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IMPACTS OF NUTRITION MANAGEMENT ON INSECT PESTS AND DISEASES OF RICE

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ABSTRACT

To identify the influences of nutrition management on rice insect pests and diseases, a large-scale experiment of 1 ha was carried out in Cuulong Delta Rice Research Institute (CLRRI) based on the randomized complete block design with three replications. A combination of 5 N levels and 4 P_2O_5 levels were designed into different treatments. After two seasons, the results showed that nitrogen fertilizer did not affect rice growth only, but also more impacted to the outbreak of insect pests and diseases such as brown plant hopper, stem borer, leaf folder, blast, red stripped disease. Phosphorous fertilizer was less promoted to the plant growth than nitrogen, therefore, it did not affect to development of insect pests and diseases. Balanced fertilizer application can help rice plant become more resistant to pests effectively.

INTRODUCTION

Nutrition management is one of the most important practices for high production system, but nutrition management may affect response of rice to pests, as well as development pattern of pest populations due to the change of environments. The understanding of impacts of nutrition management on interactions between rice and pests is a basis to stimulate high yield production system. Most pest management methods used by farmers can be considered as soil fertility management strategies and vice-versa. There are positive interactions between soils and pests that once identified, can provide guidelines for optimizing total agro-ecosystem function. Increasingly, new research is showing that the ability of a crop plant to resist or tolerate insect pests and diseases is tied to optimal physical, chemical and mainly biological properties of soils. Soils with high organic matter and high biological activity generally exhibit good soil fertility as well as complex food webs and beneficial organisms that prevent infection. On the other hand, farming practices that cause nutrition imbalances can lower pest resistance (Magdoff et al. 2000). Meyer (2000) argues that soil nutrient availability not only affects the amount of damage that plants receive from herbivores but the ability of plants to recover from herbivores; however, these two factors are rarely considered together.

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 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 activities mainly focused on impacts of nitrogen and silicon on major pests, such as rice blast, stem borers, and BPH. As rice production system is changing due to the development of new technology and yield is getting higher, the interaction between nutrition management and

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pests is becoming more complicate and more important. The understanding of these interactions are considered as the basis to stimulate the sustainable rice production system.

Objectives

- To understand impacts of nutrition components, including N, P on rice physical and physiological characters and yield.
- To understand response of rice plants treated with different levels of the main nutrition components to major pests;
- To understand response of major pests to rice plants treated with different levels of the nutrition components.

MATERIALS & METHODS

a. Location: Experimental farm of Cuulong Delta Rice Research Institute, Thoi thanh village, Omon district, Cantho Province.

b. Timing of study: 2000-2001 Dry season and 2001 Wet season.

c. Experimental design:

- A randomized complete block design was set up with three replications on the large field, which yielded about 20% higher than the average yield in the country and more even in various locations in the paddy. Each treatment, which has plot size of 110m^2, was a combination of N-P level based on the same K application of 30 kg K_2O /ha

-Variety KDM 39 was sown on Dec. 6, 2000 /May. 9, 2001 in the seed rate of 180 kg/ha. Rice plants were harvested on March 16, 2001 / Aug. 20, 2001.

Treatments

Nutrition components added as followed:

Level 1: without any input of the component;
Level 2: half of the amount of the component input on average in the area;
Level 3: The amount of input on average in the area (as a control);
Level 4: 1.5 times of the amount input on average;
Level 5: Double input of the average input in the area.

Each treatment was a combination between N-P based on the same level of potassium.

N levels: 0, 50, 100, 150, 200 kg/ha and P_2O_5 levels: 0, 20, 40, 60 kg/ha; 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. Pests: Sheath blight, Rice blast, Stem borer, BPH;

b. Plant growth: Number of tillers, height of rice plants, contents of N, P, K in plant leaves, leaf color.

c. Other factors: Soil conditions related to nutrition levels, natural enemy complex.

d. Yield and main components for yield

e. Data analysis by SPSS.

Field investigation

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

Plant hoppers

Visual scoring was used with sampling size of 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

Visual scoring was used with sampling size of 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

Visual scoring was used with sampling size of 400 seedlings, 20 plants including tillers per sampling point per direct seeded plot. The number of injury plants were recorded based on the level of injury. The injury levels were separated into 5 levels based on the IRRI standards.

RESULTS AND DISCUSSION

Soil in the experimental field is belong to alluvial soil type, pH of 4.86, EC of 0.81 dS/m, nitrogen (0.185%), phosphorous (0.023%), potassium (1.535%), sulphate (131.6ppm) and iron (1.566ppm). Usually this soil is typically suitable to intensive rice production in the Mekong Delta (Table1).

Impacts of nitrogen

Nitrogen is a main nutrient for contributing to rice growth. Therefore, nitrogen fertilizer offered more impacts on the development of rice including plant height. The plant height was differently significant between <50 N levels and >100N levels. The plant height was responded up to 100kg N/ha and after that it declined. Tillering and SPAD index were increased to N levels, but there was no difference among treatments of nitrogen application.

The plant height and SPAD index were significantly related to N fertilizer, N, P, K leaf contents and grain yield with high correlation coefficient ® (Table 2). Phosphorous fertilizer only affected the SPAD index. The SPAD index increased gradually to nitrogen levels, obtained the highest SPAD value in the treatment of 200 kg N/ha applied. The number of tillers per square foot produced more on the treatment of 150 kg N/ha(Table 3&4).

Leaf nitrogen and phosphorous contents were positively correlated to N fertilizer. The statistic significance was showed in the leaf N content and leaf P content based on the nitrogen fertilizer. The leaf potassium content was not changed to N application treatments. Leaf N content offered the highest in the treatment of 200 kg N/ha, but leaf P content was most available in the treatment of 100 kg N/ha (Table 5).

Application of more nitrogen fertilizer caused increasing of unfilled grain percentage and reducing 1000-grain weight, although it was not significantly different among treatments of various N levels. Application of 200 kg N /ha enhanced unfilled grain percentage higher as compared to other treatments (30.39%) and 1000-grain weight lower than other one (28.85 g).

Although number of panicles per m^2 was increased based on the quantity of nitrogen fertilizer applied, but it is not significantly different among treatments of various N levels. The highest panicle number was responded to the treatment of 150 kg N /ha. However, the filled grains /panicle only offered the most in the treatment of 150 kg N/ha. Therefore, the response of grain yield to nitrogen fertilizer was not related to N level increasing. This is similar to conclusion of Anh (2002), which showed that the correlation of nitrogen uptake and grain yield was not statistically significant.

Among the nutritional factors that influence the level of arthropod damage in a crop, total nitrogen (N) has been considered to become critical for both plants and their consumers (Mattson 1980; Scriber 1984; Slansky et al. 1987).

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

It is likewise in our results, the impact of nitrogen on the outbreak of insect pests and diseases was clearly addressed in our studies. More nitrogen application was forced more occurrence of insect pests and diseases, especially stem borer (SB), brown plant hopper (BPH), leaf folder (LF), blast (Bl) and red-stripped disease (RSD). Higher percentage of nitrogen in rice leaf enhanced its photosynthesis to produce more nutrition for compensation to the losses due to BPH feeding (Chau 2000). This observation was confirmed by Sogawa (1992,1994), this showed that the rate of honeydew excretion by BPH increased with nitrogen content increase in leaves. Therefore, the correlation between N fertilizer, N leaf content and BPH, SB, LF, Bl, SSD were positively and statistically significant (Table2). Population of BPH was induced when applying more nitrogen fertilizer and most abundance in the treatment of 200 kg N/ha (4.97 nymphs/ square foot). Similarly, the same trend occurred on the damage of LF (1.99 larva/square foot and 8.53%), SB (1.9%)and Bl (48.96%) at the treatment of 200N. Particularly, RSD was the most serious (41.94%) in the treatment of 150 kg N/ha. However, there were only rice insects as BPH, SB, LF could cause yield loss significantly (Table 2).

Exceptionally, whorl maggot, rice thrips, brown spot, cercospora small spot diseases were not developed following as the doses of nitrogen increased. Damage index of these pests was very low (0.12-4.50 %) and they did not affect to rice yield (Table 6&7 and figure 1&2)

These results confirmed 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). Although more research is needed, preliminary evidence suggests that fertilization practices can influence the relative resistance of crops to insect pests. Increasing soluble nitrogen levels in plant tissue was found to decrease pest resistance, although this is not a universal phenomenon (Phelan et al. 1995).

Population of natural enemies followed to the development of insect preys as BPH, LF, SB, therefore, it was positively related to N levels, especially in case of spiders and mirid buds. Spiders and mirid bugs were most abundance in the treatment of 200 kg N/ha with the rate of 2.44 and 2.19 adults /square foot, respectively (Figure 3).

Impacts of phosphorous

Phosphorous fertilizer did not much affect rice growth, then there was not difference in plant height, number of tillers / square foot at various P_2O_5 levels. Only the SPAD index was responded to P_2O_5 levels, higher dose of phosphorous made the rice leaves greener than as compared to control (no phosphorous application).

When applying more phosphorous fertilizer, the number of panicles per m^2, number of filled grains/ panicle trended upward, however, difference among the treatments was not significant. Application of 60 kg P_2O_5 obtained 723 panicles/m^2 and 63 filled grains/panicle (Table 8).

Meanwhile the more application of phosphorous fertilizer, the more unfilled grain percentage was observed, and the more reduced 1000-grain weight. The unfilled grain percentage was the highest in the treatment of 60 kg P_2O_5/ha (Table 9).

Otherwise, application of more phosphorus fertilizer did not increase P content in leaf, and it could decrease grain yield. Nitrogen and potassium contents in leaves was not significantly different when applying more phosphorous fertilizer, unless grain yield. The lowest grain yield was recorded as 2.65 tons/ha in the treatment of 60 kg P_2O_5/ha (Table 10).

Phosphorous doses which were applied increasingly, did not affect to the outbreak of insect pests and diseases. Usually, it was not different among treatments of P_2O_5 levels although the damage of BPH, SB, LF, Bl, RSD obtained very high index for all treatments.

Exceptionally, the result also showed that SB damaged index offered the lowest value in the treatment of 40 kg P_2O_5 /ha (1.09%) (Table 11&12).

Population of natural enemies as spiders, mirid bugs and *Paederus* beetles was not changed when applying more phosphorous fertilizer of 20-60 kg P_2O_5 /ha (Table 13).

Table 1. Characteristic of soil in experimental site, CLRRI, 2000.

Location	pH	EC (dS/m)	N (%)	P (%)	K (%)	SO_4^{--} (ppm)	Al^{+++} (ppm)	Fe^{++} (ppm)
Replication 1	4.76	0.89	0.183	0.024	1.536	127.0	*	1.788
Replication 2	4.77	0.79	0.171	0.018	1.502	142.0	*	0.944
Replication 3	5.06	0.75	0.201	0.026	1.568	126.0	*	1.968
Average	4.86	0.81	0.185	0.023	1.535	131.6	*	1.566

* No detection

Table 2. Correlation coefficient ® between nutrition and plant growth, insect pests and diseases, CLRRI, 2000-2001.

Parameters	N fertilizer	P_2O_5 fertilizer	Leaf 's N content	Leaf's P content	Leaf's K content	Grain yield
Plant height	0.4133^{**}	0.1173^{ns}	0.4438^{**}	0.2154^{*}	0.2240^{*}	0.1506^{ns}
SPAD index	0.2533^{**}	0.3708^{**}	0.3646^{**}	0.6022^{**}	0.5244^{**}	0.3111^{**}
Stem borer	0.2025^{*}	0.0023^{ns}	0.3643^{**}	0.4688^{**}	0.7122^{**}	-0.7292^{**}
Brown plant hopper	0.6310^{**}	0.0471^{ns}	0.6528^{**}	0.4613^{*}	0.3311^{**}	-0.6602^{**}
Leaf folder	0.7549^{**}	0.1177^{ns}	0.6465^{**}	0.8627^{**}	0.8678^{**}	-0.3383^{**}
Blast	0.3965^{**}	-0.0332^{ns}	0.3039^{*}	0.3544^{**}	0.7450^{**}	-0.1854^{ns}
Red stripped	0.4205^{**}	0.4721^{ns}	0.5140^{**}	0.4460^{**}	0.5344^{**}	-0.2193^{ns}

ns : non significant; * : significant at the level of 0.05 ; ** : significant at the level of 0.01

Table 3. Effect of nitrogen fertilizer on the plant growth, CLRRI, 2000-2001.

N level (kg/ha)	Tillers (No/ square foot)	Height (cm)	SPAD index
0	48.65 a	86.89 b	32.44 a
50	49.91 a	87.75 b	32.21 a
100	50.61 a	92.03 a	33.02 a
150	51.25 a	91.93 a	34.30 a
200	50.22 a	89.96 a	34.61 a
F	0.218	8.36	0.429
p	0.928	0.000 **	0.787

Table 4. Effect of Nitrogen fertilizer on the yield component, CLRRI, 2000-2001.

N level (kg/ha)	Panicles/m^2	Filled grains/panicle	Unfilled grain (%)	100-grain weight (g)
0	680.54 a	58.08 b	27.38 a	29.40 a
50	700.06 a	60.70 b	25.08 a	29.05 a
100	647.65 a	57.30 b	24.45 a	28.55 a
150	677.20 a	73.52 a	30.09 a	28.33 a
200	714.55 a	65.13 b	30.39 a	28.85 a
F	0.40	5.26	1.95	0.73
p	0.806	0.001**	0.114	0.569

Table 5. Effect of nitrogen fertilizer on leaf nutrition and grain yield - CLRRI, 2000-2001.

N level (kg/ha)	Leaf' N content (%)	Leaf's P content (%)	Leaf's K content (%)	Grain yield (ton/ha)
0	2.315 d	0.1167 b	1.6133 a	2.09 a
50	2.699 c	0.1292 ab	1.6325 a	2.80 a
100	3.050 b	0.1342 a	1.6083 a	2.72 a
150	3.440 a	0.1242 ab	1.6200 a	2.63 a
200	3.630 a	0.1292 ab	1.6000 a	2.85 a
F	67.61	2.05	0.94	0.454
p	0.000**	0.099	0.984	0.769

Table 6. Effect of nitrogen fertilizer on rice insects, CLRRI, 2000-2001.

N level (kg/ha)	Leaf folder larva (No/square foot)	Thrips (%)
0	0.09 c	1.09 a
50	0.37 bc	0.22 b
100	0.78 b	0.36 b
150	1.52 a	0.25 b
200	1.99 a	0.12 b
F	11.78	4.48
p	0.000**	0.003*

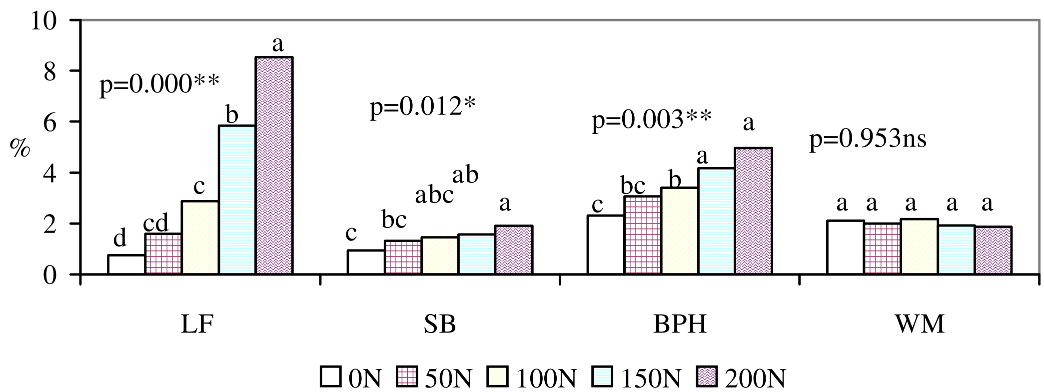

Figure 1. Effect of N fertilizer on the rice insects
LF: leaf folder, SB: stem borer, BPH: brown plant hopper, WM: whorl maggot

Table 7. Effect of nitrogen fertilizer on the rice diseases, CLRRI, 2000-2001.

N level (kg/ha)	Brown spot (%)	Cercospora small spot (%)
0	3.21 a	0.89 a
50	4.06 a	0.81 a
100	4.50 a	0.55 a
150	3.56 a	0.64 a
200	3.22 a	0.18 a
F	0.12	0.74
p	0.973	0.565

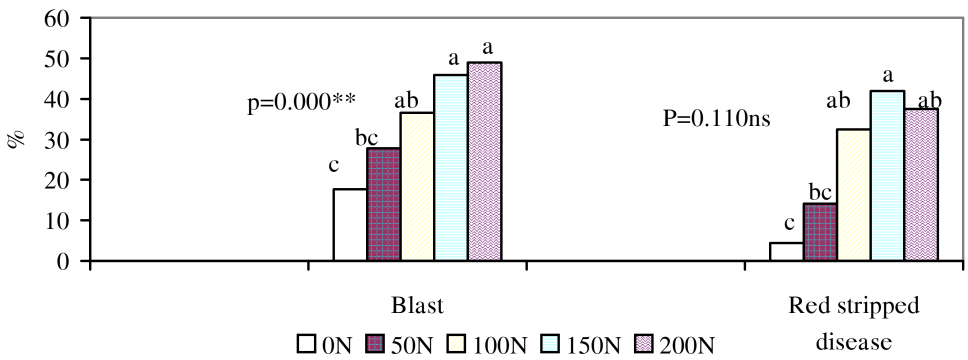

Figure 2. Effect of N fertilizer on the rice diseases

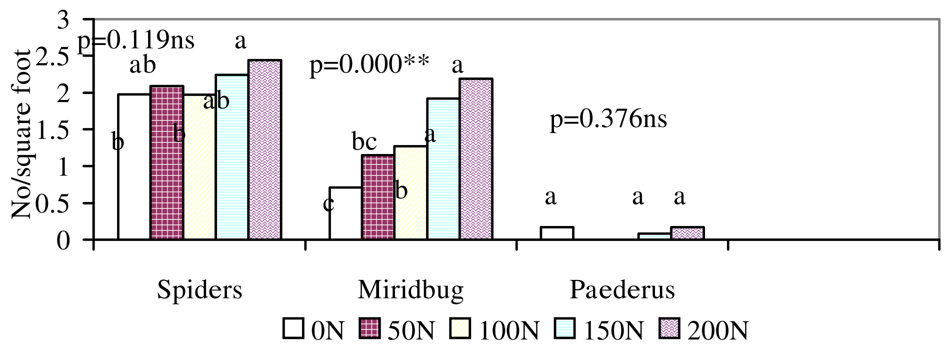

Figure3. Effect of N fertilizer on the natural enemies

Table 8. Effect of phosphorous fertilizer on the plant growth, CLRRI, 2000-2001.

P_2O_5 Level (kg/ha)	Tillers (No/ square foot)	Height (cm)	SPAD index
0	50.57 a	89.00 a	28.62 c
20	48.81 a	89.45 a	32.11 b
40	50.39 a	90.29 a	35.69 a
60	50.74 a	90.11 a	36.85 a
F	0.234	0.434	9.29
p	0.872	0.730	0.000**

Table 9. Effect of Phosphorous fertilizer on the yield component, CLRRI, 2000-2001.

P_2O_5 Level (kg/ha)	Panicles/m^2	Filled grains/panicle	Unfilled grain (%)	1000-grain weight (g)
0	668.67 a	59.54 a	24.15 b	29.53 a
20	679.61 a	62.06 a	25.99 b	28.72 a
40	664.40 a	67.0 a	28.28 ab	28.53 a
60	723.32 a	63.13 a	31.43 a	28.56 a
F	0.582	1.113	3.310	1.208
p	0.629	0.344	0.026 *	0.315

Table 10. Effect of phosphorous fertilizer on leaf nutrition and grain yield, CLRRI, 2000-2001.

P_2O_5 Level (kg/ha)	Leaf N content (%)	Leaf P content (%)	Leaf K content (%)	Grain yield (ton/ha)
0	3.086 a	0.114 b	1.607 a	3.135 a
20	3.014 a	0.125 a	1.650 a	2.801 ab
40	3.077 a	0.132 a	1.608 a	2.599 b
60	2.944 a	0.135 a	1.594 a	2.654 ab
F	0.220	6.172	0.514	2.054
p	0.882	0.001**	0.674	1.117

Table 11. Effect of phosphorous fertilizer on the rice insects, CLRRI, 2000-2001.

P_2O_5 Level (kg/ha)	Whorld maggot (%)	Stem borer (%)	Brown plant hopper (No/square foot)	Leaf folder larva (No/square foot)	Leaf folder streak (%)	Thrips (%)
0	1.78 a	1.55 ab	3.40 a	0.76 a	3.21 a	0.449a
20	2.15 a	1.42 ab	3.88 a	0.95 a	4.70 a	0.267a
40	2.04 a	1.09 b	3.40 a	1.05 a	3.92 a	0.553a
60	2.08 a	1.66 a	3.63 a	1.04 a	3.83 a	0.380a
F	0.358	1.856	0.215	0.229	0.492	0.414
p	0.783	0.148	0.886	0.876	0.690	0.743

Table 12. Effect of phosphorous fertilizer on the rice diseases, CLRRI, 2000-2001.

P_2O_5 Level (kg/ha)	Blast (%)	Brown spot (%)	Red stripped (%)	Cercospora small spot (%)
0	36.51 a	4.26 a	23.78 a	0.67 a
20	39.90 a	2.92 a	25.33 a	0.71 a
40	29.94 a	3.36 a	28.00 a	0.48 a
60	35.31 a	4.30 a	27.33 a	0.60 a
F	0.699	0.240	0.052	0.120
p	0.557	0.868	0.984	0.948

Table 13. Effect of phosphorous fertilizer on the natural enemies, CLRRI, 2000-2001.

P_2O_5 Level (kg/ha)	Spiders (No/ square foot)	Mirid bugs (No/ square foot)	Paederus beetles (No/ square foot)
0	2.18 a	1.44 a	0.066 a
20	2.09 a	1.47 a	0.066 a
40	2.19 a	1.41 a	0.200 a
60	2.11 a	1.48 a	0.000 a
F	0.154	0.022	1.385
p	0.927	0.995	0.257

Conclusion

- Nitrogen fertilizer clearly influenced to rice plant growth as inducing plant height and tillering, however, if more nitrogen fertilizer could be applied, the grain yield would reduce due to increasing unfilled grain percentage and decreasing 1000-grain weight.
- Number of panicles /m^2 and filled grains /panicle only increased when applying from 100 kg to 150 kg N/ha, if more than 150 kg N/ha applied, yield components and yield were down.
- SB, BPH, LF, Bl, RSD were rice pests positively related to increased nitrogen level application, with serious outbreak of insect pests and diseases. Natural enemies developed based on the quantity of preys, then it also came up when N levels increased.
- Balanced fertilization of NPK can help rice plant more healthy for resistance to rice insect pests and diseases.
- Phosphorous fertilizer was less effect to plant growth as compared to nitrogen fertilizer. But, more phosphorous fertilizer applied also caused to obtain high unfilled grain percentage and to reduce 1000-grain weight.
- Phosphorous levels ranged from 0 kg to 60 kg P_2O_5 did not affect to the expansion of insect pests, natural enemies and diseases in the rice field. Nevertheless, application of 40 kg P_2O_5 was observed the SB damage lower than other treatments.

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SUMMARY IN VIETNAMESE

Ảnh hưởng của quản lý dinh dưỡng đến sâu bệnh hại lúa.

Để xác định ảnh hưởng của quản lý dinh dưỡng đến sâu bệnh trên đồng ruộng, một thí nghiệm trên diện rộng được thực hiện qua 2 vụ Đông Xuân 2000-2001 và Hè Thu 2001 tại Viện Lúa ĐBSCL với kiểu bố trí khối hoàn toàn ngẫu nhiên, 3 lần nhắc lại, nghiệm thức là kết hợp 5 mức phân đạm 0, 50, 100, 150, 200 kg N/ha và 4 mức phân lân 0, 20, 40, 60 kg P_2O_5/ha trên nền 30 kg K_2O / ha . Kết quả cho thấy phân đạm không những ảnh hưởng đến sự tăng trưởng của lúa mà còn gây bộc phát sâu bệnh hại như rầy nâu, sâu đục thân, sâu cuốn lá, bệnh cháy lá và vàng lá. Phân lân ít ảnh hưởng đến sự tăng trưởng của cây lúa hơn phân đạm, cho nên cũng không ảnh hưởng đến sự gây hại của sâu bệnh trên lúa. Bón phân cân đối NPK giúp cho cây lúa chống chịu được sâu bệnh hại có hiệu quả cao.