EM 4 is applied, Lactobacilli will ferment the grass without complete decomposition. This means that the problems which occur during the decomposition process in soil are avoided and, hence, green grass can be converted into a compost-like material which, in turn, can improve soil productivity and the growth and yield of crops.

Method of Spraying EM 4

At fall plowing and spring plowing (no water in the field), 1 liter of a liquid stock culture of EM 4 was diluted with water to 1:1000 and sprayed over the field with a powered sprayer. At puddling and leveling (water in the field), 1 liter of a liquid stock culture of EM 4 was diluted with water to 1:50 to 1:10 and sprayed evenly over the field with a sprinkling can.

Results

In both the comparative experiments, the time required for weeding was shorter for the lot treated with EM 4 than for the untreated controls. Visual inspection of the fields clearly showed that the application of EM 4 reduced both the amount and species of weeds.

In the practical experiments, the weeding effect of EM 4 was more noticeable than for the comparative experiments. The time required for weeding was zero in both experiments. Visual inspection of the fields showed almost no weeds in the fields. Additional details are reported in the tables.

Discussion

Number of EM 4 Applications

Practical experiment 1 showed excellent results with the simplest procedure. In practical experiment 2, EM 4 was sprayed on the field a total of three times, once each at fall plowing, spring plowing, and puddling and leveling. It was sprayed only once at puddling and leveling in practical experiment 1, resulting in the same weeding time of zero hours. A conclusion here is that the spraying of EM 4 at fall plowing is unnecessary.

Water in the Field

It is inferred from the results of comparative experiment 1 that microorganisms become less active if they are sprayed when there is no water in the field (fall and spring plowing). This is supported by results from another practical experiment that concluded the amount of weeds in a wet field was reduced to one-half by spraying EM 4 only once at fall plowing.

Temperature and Puddling Interval

Since rice was planted late in the season in the practical experiments, the water temperature in the field was higher than that in the comparative experiments. Therefore, it can be assumed that weed seeds germinated fully in the practical experiments, although the interval of rough puddling and finished puddling was short (5 or 6 days) because the germination of weed seeds is faster at higher temperatures.

However, in comparative experiment 1, the germination of weed seeds was incomplete in the EM 4 treated lot because water temperature was low, although the puddling interval was 15 days.

The puddling interval in the EM 4 treated lot in comparative experiment 2 was only 4 days. If the interval was longer, more seeds could have germinated and weeding would have been more effective.

Among all the experiments, practical experiment 1 was the simplest and most effective method of weeding. However, the puddling interval needs to be longer in regions where rice is planted earlier in the season, and in cooler regions where early temperatures are low. Therefore, the most suitable and effective procedure of EM 4 application for each region will depend on specific climatic and agroecological conditions.

Further Research

The results of these experiments indicate that EM 4 can effectively control certain weeds in paddy rice cultivation. However, the weeds in these experiments were mainly annual weeds such as barnyard grass and, thus, it is not clear whether these same procedures would also be effective against perennial weeds. Therefore, weeding methods to control perennial weeds will be evaluated in future experiments.