Effect of EM on Rice Production and Methane Emission from Paddy Fields in Malaysia

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Introduction

There is growing interest worldwide in alternative agricultural practices that can help farmers reduce their dependence on chemical fertilizers and pesticides. The excessive use and misuse of these synthetic chemicals have raised serious questions about their adverse effects on human health, soil quality and the environment. Proper and regular additions of organic amendments (i.e:, crop residues, animal manures, agricultural processing wastes, municipal wastes and composts) to agricultural soils can help to improve soil quality and control pests in lieu of agrichemicals. Organic amendments applied to rice fields often require special management because they can create highly reduced soil conditions which may adversely affect rice yields and enhance the emission of greenhouse gases such as methane. A recent estimate indicates that the atmospheric concentration of methane is increasing by one percent each year (IPCC, 1990) which could be a threat to the ozone layer.

In view of these concerns the Malaysian Agricultural Research and Development Institute (MARDI) and the University of Agriculture initiated experiments in 1993 to determine the effect of different organic amendments and Effective Microorganisms (EM) on rice yields and methane emission under field conditions.

Materials and Methods

Field experiments were conducted in Muda and Tanjung Karang, two of Malaysia's main rice growing areas. The soil was of marine alluvial origin and the following treatments were applied:

1. NPK (80-30-20 kg/ha) applied to soil before transplanting rice.
2. NPK + EM4
3. *Sesbania rostrata* (seed rate 50 kg/ha) + N (80 kg/ha)
4. *Sesbania rostrata* + N + EM4
5. Sacom (composted rice husk at 5 tons/ha) + NPK
6. Sacom + NPK + EM4
7. POME (Palm oil mill effluent at 5 tons/ha) + NPK
8. POME + NPK + EM4
9. Rice straw (5 tons/ha) + NPK
10. Rice straw + NPK + EM4

The organic amendments were incorporated into the soil by shallow plowing prior to transplanting rice. EM4 was first applied to the soil before transplanting and then at weekly intervals to the rice plants as a foliar spray. The experiments were conducted using a randomized complete block design (RCBD) with four replications. Plot size was 5 x 5 m. Plant growth measurements and grain yields were recorded.

Methane emission measurements were made using the "closed chamber method" described by Yagi and Minami (1989). Gas samples were collected by pumping from the chamber into Tedlar bags twice daily at 11:00 and 14:00 hours. Methane concentrations were determined by gas chromatography.

Table 1. Effect of EM, Chemical Fertilizer and Organic Amendments on Rice Grain Yield in Tanjung Karang.

Treatments	1993 Monsoon season		1994 Off season		1994 Monsoon season	
	Yield (t/ha)	Rel. yield (%)	Yield (t/ha)	Rel. yield (%)	Yield (t/ha)	Rel. yield (%)
Straw+NPK	3.1	100	3.0	100	3.0	100
Straw+NPK +EM4	3.3	106	3.2	107	3.6	120
POME+NPK	3.4	100	3.3	100	3.6	100
POME+NPK +EM4	3.6	106	3.0	91	3.9	108
CV(%)	11.9		18		14.9	

Result and Discussion

Grain Yield

The effects of EM 4, chemical fertilizer and two organic amendments (rice straw and POME) on rice grain yield in Tanjung Karang are shown in Table 1. During the three seasons, EM4 applied with rice straw + NPK progressively increased rice yields by 6, 7 and 20 percent, respectively, compared with rice straw + NPK alone. The addition of EM4 to the POME + NPK treatment increased rice yields by 6 and 8 percent, respectively, in the 1993 and 1994 monsoon seasons. However, in the 1994 off season rice yields were 9 percent lower for the POME + NPK + EM4 treatment compared with POME + NPK alone.

Table 2 shows the effect of foliar-applied EM and soil-applied chemical fertilizer on the yield and relative yield of rice grain in Tanjung Karang. The application of EM4 to the NPK treatment (i.e., NPK + EM 4) increased rice grain yield by 9 percent compared with NPK alone. Although the rice yield was 6 percent lower for EM4 compared with NPK alone, it does suggest that the proper and regular additions of EM would allow farmers to markedly reduce their inputs of chemical fertilizers under these cultural and management conditions. These field experiments have shown that the application of EM4 increased the mean rice grain yields by about 10 percent.

Methane Emission

The effects of EM, chemical fertilizer and organic amendments on methane emission at different growth stages of rice in Muda are shown in Table 3. The application of EM4 with *S.*

rostrata, Sacom and POME generally reduced methane emission at most of the growth stages indicated except for ripening. It is noteworthy that the last application of EM was made before flowering, with no EM applied during grain formation. The overall mean reduction in methane emission from EM4 applied with *S. rostrata*, Sacom and POME was 54, 43 and 19 percent, respectively, compared with no EM.

Table 2. Effect of Foliar-Applied EM and Soil-Applied Chemical Fertilizer on Rice Grain Yield in Tanjung Karang.

Treatments	Yield (t/ha)	Relative yield (%)
NPK	4.7	100
EM4	4.4	94
NPK+EM4	5.1	109
CV(%)	6.5	

Table 3. Effect of EM, Chemical Fertilizer and Organic Amendments on Methane Emission at Different Growth Stages of Rice in Muda

Treatments	($mg/m^2/hour$)						Relative Emission (%)
	Maximum tillering	Reduction division	Heading stage	Dough stage	Ripening stage	Mean emission	
S.rostrata+N	368	18	26	23	17	90	100
S.rostrata+N+EM4	137	10	26	13	24	42	46
Sacom+NPK	191	16	26	7	5	49	100
Sacom+NPK+EM4	85	15	8	13	19	28	57
POME+NPK	475	18	22	17	4	107	100
POME+NPK+EM4	375	24	9	13	15	87	81
Rice straw+NPK	202	19	16	16	9	52	100
Rice straw+NPK+EM4	385	25	29	43	26	102	194

seeding Rate: S. rostrata, 50 kg/ha.

Application Rates: Sacom, 5 t/ha; POME, 5 t/ha; rice straw, 5 t/ha; NPK, 80-30-20 kg/ha. Sacom is a compost produced mainly from rice hulls.

In the case of straw, the application of EM4 resulted in a 94 percent increase in methane emission. A possible explanation for this is that the straw had a very high C:N ratio (67 compared with 5.5, 5.6 and 40 for *S. rostrata*, POME and Sacom, respectively). Since N was added to both of the straw treatments it is likely that much of the straw carbon was readily available to the soil microflora and especially the EM cultures. Thus, the resulting microbial activity could have led to highly reduced soil conditions that are conducive to methane production and emission.

Conclusions

This study has shown that EM has the potential to increase rice yields by about 10 percent.

EM appears to be capable of reducing the emission of methane in flooded rice fields when applied with organic amendments such as green manure (*S. rostrata*), Sacom and POME which have reasonably low C:N ratios. The effect of EM applied with high C:N organic amendments on methane emission, and the growth and yield of rice, should be investigated more thoroughly.

References

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