Nature Farming in Taiwan: Effect of EM on Growth and Yield of Paddy Rice

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Abstract

The highly intensive farming systems in Taiwan have come to depend on heavy applications of chemical fertilizers and pesticides. This has led to serious environmental pollution problems and gradual sterilization of arable land.

Preliminary experiments with Kyusei Nature Farming in various districts of Taiwan prove that by utilizing effective microorganisms (EM) arable land is visually fortified and revitalized, enhancing plant health and improving the growth and yield of paddy rice. Microbial control farming offers the best means of achieving high production without polluting the environment.

Introduction

Along with the increased income per capita, people are seeking higher quality for their daily life. Recently, pesticide residues on vegetables and environmental pollution caused by industrial wastewater have resulted in serious problems for society (Fang and Wu, 1989).

Most naturally-occurring or synthetic organic materials are decomposed through microbiological processes. Therefore, it is appropriate to devote more effort to research on microorganisms to resolve the problem of environmental pollution.

Microbial Control: The Best Option for Pest Control

It is a natural rule that all creatures must eventually become sick and die, including human beings and insects. This rule keeps all creatures living in a balanced condition without overloading. Human beings have struggled for centuries against insects for their production of food. Chemical pesticides became an effective way of controlling diseases and insects. However, side effects of such chemical applications have created unexpected problems in past years, i.e., hazardous pesticide residues in food, poisoning of nontarget beneficial species, environmental pollution, and occurrence of antibiotic pests. Because of this, microbial control has been emphasized as a remedial measure to replace chemical fertilizers and pesticides (Liu, 1989).

Production Objective of Nature Farming

Nature farming is one of the most effective ways to avoid environmental pollution. Under this system, useful fertilizer is produced by allowing the primary resources to enhance the farming objectives. Meanwhile, entomopathogenic groups will be reduced or depressed, and the crop and land will be protected at less cost. No chemical fertilizers or pesticides will be used in the farming systems (Higa, 1987).

Promoting Nature Farming in Taiwan

The highly intensive farming methods practiced in Taiwan are dependent on heavy applications of chemical fertilizers and pesticides to sustain a high level of agricultural production. This has caused serious pollution problems and gradual sterilization of arable land (Liu, 1989).

It was indeed fortunate that Mr. Yasushi Matsumoto, President of Sekai Kyusei Kyo and his colleagues visited Chiuka-Minkoku Shin-Sei Sokai, Taipei, Taiwan in May of 1989. He ked Dr. Teruo Higa of the University of the Ryukyus, Okinawa, Japan, and Mr. as Yoshikazu Arakawa of the International Nature Farming Research Center, Atami, Japan, to conduct a technical seminar on effective microorganisms (EM), and to teach our farmers how to use EM so as to avoid the application of chemical fertilizers and pesticides. We wanted to achieve a greater harvest at lower cost, and without the health hazards of wan pesticide residues on the crop. This would help us to achieve the objectives of Kyusei Nature Farming.

At the time of the visit, nature farming in Taiwan was only in the initial stage of development.

However, under the aggressive promotion of the late Mr. Wu Huan-Shin, preliminary experiments were initiated to assess the effects of seasonal differences on crops in various regions. Thus, nature farming has officially been implemented, and the following results obtained.

Results of Nature Farming on Paddy Rice

The preliminary locations for testing the nature farming system for paddy rice are: 200 m^2 of sloping land at Tou-Sur, Nan-Tou Hsien, furnished by the President of the Judicial Yuan, his excellency, Mr. Lin, Yang-Kang; 80 m^2 of farmland at Shiao-Chia, Tainan Hsien, furnished by Mr. Lou, Hou-Chuan; and 300 m2 of farmland at Shan-Hua, Tainan Hsien, furnished by Mr. Lin, Chin-Pao.

Results of EM on Control of Weeds

Generally, conventional farming systems apply chemical herbicides to control weeds after the seeding of crops and after seeding of paddy rice, in lieu of hand weeding or other mechanical control methods.

According to Dr. Teruo Higa, the innovator of the concept of effective microorganisms, EM can be used to treat farmland before seeding paddy rice, and thereby encourage the early germination of weed seeds. The germinated weeds are then fully in contact with EM and rake sowing can proceed. This ensures that all the weeds are covered by soil so that they can be decomposed and fermented by microorganisms and turned into humus. This, in turn, will increase the availability of plant nutrients in the soil (Higa, 1987).

In the EM treatment at Nan-Tou, Taiwan, the re-growth of weeds was not fully controlled. This was because we were not able to carry out the EM treatment properly before the seeding of paddy rice, but we did achieve more than 70 percent efficiency of control. An interesting phenomenon was discovered on the EM treated farmland, i.e., the re-growing weeds were more easily removed by manual labor than on land that was farmed with conventional methods.

Control of Diseases and Insects

Conventional farming usually applies pesticides to all types of insect infestation, and often good results are achieved, However, residual toxic chemical residues in agricultural products are creating a potential hazard to human health which is not acceptable to the consumer.

Because of the need for intensive agricultural production in Taiwan, it is almost impossible to leave farmland fallow or unplanted. Therefore, all types of diseases and insects are continuously infesting different crops.

In comparing nature farming with conventional farming, with respect to the control of disease and insect infestations, the major difference is that the pesticides are aggressive and instantly effective, but also directly and indirectly toxic.

EM is used to increase the initial resistance factor of the crop, and then to slowly cause a decline in the activity of harmful insects, thereby achieving the results of natural death. Therefore, it is predictable that the effect of EM is preventive rather than toxic.

Thus far, we have not been able to show effective inhibition of the disease-causing organisms *Thanatephorus cucumeris* (Frank) Donk and *Chilo suppressalis* (Walker). However, early and proper EM treatment has effectively inhibited such plant pests as *Rhizoctonia solani*, the mycoplasma-like organisms, *Tryporyza incertulas* (Walker), *Nilaparvata lugens* (Stal), *Cnaphalocrocis medinalis* (Guenee), and *Hydrellia sasokii* (Yuosa) (Table l) (COAT, 1984).

Table 1. The Effects of Effective Microorganisms (EM) on Diseases and Insect Infestation Control on Paddy Rice.

Experiment Period : Jun. 22 thru Oct. 8, 1989

Date of Checking		6/22	6/29	7/22	7/29	8/02	8/12	8/19	9/02	9/16
Day after Seeding		1st Day	7th Day	30th Day	37th Day	41st Day	51st Day	58th Day	72nd Day	88th Day
Type of Disease	Group									
Rhizoctonia solani	EM-GP	-	x	x	x	-	-	-	-	-
	CK-GP	-	x	x	-	-	-	-	-	-
Mycoplasma-like organism	EM-GP	-	-	x	xx	x	-	-	-	-
	CK-GP	-	-	x	x	x	-	-	-	-
Thanateohorus cucumeris Donk	EM-GP	-	-	x	xx	xx	xxx	xxx	xx	xx
	CK-GP	-	-	x	xx	x	x	-	-	-
Chilo suppressalis Walker	EM-GP	-	-	x	xx	xx	xxx	xxx	xxx	xx
	CK-GP	-	-	x	xx	x	-	-	-	-
Tryporyza incertulas Walker	EM-GP	-	-	x	x	-	-	-	-	-
	CK-GP	-	-	x	-	-	-	-	-	-
Nilaparavata lugens (Stal)	EM-GP	-	x	xx	x	x	-	-	-	-
	CK-GP	-	x	x	-	-	-	-	-	-
Cnaphalocrocis medinalis Guenee	EM-GP	-	-	x	x	xx	xx	x	-	-
	CK-GP	-	-	x	x	xx	x	-	-	-
Hydrellia sasokii Yuosa	EM-GP	-	-	x	x	xx	xx	x	-	-
	CK-GP	-	-	x	x	x	x	-	-	-
Pyricularia oryzae Cav.	EM-GP	1st Day of Seeding on Aug. 13, 1989						-	x	xx
	CK-GP							-	x	x
Xanthomonas campestinis lshi.	EM-GP	1st Day of Seeding on Aug. 13, 1989						-	-	x
	CK-GP							-	-	x
Nephotettix spp.	EM-GP	1st Day of Seeding on Aug. 13, 1989						-	x	xx
	CK-GP							-	x	x

Remarks: 1/. At 7th day after seeding - EM 0.1% for EM group (EM-GP), Pesticide for Checking group (CK-GP) has been sprayed.
2/. At 36th day after seeding - EM 0.2% for EM-GP, Pesticide for CK-GP has been sprayed.
3/. At 41st day after seeding - EM 1.0% for EM-GP, Pesticide for CK-GP has been sprayed.
4/. At 52nd day after seeding - EM 1.25% for EM-GP, Pesticide for CK-GP has been sprayed.
5/. At 59th day after seeding - EM 1.50% for EM-GP, Pesticide for CK-GP has been sprayed.
6/. Average pH value is 7.3, and Temperature is 32 degree of C.
7/. '-' means infestation NIL, 'x' means primary infestation.
'xx' means serious infestation, 'xxx' means very serious.

Results of Propagation and Growth of Paddy Rice

After the EM treatment, the germination and early growth of paddy rice was about the same as that planted with conventional farming methods. Later on, however, the rice plants receiving the EM treatment developed straighter stems and heavier leaves than plants grown by the conventional methods. Moreover, the EM treated plants developed a more extensive root system. Hence, despite the devastation to crops caused by Typhoon Sara in September 1989, the EM treated paddy rice was still straight and stems were neither bent nor broken. However, the conventionally-grown paddy rice

was bent in every direction, with the leaves dropping down and the stems broken.
After treatment with EM, the flowering and fruiting of the paddy rice were 7 to 10 days earlier than rice grown with conventional methods (Table 2 and Figures 1 and 2).

Table 2. The Effects of Effective Microorganisms on the Propagation and the Growth of Paddy Rice.

Experiment Period: Jun. 22 thru Oct. 08, 1989

Day after Seeding	Average Numbers of Paddy Rice (pcs)		Height of Paddy Rice (cm)		Quantity of EM Treatment for EM Group
	EM-GP	CK-GP	EM-GP	CK-GP	
1st Day	8	6	11	9	0.1%
30th Day	11	13	18	16	0.1%
37th Day	13	16	34	31	0.2%
41st Day	16	21	39	34	1.0%
42nd Day	20	24	60	55	1.25%
59th Day	24	27	71	63	1.5%
73rd Day	24	27	100	73	-

Regression Output: (Buds)

Constant	9.160874
Std Err of Y Est	1.993146
R Squared	0.909369
No of Observations	6
Degrees of Freedom	4
X Coefficient(s)	892.4037
Std Err of Coef.	140.8633

Regression Output: (Height)

Constant	14.98126
Std Err of Y Est	9.136979
R Squared	0.876995
No. of Observations	6
Degrees of Freedom	4
X Coefficient(s)	3448.491
Std Err of Coef.	645.7457

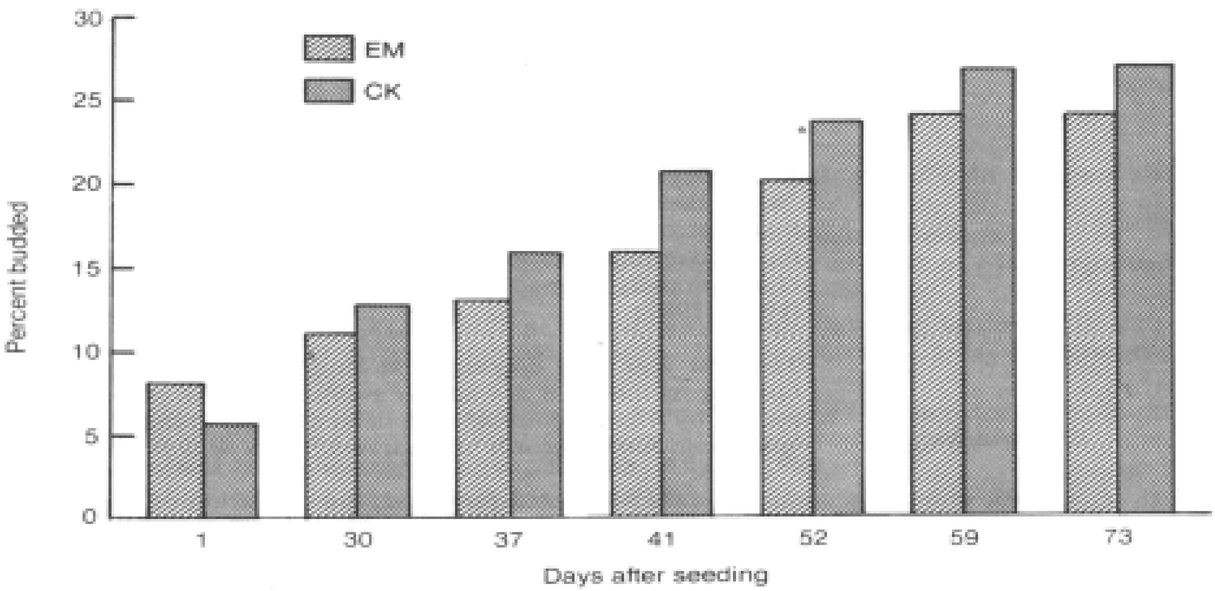

Figure 1. Budded Paddy Rice.

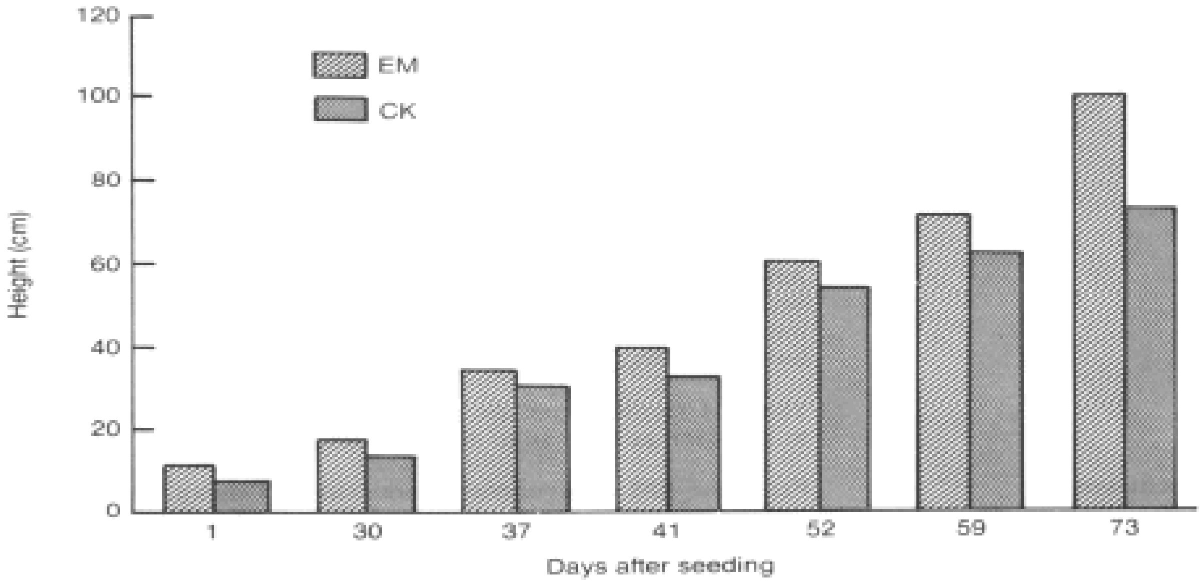

Figure 2. Height of Paddy Rice.

Soil Improvement and Environmental Impact

According to Dr. Teruo Higa, after the EM treatment organic materials in the soil are decomposed by EM; the humus content is increased; the content and availability of nutrients are increased; the nitrogen cycling function of the soil is increased; and the soil oxygen content or volume is increased. Consequently, the physical nature of the soil has improved which enhances tilth, drainage, and a water-holding capacity (Higa, 1987).

These results, indicate that the EM treated farmlands are really more friable, less compact, and better drained than the conventionally farmed lands. Thus, the EM treated soils provided a more favorable environment for crop growth.

Another obvious difference was that the EM treated rice paddy had a great number of phytoplankton and algae which spread throughout the paddy. This is indirectly beneficial to the growth of paddy rice. It is noteworthy that the conventionally-farmed paddy did not have noticeable growth of phytoplankton.

As for the environmental pollution impacts, because the EM treatment replaces conventional cultivation's use of chemical fertilizers and pesticides, there is no concern about residual toxicity in the paddy rice. Also, the propagation and growth of paddy rice are more suitable. It is easy to obtain the sunshine and the ventilation of air which accelerates the growth of paddy rice. Meanwhile the soil quality and air quality are greatly improved.

Harvest of Paddy Rice and Future Outlook

According to Dr. Teruo Higa, studies on the nature farming method have shown that during the first year, the production of crops following EM treatment is little different than that of the conventionally cultivated farmland. However, in the second or third year, the production of crops from nature farming and use of EM greatly exceeds that of the conventionally farmed land. Moreover, the quality of paddy rice is improved due to EM (Higa, 1987).

The first year tests conducted at Non-Tou, Taiwan on the implementation of the nature farming method, do not appear promising. The obvious reason is that the two diseases caused by *Thanatephorus cucumeris* (Frank) Donk and *Chilo suppressalis* (Walker) are still spreading. Consequently the harvest yields will be reduced.

As for the EM treated farmland, the inhibition of weed regeneration and removal of weeds will be key research subjects for the implementation of the nature farming method.

After EM treatment, research will also focus on how to avoid the occurrence of disease and insect infestations and which phases of the pathogen's life cycle can be controlled by EM. This research will be a high priority in the future implementation of successful nature farming in Taiwan.

Hopefully, this will also help to decrease the cost of EM.

An analysis comparing the overall costs with those of conventional farming shall also be one of our priorities. But the nature farming method can undoubtedly prevent environmental pollution. As a matter of fact, all these effective microorganisms exist in the natural environment. All we are doing is increasing the numbers and activities of these beneficial microorganisms, to give them more opportunities to combat plant pathogens, insects, and disease. Moreover, the harmful insects cannot readily generate resistance to these microorganisms. While the physiological capability of these beneficial microorganisms varies, when applied as mixed cultures they can effectively suppress a wide range of harmful insects and plant pathogen.

After application to the rice paddy , these organisms will adapt to this environment and become an effective control mechanism, which will be widely spread by means of natural forces. They should also be effective over the long-term against insects that are harmful to human health (Tsai, 1988).

The EM formulations are not harmful to humans or other animals; therefore, they are safe to the user as well as to the consumer.

Conclusions

From the EM experiments conducted in Taiwan, the following conclusions were reached:

1) Kyusei Nature Farming is one of the most effective ways to prevent environmental pollution.
2) By utilizing effective microorganisms (EM), arable lands are fortified and revitalized, thereby enhancing the healthy and vigorous growth of paddy rice.
3) The EM treatment made the stems and the leaves of the paddy rice stronger, straighter, and heavier than conventionally grown rice.
4) In controlling disease and insect infestations, it is predictable that the effects of EM are preventive rather than toxic.
5) EM formulations are not harmful to humans or animals; therefore, they are safe to the user as well as to the consumer.

References

Council of Agriculture, Taiwan. 1984. Plant protection manual. p. 1-37. In Diseases and insects infestation in the field of paddy rice. Taipei, Taiwan.

Fang, H. Y. and L. M. Wu. 1989. Development of bioaugmentation products for degradation of petroleum pollutants. p.5. First Conference on Role of Microorganisms in Environmental Biotechnology. Taipei, Taiwan. August 1989.

Higa, T. 1987. Studies on the application of microorganisms in nature farming (II): The practical application of effective microorganisms (EM) in Japan. p.1-11. International Nature Farming Research Center, Atami, Japan.

Liu, S. D. 1989. Development and application of entomopathogenic fungi for agricultural pests control in Taiwan. p.9-10. First Conference on Role of Microorganisms in Environmental Biotechnology. Taipei, Taiwan. August 1989.

Tsai, Y. S. 1988. Microorganisms to prevent disease and insect infestation without environmental pollution. No. 20 Harvest Semi-monthly 38:26-29.