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EFFECTS OF ORGANIC FERTILIZERS ON INSECT PEST AND DISEASES OF RICE

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ABSTRACT

To address the effect of organic fertilizers on rice insect pests and diseases, an experiment was carried out in Cuulong Delta Rice Research Institute (CLRRI) based on the randomized complete block design with three replications. The treatments were including a combination of four animal manure compost levels (2.5, 5.0, 7.5, 10.0 tons/ha) and four organic fertilizer levels (2.5, 5.0, 7.5, 10.0 tons/ha) as compared to NPK fertilizer as comparison treatment. The results showed that organic fertilizers affected to rice plant growth and minimized the outbreak of insect pests and diseases such as brown plant hopper, stem borer, leaf folder, blast and sheath blight.

INTRODUCTION

The most important management for high-yielding production is nutrition management, but it may affect the response of rice plants to insect pests and diseases due to the change of microclimate under rice plant canopy. The knowledge of nutrition management on relationship among rice pests is a basis for setting up a high yield production system. Most pest control procedures used by farmers can be considered as soil fertility management. Based on interaction between soils and pests, we can provide instruction for optimizing total agro-ecosystem. We also have known that the capacity of a resistant plant to insect pests and diseases is strictly related to optimal physical, chemical and mainly biological characteristics of soils. Soils with high organic matter and active soil biological activity generally exhibit good soil fertility as well as complex food webs and beneficial organisms that prevent infection. Ramesh et al. (2005) concluded that organic crops have been shown to be more tolerant as well as resistant to insect attacks and organic rice is reported to have thicker cell wall and lower levels of free amino acid than conventional rice.

Magdoff et al.(2000) indicated farming practices that cause nutrition imbalances can lower pest resistance. Meyer (2000) proposed that soil nutrient availability not only affects the amount of damage that plants receive from herbivores but also the ability of plants to recover from herbivores. Much of what we know today about the relationship between crop nutrition and pest incidence comes from studies comparing the effects of organic agricultural practices and modern conventional methods on specific pest populations. Soil fertility practices can impact the physiological susceptibility of crop plants to insect pests by either affecting the resistance of individual plant to attack or by altering plant acceptability to certain herbivores. Some studies have also documented how the shift from organic soil management to chemical fertilizers has increased the potential of certain insects and diseases to cause economic losses.

Although researches on this area have been done for many years, most of the research mainly focused on impacts of chemical nitrogen and silicon on major pests, such as rice blast, stem borers and brown plant hopper (BPH) and the role of organic fertilizers on the reaction of rice to insect pests and diseases is still clearly have not known

The understanding of these interactions between organic fertilizers and insect pests and disease becomes the basis for design of the sustainable rice production system.

Objectives

- To understand effect of organic fertilizers as animal manure compost and organic matter on rice physical and physiological characters and yield.
- To understand response of rice plants treated with different levels of organic fertilizers to major pests.

MATERIALS AND METHODS

Location: Experimental farm of Cuulong Delta Rice Research Institute, Thoi thanh village, Co do district, Cantho city.

Timing of study: 2001 dry season

Experimental design

- A randomized complete block design was set up with three replications. Each treatment, which has plot size of $100m^2$, was a combination of 4 manure compost levels and 4 organic fertilizers compared to NPK fertilizer treatment (100N- $40P_2O_5$ -$30K_2O$ kg/ha)

- Variety DS 20 was sown on December 10, 2000 in the seed rate of 180 kg/ha. Rice plants were harvested on March 20, 2001.

Treatments

1. Manure compost 2.5tons/ha
2. Manure compost 5.0tons/ha
3. Manure compost 7.5tons/ha
4. Manure compost 10.0tons/ha
5. Organic fertilizer 2.5tons/ha
6. Organic fertilizer 5.0tons/ha
7. Organic fertilizer 7.5tons/ha
8. Organic fertilizer 10.0tons/ha
9. Control check (100-40-30 kg NPK/ha)

Manure compost composition is chicken and hog manure compost which has 0.8 %N and 0.4% P_2O_5.

Organic fertilizer composition is 23.5% organic matter, 3.2% P_2O_5 and 5.6% humic acid.

Small ridges were established between plots with different treatments to avoid the influences of nutrition from neighbor plots.

Management: No pesticide application was taken in order to avoid experimental errors.

Data collected as following

a. Scoring damages by sheath blight, rice blast, stem borer, BPH;
b. Noticing number of tillers, height of rice plants, contents of N, P, K in plant leaves, leaf color.
c. Other factors as soil conditions related to nutrition levels, natural enemy complex.
d. Yield and yield components
e. Data analysis by SPSS.

Field investigation

3-4 field investigations were carried out at tillering stage (26-28DAS), elongation stage (40-42DAS), booting stage (55 DAS) and flowering stage (75-76DAS) and the methods used to be based on the pest species.

Plant hoppers

Eye counting method was used. The sampling size was 100 rice plants (5 rice plants including their tillers per sampling point) per plot for direct seeded plots.

Stem borer

Sampling size was 20 square feet (4 square feet per sampling point) for direct seeded rice plots.

The injury plants were counted and recorded separately based on the symptoms, tillers with dead hearts, and white heads and total effective tillers were also recorded. Total injury plants for each symptom and percentage of injury plants were calculated.

Sheath blight

Eye counting method was used. Sampling size was 10 square feet (2 square feet per sampling point) per direct seeded plot. The sampling points were fixed and injury plants were counted and the injury tillers were recorded based on the level of injury. The injury levels are usually separated into 5 levels based on the IRRI standards

Rice blast

Eye counting method was used. Sampling size was 400 seedlings, 20 plants including tillers

per sampling point per direct seeded plot. The number of injury plants was recorded based on the level of injury. The injury levels were separated into 5 levels based on the IRRI standards.

RESULTS AND DISCUSSION

The soil of our experiment is belong to alluvial soil type which have the pH of 4.86, EC of 0.81 dS/m, average nitrogen (0.185%) and poor phosphorous (0.023%), average potassium (1.535%), rich sulfate (131.6ppm) and iron (1.566ppm). Usually, this soil is suitable to intensive rice production in the Mekong Delta.

1. Impacts of chicken manure compost and organic fertilizer on plant growth

First of all, manure compost and organic fertilizer made tiller number per square feet ($0.09m^2$) not increased as compared to control check except the treatment of organic fertilizer 7.7tons/ha, the average tiller number was 10.7 / square feet ($0.09m^2$) and the highest tiller number occurred in the treatment of animal manure compost at the dose of 10.0 tons/ha (10.95 tillers/square feet [$0.09m^2$]). However organic fertilizer could induce rice plant height which was 5cm taller than as compared to chemical fertilizer treatment. The most high rice plant was recorded in the plot treated organic fertilizer at the dose of 10.0 tons/ha (111.55cm). Otherwise, leaf color was greener on both chicken and hog manure compost and organic fertilizer treatments by SPAD index of 34.66 which were higher than control check SPAD index of 31 although the statistical differences were not clear. Maybe the effect of chicken and hog manure compost and organic fertilizer on the plant growth was gradually and stably increased (table 1).

Table 1 Effect of chicken and hog manure compost and organic fertilizer on the rice plant growth

Treatment	Tillers no./ square feet	Height (cm)	SPAD index
Manure compost 2.5 tons/ha	10.41 a	107.08 a	34.66 a
Manure compost 5.0 tons/ha	10.50 a	106.83 a	29.13 a
Manure compost 7.5 tons/ha	10.63 a	106.86 a	31.33 a
Manure compost 10.0 tons/ha	10.95 a	104.47 a	32.93 a
Organic fertilizer 2.5 tons/ha	10.55 a	109.71 a	32.53 a
Organic fertilizer 5.0 tons/ha	10.55 a	109.73 a	33.83 a
Organic fertilizer 7.5 tons/ha	11.05 a	110.63 a	34.60 a
Organic fertilizer 10.0 tons/ha	10.91 a	111.55 a	33.03 a
Control check (NPK)	10.70 a	106.91 a	31.06 a
F	0.586	2.013	0.569
p	0.777	0.104	0.789

2. Impacts of chicken and hog manure compost and organic fertilizer on the insect pests and diseases

The population of insect pests as stem borer (SB), brown plant hopper (BPH) and leaf folder (LF) on the chemical fertilizer treatment exhibited the severe outbreak more than in the treatments of chicken and hog manure compost and organic fertilizer application. In the treatment of manure compost and organic matter with higher level, damaged index of stem borer came down 2-3% as compared to control check treatment (4.03%). The lowest incidence of SB recorded in the plots applied organic fertilizer at the dosage of 10 tons/ha (0.733%). The population of brown plant hopper and leaf hopper reduced 15-30% and 50-60%, respectively as compared to chemical fertilizer treatment, especially in organic treatments of 5.0-7.5 tons/ha. Density of BPH came down to 32.8 nymphs/square feet in the treatment of manure compost 2.5 tons / ha.

The number of LF larva leaf folded streak were most low in the treatment of manure compost at the dose of 7.5 tons/ha (6.6 larva/square feet and 29.7%).These results were similar to conclusion by Alice et al. (2003) that is also recorded the low BPH population in plots treated by organic amendments. The main cause is recognized by low of nitrogen content in rice plant.

According to van Emden (1966) increases in fecundity and developmental rates of the green peach aphid, *Myzus persicae*, were highly correlated to increased levels of soluble nitrogen in leaf tissue.

Our results were contributed to confirm the similar conclusions, which are soil fertility management, could have several effects on plant quality, which in turn, can affect insect abundance and subsequent levels of herbivore damage. The reallocation of mineral amendments in crop plants can influence oviposition, growth rates, survival and reproduction in the insects that use these hosts (Jones, 1976). Chino et al (1987) reported that asparagine content of plant phloem sap was significantly lower under organic cultivation, thereby adversely affecting the feeding activity of BPH. Although more research is needed, preliminary evidence suggests that fertilization practices can influence the relative resistance of agricultural crops to insect pests. Increasing soluble nitrogen levels in plant tissue by applied chemical fertilizers was found to decrease pest resistance, although this is not a universal phenomenon (Phelan et al. 1995).

The disease index of blast and sheath blight (ShB) was reduced 50-60% and 90%, respectively in the plots treated chicken and hog manure compost and organic fertilizer (0-5%) as compared to chemical fertilizer application (5-7%), especially in treatment of manure compost at the dose of 2.5-5.0 tons/ha. The most tolerant reaction appeared in the treatment of manure compost at the dose of 5.0tons/ha (2.186%). The lowest disease incidence of ShB was recorded in the plots applied manure compost at the dose of 2.5tons/ha (0.0037%). Our results were suitable to the idea by Sullivan (2003) which concluded that excessive nitrogen levels are rarely a problem of disease in organic production (table 2, 3).

Table 2. Effect of chicken and hog manure compost and organic fertilizer on the insect pests

Treatment	Stem borer (%)	Brown planthopper (No/square feet)	Leaf folder larva (No/square feet)	Leaf folder streak (%)
Manure compost 2.5 tons/ha	2.070 ab	32.80 a	11.55 a	36.85 a
Manure compost 5.0 tons/ha	2.070 ab	43.58 a	9.07 a	34.65 a
Manure compost 7.5 tons/ha	2.383 ab	40.15 b	6.60 a	29.70 a
Manure compost 10.0 tons/ha	0.917 a	46.88 a	12.10 a	36.02 a
Organic fertilizer 2.5 tons/ha	2.070 ab	56.23 b	11.27 a	43.72 a
Organic fertilizer 5.0 tons/ha	3.300 b	48.95 a	7.97 a	38.50 a
Organic fertilizer 7.5 tons/ha	0.733 a	41.25 a	11.82 a	33.55 a
Organic fertilizer 10.0 tons/ha	3.300 b	41.25 a	9.07 a	37.40 a
Control check (NPK)	4.030 c	66.47 b	25.77 b	51.05 b
F	1.020	1.020	0.587	0.336
p	0.000	0.056	0.001	0.003

Table 3: Effect of chicken and hog manure compost and organic fertilizer on the rice diseases

Treatment	Blast (%)	Sheath blight (%)
Manure compost 2.5 tons/ha	2.559 a	0.037 a
Manure compost 5.0 tons/ha	2.186 a	0.111 a
Manure compost 7.5 tons/ha	2.503 a	0.203 a
Manure compost 10.0 tons/ha	2.845 a	0.129 a
Organic fertilizer 2.5 tons/ha	2.966 a	0.203 a
Organic fertilizer 5.0 tons/ha	4.315 b	0.407 a
Organic fertilizer 7.5 tons/ha	4.833 b	0.166 a
Organic fertilizer 10.0 tons/ha	5.602 b	0.333 a
Control check (NPK)	7.825 c	5.037 b
F	8.559	0.518
p	0.000*	0.827

3. Impacts of chicken and hog manure compost and organic fertilizer on natural enemies

Population of natural enemies as spiders, mirid bugs, water bugs was induced in the plots which treated by manure compost and organic fertilizer. Density of spiders was 31.16 adults/square feet ($0.09m^2$) in the treatment of chicken hog manure compost at 7.5 tons/ha , 31.9 adults /square feet in the treatment of organic fertilizer at 5.0 tons/ha. Population of mirid bugs was higher on treatments of manure compost at 5.0 tons/ha with 38.5 adults/square feet, organic fertilizer at 5.0 tons/ha with 40.88 adults/square feet. Number of water bugs also was increased on these above treatments and the plot treated manure compost 2.5 tons/ha (table 4)

Table 4. Effect of chicken and hog manure compost and organic fertilizer on the natural enemies

Treatment	Spiders (No/ square feet)	Mirid bugs (No/ square feet)	Water bugs (No/ square feet)
Manure compost 2.5 tons/ha	28.96 a	30.43 a	32.08 ab
Manure compost 5.0 tons/ha	21.13 a	38.50 a	25.11 b
Manure compost 7.5 tons/ha	31.16 a	37.21 a	25.11 b
Manure compost 10.0 tons/ha	28.96 a	31.53 a	28.41 ab
Organic fertilizer 2.5 tons/ha	29.33 a	32.45 a	28.05 ab
Organic fertilizer 5.0 tons/ha	31.90 a	40.88 a	31.10 a
Organic fertilizer 7.5 tons/ha	28.78 a	37.95 a	27.86 ab
Organic fertilizer 10.0 tons/ha	28.60 a	37.95 a	29.88 ab
Control check (NPK)	30.06 a	33.36 a	24.93 b
F	0.219	0.873	1.777
p	0.983	0.556	0.148

4. Impacts of chicken manure compost and organic fertilizer on nutrition and rice yield

Total N, total P and organic content of N, P were less in all treatments which applied manure compost and organic fertilizer than control check (NPK application). Total nitrogen was reduced 30% in the treatment applied manure compost at the dose of 2.5 tons/ha (42.5 ppm) and it was not available in the treatments applied organic fertilizer. Same trend was shown in total P and organic P content in the manure compost and organic amendments. However, total K and organic K content exhibited higher in treatments of manure compost as compared to chemical fertilizer treatment. That was the main cause

to decrease the population of insect pests and disease incidence of blast and ShB.

Consequently, leaf N content and leaf P content were lesser in the treatments of manure compost and organic fertilizer than control check that made rice yield relatively lower than control check (NPK fertilizer) excepted the treatment of organic fertilizer at the dose of 2.5 tons/ha. But there was no significantly different among treatments and control. Our results were also similar to conclusion by Hsieh (1995) and Altiei et al (2003). Otherwise, leaf K content in the treatment of manure compost and organic fertilizer was higher than control check that was another reason to explain tolerance of rice plant to insect pests and diseases.

The most important thing was recorded that all treatments with the manure compost and organic application could reduce unfilled grain percentage and induce the weight of rice grains although there was no difference in number of panicles/ m^2 and filled grains/panicle (tables 5, 6, 7). Lastly, the most effective application of manure compost and organic fertilizer was the dose of 2.5 tons/ha.

Table 5: Effect of chicken and hog manure compost and organic fertilizer on the NPK total

Treatment	Total N (%)	Organic N (%)	Total P (%)	Organic P (%)	Total K (%)	Organic K (%)
Manure compost 2.5 tons/ha	42.5 b	2.5 c	32.25 d	2.25 d	31.50 d	1.50 d
Manure compost 5.0 tons/ha	45.0 b	5.0 b	34.50 c	4.50 c	33.00 b	3.00 b
Manure compost 7.5 tons/ha	47.5 b	5.5 a	36.75 a	6.75 a	34.50 a	4.50 a
Manure compost 10.0 tons/ha	0.0 c	0.0 d	0.00 f	0.00 e	0.00 f	0.00 e
Organic fertilizer 2.5 tons/ha	45.0 b	5.0 b	35.00 b	5.00 b	32.50 b	2.50 c
Organic fertilizer 5.0 tons/ha	0.0 c	0.0 d	0.00 f	0.00 e	0.00 f	0.00 f
Organic fertilizer 7.5 tons/ha	0.0 c	0.0 d	0.00 f	0.00e	0.00 f	0.00 f
Organic fertilizer 10.0 tons/ha	0.0 c	0.0 d	0.00 f	0.00 e	0.00 f	0.00 f
Control check (NPK)	60.0 a	10.0 a	40.00 e	10.00 e	30.00 e	0.00 f
F	*	*	*	*	*	*
p	*	*	*	*	*	*

* could not calculated

Table 6. Effect of chicken and hog manure compost and organic fertilizer on the NPK leaf'content and rice grain yield.

Treatment	Leaf N content (%)	Leaf P content (%)	Leaf K content (%)	Grain yield (ton/ha)
Manure compost 2.5 tons/ha	2.236 ab	0.150 cd	1.126 c	5.667 a
Manure compost 5.0 tons/ha	2.376 a	0.160 bc	1.306 bc	5.333 a
Manure compost 7.5 tons/ha	2.250 ab	0.166 ab	1.433 ab	5.600 a
Manure compost 10.0 tons/ha	2.136 abc	0.143 de	1.183 bc	5.667 a
Organic fertilizer 2.5 tons/ha	1.866 cd	0.150 d	1.593 a	6.000 a
Organic fertilizer 5.0 tons/ha	1.753 d	0.133 e	1.603 a	5.400 a
Organic fertilizer 7.5 tons/ha	1.996 bcd	0.133 e	1.403 ab	5.667 a
Organic fertilizer 10.0 tons/ha	2.143 abc	0.160 bc	1.363 abc	5.267 a
Control check (NPK)	2.393 a	0.176 a	1.313 bc	5.733 a
F	4.541	10.294	3.985	0.757
p	0.004	0.000	0.007	0.643

Table 7. Effect of chicken and hog manure compost and organic fertilizer on the yield component

Treatment	Panicles/m^2	Filled grains /panicle	Unfilled grain (%)	Weight of 1000 grains (g)
Manure compost 2.5 tons/ha	293 33 a	61.00 a	8.21 b	20.33 a
Manure compost 5.0 tons/ha	308.00 a	76.67 a	7.19 b	25.55 a
Manure compost 7.5 tons/ha	311.67 a	69.67 a	13.19 ab	23.22 a
Manure compost 10.0 tons/ha	333.67 a	72.33 a	13.42 ab	24.11 a
Organic fertilizer 2.5 tons/ha	304.33 a	60.67 a	8.66 a	20.22 a
Organic fertilizer 5.0 tons/ha	326.33 a	65.67 a	7.25 b	21.75 a
Organic fertilizer 7.5 tons/ha	300.67 a	61.00 a	7.33 ab	20.33 a
Organic fertilizer 10.0 tons/ha	267.67 a	62.33 a	5.88 ab	20.74 a
Control check (NPK)	333.67 a	70.67 a	15.96 ab	23.55 a
F	0.412	0.817	2.02	0.817
p	0.899	0.557	0.102	0.557

CONCLUSION

- Manure and organic fertilizers have more effective than chemical fertilizer to induce rice plant growth and tolerance to insect pests and diseases. Their effects exhibited through increasing plant height, number of tillers, SPAD index and decreasing population/incidence of SB, BPH, LF, ShB, blast.
- Main mechanism of defense in rice variety was recorded by low nitrogen and phosphate content and high potassium content in rice plant.
- Application of manure and organic fertilizers was sound effect to protect natural enemies under field condition.
- Manure compost and organic fertilizer also obtained the same yield as compared to chemical fertilizer by lowering unfilled grains and increasing weight of grains.
- The best dose of manure compost and organic fertilizer was recommended as 2.5 tons / ha.

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Ảnh hưởng của phân hữu cơ đối với sâu bệnh hại lúa

Để xác định ảnh hưởng của phân hữu cơ đối với sâu bệnh hại lúa, Viện Lúa ĐBSCL đã thực hiện thí nghiệm bố trí theo kiểu khối hoàn toàn ngẫu nhiên, 3 lần nhắc lại. Nghiệm thức bao gồm bốn mức phân chuồng (2,5; 5,0; 7,5;10.0 tấn/ha) và bốn mức phân hữu cơ thành phẩm (2,5; 5,0; 7,5;10.0 tấn/ha), nghiệm thức so sánh là công thức phân hóa học 100N-40P_2O_5–30K_2O kg/ha, mỗi nghiệm thức được xử lý trong lô rộng 100m^2, sạ giống lúa ĐS20. Kết quả cho thấy phân bón hữu cơ có ảnh hưởng đến sự tăng trưởng và năng suất lúa và giảm thiểu sự bộc phát của sâu bệnh như rầy nâu, sâu đục thân, sâu cuốn lá, bệnh cháy lá và bệnh đốm vằn.