Nature Farming Research in Malaysia: Effect of Organic Amendments and EM on Crop Production

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Abstract

The use of organic amendments in nature farming systems for food and agricultural production has long been practiced in Malaysia. Prior to the introduction of chemical fertilizers and pesticides, Malaysian farmers depended solely on organic manures as a source of nutrients for crop production. However, under this system, production was low and agricultural activities remained at a subsistence level. With the advent of chemical fertilizers and pesticides, especially after the Second World War, Malaysia emerged as the world's top producer of natural rubber, and later, in the 1980's, as the top supplier of palm oil.

Because of increasing concern about the adverse effects of agrichemicals on the environment and human health and questions on the sustainability of these intensive agricultural systems, research on alternative farming emerged in the 1970's with special emphasis on the use of natural products and agricultural wastes. Through these concerted efforts, Malaysian agriculture has now largely utilized most of the available agricultural and processing wastes, which has greatly improved soil quality and the environment. Under the Sixth Malaysian Plan (1991-1995), research was intensified to bring about a more efficient agricultural system that is productive, highly profitable, sustainable and environmentally-friendly.

In 1990, research on nature farming using Effective Microorganisms (EM) started in Malaysia after the First International Conference on Kyusei Nature Farming in 1989. For the past three years, research efforts have compared nature farming using organic amendments and EM with conventional farming using chemical fertilizers in the production of sweet corn (Zea mays L.) and leaf mustard (Brassica juncea). Results indicate that the use of organic amendments, particularly chicken dung, with EM can significantly increase the yield of both crops.

Currently, nature farming research with EM is being conducted on the production of sweet corn, leaf mustard and flooded rice. Before the end of the year, two more research projects will be added, namely, the production of strawberry (Fragaria sp.) and of durian (Durio zibethinus Murr.).

Introduction

Nature farming research in Malaysia started in 1990 after the First International Conference on Kyusei Nature Farming held at Khon Kaen, Thailand. Prior to this, research on utilization of agricultural wastes was conducted by government agencies as well as by the private sector to find ways and means of disposing of agricultural wastes that, if not properly utilized, can result in serious environmental pollution. This research has drastically changed the management of plantation crops. In the oil palm sector, all plant residues and mill effluents are utilized mainly as organic fertilizer, thus effectively reducing pollution and the need for chemical fertilizers. Similarly, rubber effluents are also utilized, but to a much lower extent. At the time of replanting, oil palm trunks and leaves are shredded and used as fertilizer; under the old system they were felled and burned. Rubber wood is used to make furniture which reduces pollution caused by open burning. Animal wastes, except for pig dung (a taboo for the Muslim population), are used in production of vegetable and horticultural crops.

Interest in natural and organic farming has long been expressed by individuals who view the advent of high-input technology (especially agricultural chemicals) in farming systems as a potential threat to the environment and human health. However, attempts to grow food crops by organic farming methods have proven to be uneconomical because of low yields, increased labor requirements, high incidence of weed and insect infestations. and inadequate amounts of good quality organic amendments to sustain the crop's nutrient requirements. Serious thought to growing food crops organically, especially vegetables, surfaced again in the 1980's when vegetables intended for export to Singapore were rejected because of high levels of pesticide residues. The pesticide issue was further aggravated when some people became ill after consuming sweet corn that had received heavy applications of pesticides. As a result, research on alternative agriculture was conducted that included organic farming, nature farming, rain shelter, and integrated pest management (including biocontrol strategies) with minimal use of pesticides.

Currently, research on organic/nature farming and use of organic fertilizers is being conducted mainly by the University Pertanian Malaysia (UPM) and Malaysian Agricultural Research and Development Institute (MARDI). The Department of Agriculture (DOA), Farmers Organization Authority (FOA) and MARDI are examining the feasibility of using insect netting for vegetable production. At least seven farms in Malaysia are now practicing organic farming particularly for vegetable and fruit production. Two organizations that are devoted to nature/organic farming were founded in 1990, i.e., the Malaysian Organic Farming Network (MOFAN) and Asia-Pacific Natural Agricultural Network - Malaysia (APNAN-Malaysia). Data reported here represent some of our research results that involved the use of EM technology in the production of corn and mustard.

Materials and Methods

Pot Experiment 1

A subtractive pot experiment technique was conducted to identify the basic requirements of Effective Microorganisms (EM4) using two Ultisol soils, namely, from the Bungor and Renggam soil series. The treatments (Table 1) were applied in a randomized complete block design with 4 replications. The experiment involved two types of shelter, namely, the enclosed glasshouse and an open plastic canopy (shed). The glasshouse, with cement floor, glass roof and insect proof wall netting, was much warmer for a longer period of time than the plastic-roofed shed. This experiment determined the effect of temperature and type of shed on the yield of leaf mustard (Brassica juncea) and efficacy of EM.

Table 1. Treatments Assigned to Pot Experiment 1.

Treatment No.	Subtractive Amendments[1]
T1	Complete[2]
T2	(-)EM4
T3	(-)inorganic fertilizer
T4	(-)lime
T5	(-)chicken dung
T6	(-)phosphate
T7	Control (no amendment)

[1]Cumutative ingredients removed one at a time.
[2]Amount of each amendment in the complete treatment:
EM 4.2 ml pot^{-1}
Inorganic fertilizer, 390 kg ha^{-1} of Nitrophoska green
Lime, limed up to pH 6.3 with dolomitic limestone
Chicken dung, 10 ton ha^{-1}
Phosphate, 100 kg ha^{-1}

Pot Experiment 2

A pot experiment was conducted to determine the effect of EM4 on the mineralization of some common organic amendments in Malaysia. Treatment descriptions are summarized in Table 2. Three plant residues were used, namely, a legume cover crop from the plantation industry (Calopogonium muconoides), corn stubble and sugarcane bagasse; the nitrogen and phosphorus content of these residues are shown in Table 3. The residues were oven dried at $500^{o}C$ for 5 days to a constant weight and then mechanically shredded individually. Except for the control, 100g of each plant residue was thoroughly mixed with 5kg of Serdang series soil (Typic Paleudult) in plastic pots.

The contents of the pots were allowed to equilibrate for one month prior to planting. EM 4 was prepared as described by Higa (1987) and sprayed on the soil weekly for the EM treatment. Corn (Zea mays L.) was planted at the end of the equilibration period, and subsequently crop yields were determined.

Table 2. Treatments Assigned to Pot Experiment 2.

Treatment No.	Amendment	Rate	EM[1]
T1	Legume	20t ha^{-1}	-
T2	Legume	20t ha^{-1}	+
T3	Corn	20t ha^{-1}	-
T4	Corn	20t ha^{-1}	+
T5	Sugarcane	20t ha^{-1}	-
T6	Sugarcane	20t ha^{-1}	+
T7	Control	0t ha^{-1}	-
T8	Control	0t ha^{-1}	+

[1]EM sprayed on son weekly.

Table 3. Nitrogen and Phosphorus Content of Organic Amendments Used in Pot Experiment2.

Amendment	Nutrient content	
	% nitrogen	% phosphorus
Legume	3.2	0.3
Corn stubble	1.8	0.2
Sugarcane	0.7	0.2

Pot Experiment 3

A pot experiment similar to that of Experiment 2 was conducted to determine the effect of some organic amendments as nutrient sources (i.e., biofertilizers) for corn (Zea mays L.) grown on a sandy tin tailings spoil material. Treatments consisted of various organic amendments with a wide range of C:N ratios compared with a chemical fertilizer treatment. Each of the organic amendments was applied to the pots with and without EM4. The treatments are shown in Table 4.

Table 4. Treatments Assigned to Pot Experiment 3.

Treatment No.	Amendment	Rate	EM1
T1	Chicken dung	10 t ha^{-1}	-
T2	Chicken dung	10 t ha^{-1}	+
T3	Quail dung	10 t ha^{-1}	-
T4	Quail dung	10 t ha^{-1}	+
T5	Saw dust	10 t ha^{-1}	-
T6	Saw dust	10 t ha^{-1}	+
T7	Corn stubble	10 t ha^{-1}	-
T8	Corn stubble	10 t ha^{-1}	+
T9	Chemical fertilizer	390 kg ha^{-1}	-
T10	Chemical fertilizer	390 kg ha^{-1}	+

Results and Discussion

Pot Experiment 1

The results presented in Tables 5 and 6 for the Bungor and Renggam soils, respectively, show that a consistent pattern of yield variation occurred according to the type of shelter provided. All treatments in the open plastic shed for both soils produced significantly higher yields of leaf mustard (Brassica juncea) than those in the enclosed glasshouse. These results might be attributed

to plant stress caused by the intense heat build-up within the glasshouse. The diurnal temperatures soared as high as 45^{o}C despite having the air circulated by a fan. Such a high temperature is generally detrimental to most biological systems. On the other hand, the environmental conditions in the plastic shed were much more favorable for plant growth and temperatures were considerably lower than those in the glasshouse. These results suggest that glasshouses under tropical conditions are not suitable for such studies because diurnal temperatures become detrimental to plant growth.
These results (Tables 5 and 6) also indicate that some form of soil treatment should be used. Plants grew poorly in the control (zero) treatment for both soils, irrespective of the shelter (glasshouse or plastic shed). However, when amendments were provided, improvement in yields occurred with both soils. The most effective amendment based on crop growth and yield was N-P-K fertilizer, followed by EM. Without fertilizer, the yields were only about 7 percent of the highest yield; without EM, the yields were about 56 percent of the highest yield for the Bungor soil and 80 percent for the Renggam scil. Organic matter and additional phosphate fertilizer were not required in either soil. This experiment shows the importance of providing adequate N-P-K and lime for these highly acid soils. Much higher yields were obtained when experiments were conducted in the cooler plastic-roofed shed than in the glasshouse.

Table 5. Dry Matter Yield of Leaf Mustard (Brassica juncea) Grown on Bungor Soil in a Subtractive Pot Experiment Conducted under Glasshouse and Shed (Plastic Canopy) Conditions (Pot Experiment 1).

Treatment No.	Subtractive Amendment	Glass house (g pot^{-1})	Shed (g pot^{-1})
T1	Complete	26.7a	71.4ab
T2	(-)EM4	29.3a	47.2bc
T3	(-)fertilizer	4.4c	3.8d
T4	(-)lime	20.0ab	36.4c
T5	(-)chicken dung	19.0ab	83.8a
T6	(-)phosphate	26.0a	81.8a
T7	Control	0.03d	0.02d

Column means followed by a common letter are not significantly different at the 5% level of probability.

Table 6. Dry Matter Yield of Leaf Mustard (Brassica juncea) Grown on Renggam Soil in a Subtractive Pot Experiment Conducted under Glasshouse and Shed (Plastic Canopy) Conditions (Pot Experiment 1).

Treatment No.	Subtractive Amendment	Glass house	Shed
T1	Complete	15.1ab	63.2a
T2	(-)EM4	10.1bc	53.6a
T3	(-)fertilizer	7.0c	4.7c
T4	(-)lime	17.3a	30.2b
T5	(-)chicken dung	11.4bc	66.9a
T6	(-)phosphate	12.6ab	64.9a
T7	Control	0.03d	0.02c

Column means followed by a common letter are not significantly different at the 5% level of probability.

Pot Experiment 2

Data from this experiment (reported elsewhere) showed that the addition of EM4 resulted in significantly higher corn yields compared with the non-EM treatment. The dry matter yield of corn was highest with the legume as an organic amendment + EM4 (T2) treatment (see Table 2), although no significant differences were obtained compared with the legume alone (T1) treatment. The lowest dry matter yields were obtained with the sugarcane bagasse treatments (T5 and T6). Results showed that all EM 4 treatments (T2, T4, T6, T8) have a significantly higher N concentration in the plant tissues. However, the highest N content was found in plants from the legume + EM (T2) treatment (Table 3). The high N content and low C:N ratio may accelerate the decomposition and mineralization of an organic amendment, which, in turn, would increase the availability of inorganic N, and plant growth and yield.

Pot Experiment 3

The results presented in Table 7 show that the addition of EM 4 resulted in a significant increase in corn yields compared with the treatments without EM. There were significant differences between the amendments with C:N > 20 (T5, T6, T7 and T8) and those with C:N < 20 (T1, T2, T3 and T4). Yields derived from C:N < 20 were much higher than those with a C:N > 20, with or without EM4. However, the highest yield was with the chemical fertilizer treatment. Again, this shows that an adequate N-P-K fertilizer was necessary for maximum yields. Table 8 indicates that, except for the chicken dung treatment, EM 4 resulted in a lower carbon content of the tin tailings spoil amended with the other organic materials. However, after harvest, the soil carbon content of pots treated with high C:N ratio residues (corn stubble and saw dust) were higher than those with the lower C:N ratio (chicken and quail dung).

Table 7. Dry Matter Yield of Com (Zea mays L.) Grown on Sandy Tin Tailings Treated with Organic Amendments with and without EM.

Treatment	(-) EM (g pot^{-1})	(+) EM (g pot^{-1})
Chicken dung	1.3bcd	1.5bc
Quail dung	1.6bc	1.8b
Saw dust	0.3e	0.5cde
Corn stubble	0.7d	1.0e
Fertilizer	2.8a	3.3a

Column means followed by a common letter are not significantly different at the 5% level of probability.

Table 8. Carbon Content of Sandy Tin Tailings Treated with Organic Amendments with and without EM.

Treatment	(-) EM (% carbon)	(+) EM (% carbon)
Chicken dung	0.16de	0.20cd
Quail dung	0.21c	0.16de
Saw dust	0.33a	0.27b
Corn stubble	0.30ab	0.27b
Fertilizer	0.13e	0.12e

Means followed by a common letter are not significantly different at the 5% level of probability.

Conclusions

Our preliminary studies indicate that organic matter with low C:N ratios, particularly chicken and quail dung, have potential for providing an adequate supply of nutrients for corn and mustard production. The incorporation of EM4 into the system resulted in significantly higher crop yields, although addition of adequate amounts of N-P-K fertilizer will increase yields to an even higher level. Plant residues with high C:N ratios, even with the incorporation of EM4, did not provide an adequate supply of nutrients for crop production. Also, lime is essential in these highly-weathered acidic soils. Glasshouses may not be suitable in the tropics because enclosed systems tend to have extremely high temperatures which can drastically reduce yields.

References

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