NUTRIENT AND PEST INTERACTION IN TERMS OF PREVENTION FROM RICE YIELD DECLINING SYMPTOM IN MEKONG DELTA

HO XUAN THIEN, PHAM VAN DU, PHAM SI TAN,
U.S. SINGH[1], POMPE C.S. CRUZ[2], A. DOBERMAN[2] AND J.E. HILL[2]

ABSTRACT

Data collection of pest injuries had been obtained in three successive rice crops (1998's wet season, 1999's dry season, and 1999's wet season), and analyzed by PIA (pest impact assessment) in case of farm monitoring in Omon district, Cantho province. The survey was aimed at finding out the relationship between different pest injury profiles with levels of nutrient management under different cultivation practices. Correspondence analysis of the data surveyed in two crops showed that a close relationship between different pest injuries with different levels of nutrient management and levels of rice yield was addressed. High injuries due to leaf folder and red stripe, which occurred at dough stage of rice growth, were found to be closely linked to high yield. On the other hand, other leaf feeding insects, grain discoloration, brown spot, weeds above and below rice canopy usually expressed high incidence in rice fields where low yield was recognized.

Key words*:* rice, yield, pest, nutrient

INTRODUCTION

A survey of main constraints in different farmers' rice production fields of irrigated ecosystem in Mekong Delta was conducted. Analysis of the survey data indicated important pest injuries for each season, but no significant effects due to fertilizer inputs on levels of injuries, except for some pests (Du et al. 1997). However, experiences from on-farm research in the Reversing Trends of Declining Productivity (RTDP) sites suggest the interaction between nutrient and pest influences to maximize and stabilize rice yield at high levels. Other observations on relative yield loss in RTDP farms were due to some important pest injuries, and the increase of N application could also increase trend of pest incidence. In this promise, the need for better understanding of the nutrient x pest interaction had to be considered. Multiple correspondence analysis of quantified survey data at various production systems could be an important tool in explaining yield variation in relation to pests, seasonal patterns, cropping practices and pesticide use. On the other hand, another important research step needs to be followed to quantify yield losses due to these pests then necessary experiments should be subsequently conducted.

Research objectives:

- to survey pest incidence in different RTDP farms in various seasons
- to identify pest injuries of a given production system.

[1] G.B. Pant University of Agriculture and Technology, Pantnagar, Uttar Pradesh, India
[2] International Rice Research Institute, Los Banos, Laguna, Philippines

MATERIALS AND METHODS

Pest and crop data were collected in three successive rice crops (1998's wet season, 1999's dry season, and 1999's early wet season) at 108 sites of farmer fileds, in 5 villages of Omon district. Due to the availability of data combination collected from different groups, we have only selected 84 fields (of 108) for our advanced data analysis.

Based on survey protocol prepared, data assessment was done at four main rice growth stages: maximum tillering (25 days after sowing - DAS), booting (50 DAS), early dough (70 DAS), and maturity (95 DAS). We collaborated with RTDP group of Agronomy Division designed to design and manage fertilizer treatments and applications.

All data of pest injuries of three different patterns were collected: (1) nutrient management using SPAD-502 to effectively guide NPK application, (2) zero fertilizer application, (3) farmers' practices in their fields without any innovative recommendation

Regarding cropping practices, pesticide use, water management and weeding, farmers' practices were maintained. Survey was conducted on following nutrient field types:

Table 1. Field types in rice pest assessment.

No.	Treatment	Size (sqm)	No. of quadrats assessed
1	0F *	36	5
2	NPK **	300 in 98's WS, 1000 in 99's DS	12
3	FFP ***	>200	12

**: No fertilizer applied.*
***: Using chlorophyll meter (SPAD-502) to manage the amount of N-fertilizer application. Each pair of 0F and NPK belonged to one host.*
****: Farmer's field practice.*
DS: dry season, WS: wet season, sqm: square meter

Data recording

To assess pest injuries, a wire quadrat, 10 x 10 cm in diameter was used to place onto the ground for scoring. Damaged leaves were recorded by counting number of injured leaves. Major pests and diseases recorded were brown spot (BS), red stripe (RS), whorl maggot (WM), leaf folder (LF) and other leaf feeding insects (OT).

Pests that were harmful to rice stem, sheath, or panicle such as sheath blight (SB), sheath rot (SR) and grain discoloration (GD) were recorded by counting number of damaged tillers or panicles

For weed infestation, another estimated one square meter quadrat was used to quantify the weed cover percentage above (WA) and below (WB) the rice crop canopy, and three quadrats used for each rice field with the following scale:

0: no weed.
1: weed cover to 10% (low).
2: weed cover above 10 % to 30% (moderate).
3: weed cover above 30 % to 60% (high).
4: weed cover above 60 % (very high).

Pesticide application by rice farmers was also recorded with the answer was just YES or NO for the presence or absence of insecticides, fungicides, or herbicides applied in their fields.

Yield (t/ha) was estimated by harvesting three samples of five sqm (2 x 2.5 m) each which were randomly chosen, seed samples were measured their present moisture, then weight was converted at 14% moisture to obtain standard rice yield.

Data analysis

Parameters of injury types were compacted over four successive development stages to account for the overall injury caused by individual pests during crop development.

Injuries affecting the entire development of the crop: BS, RS, WM, LF, OT and weed growing above and below rice crop canopy were represented by areas under injury progress curves (AUIPC, Campbell and Madden 1990) over development:

$$AUIPC = \sum_{1}^{k}[(x(i) + x(i-1))/2][DVS(i) - DVS(i-1)]$$

x (i) : number of leaves or tillers injured, or converted ratings for weeds.
DVS: development stage at each assessment (using days after sowing).
k: total number of assessments (k = 4).

Injuries affecting the rice crop at a specific development (SB, SR, and GD) were represented by maximum number of damaged tillers or panicles observed during the four assessments.

All the raw data after being collected on rice fields then were entered into computer using Microsoft Excel. We have developed a “Macro” that could process from raw data forms to the final data sheet that contained only compacted data of each variable. From the data matrix, we can submit directly for many types of analysis. Multiple correspondence analysis was performed using STAT-ICTF software (France) release 4.0. Process of data management and data analysis can be presented in figure 1

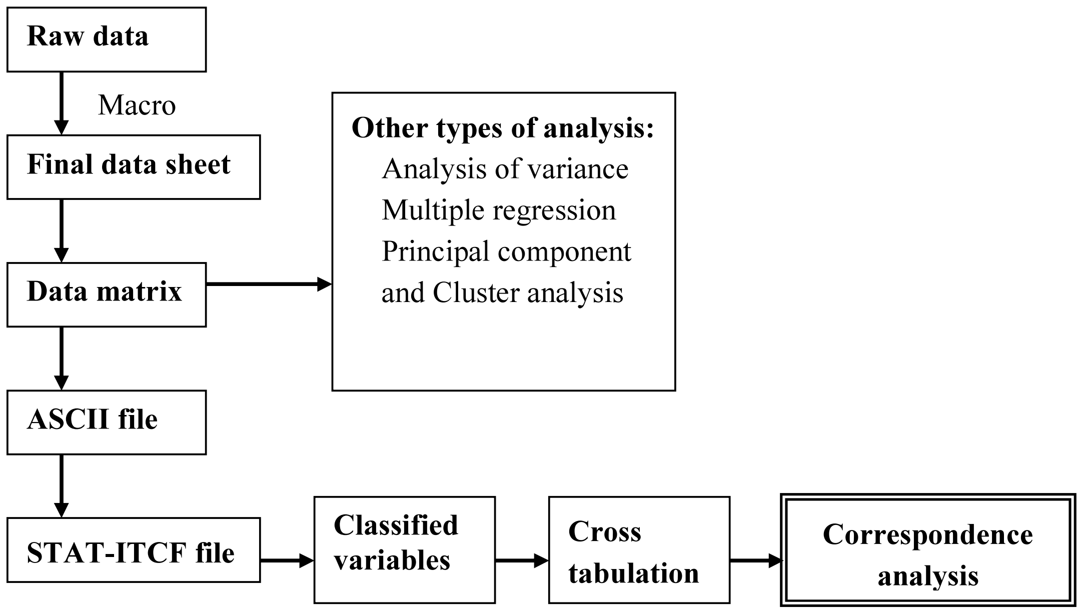

Figure 1 Flow chart of data management and analysis process.

RESULTS AND CONCLUSION

Results

From data survey of 2 successive crops, there were 16 variables represented for pest injuries, pesticide application, cropping practices, seasons and yield.

Categorization of data

From the ACSII file of data matrix, data then were translated into STAT-ITCF format. Pest injuries in the column variables were represented by three classes: low, medium, high. Pesticide application was separated into two classes: not being used (-) or being used (+). Three different field types represented for different nutrient management of 0F (no fertilizer applied), NPK (fertilizer application controlled by RTDP), FFP (fertilizer application controlled by farmers). Yield data were transformed into Y1 (very low), Y2 (low), Y3 (medium), and Y4 (high). These qualitative variables were transformed into coded quantitative variables (Table 2).

Categorization of data led to a set of variables with the same format. Bivariate frequency distributions were aptly described by contingency tables. In order to find the relationship between yield and other variables. Contingency table was built between [pests x yield], [pesticide use x yield], [seasons x yield] (Table 3).

Correspondence analysis

Correspondence analysis (CA), a non-parametric multivariate technique (Greenacre 1984), is a powerful tool to analyze contingency tables (Savary 1997). It can summarize and determine the relationships among variables. In other words, CA is an exploratory method to find a multi-dimensional representation of the complex association among variables. It finds scores for the row and column categories on a small number of dimensions accounting for the greatest proportion of the chi-square test for association between the row and column categories (Greenacre 1984).

Outputs from CA were graphed with a number of axes. Data displayed here are only the first two axes wherein axis one and two account for 77.1 and 15.0 %, respectively, of the total inertia of the data set. Axis one is horizontal, and axis two is vertical to illustrate the relationship among classes.

Figure 2 presents an overview of the relationships among analyzed variables. The coordinates of the yield classes along the first axis indicate that axis one primarily represents a gradient of increasing yields. It also points out that there are close relationships between injury types and nutrient management, between low rice yields (Y1, Y2) with wet season (WET), and medium to high yields (Y3, Y4) with dry season (DRY). Y1 tends to go with 0F treatments, Y3 and Y4 with FFP and NPK, respectively. This indicates that information based NPK treatments, using chlorophyll meter to assess the amount of fertilizer applied, gave the highest yields compared with the two remaining treatments. This also showed in figure 2 that there were not very good effects of pesticide application by rice farmers. Sheath blight and sheath rot did not show any clear relationship with any kind of yield. In the two seasons, the incidence of those diseases was rather low so that the contribution of those to rice yield loss was not enough to be displayed by correspondence analysis.

Figure 3 indicates that two cases of leaf folder and red stripe would be usually very severe if high amount of nitrogen could be used. And in this survey, red stripe disease only occurred at rice dough stage, it means very late to be able affected rice yield

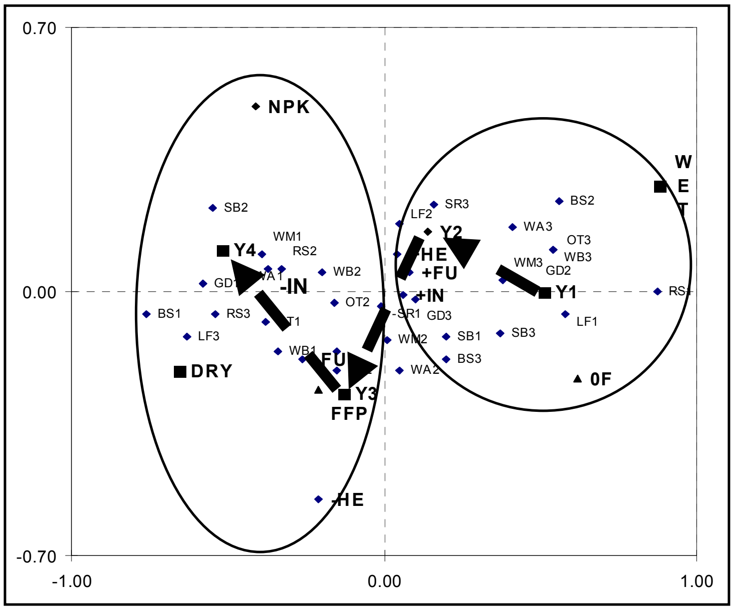

Figure 2. Correspondence analysis indicating effect of pest injury types in different nutrient management in RTDP monitoring farms. The axes were defined using classes of diseases (BS1, BS2, BS3, RS1, RS2, RS3, SB1, SB2, SB3, SR1, SR2, SR3, GD1, GD2, GD3), insects (WM1, WM2, WM3, LF1, LF2, LF3, OT1, OT2, OT3), weed infestation (WA1, WA2, WA3, WB1, WB2, WB3), pesticide application (-IN, +IN, -FU, +FU, -HE, +HE), field types (0F, NPK, FFP), yield levels (Y1, Y2, Y3, Y4), and seasons (WET, DRY).

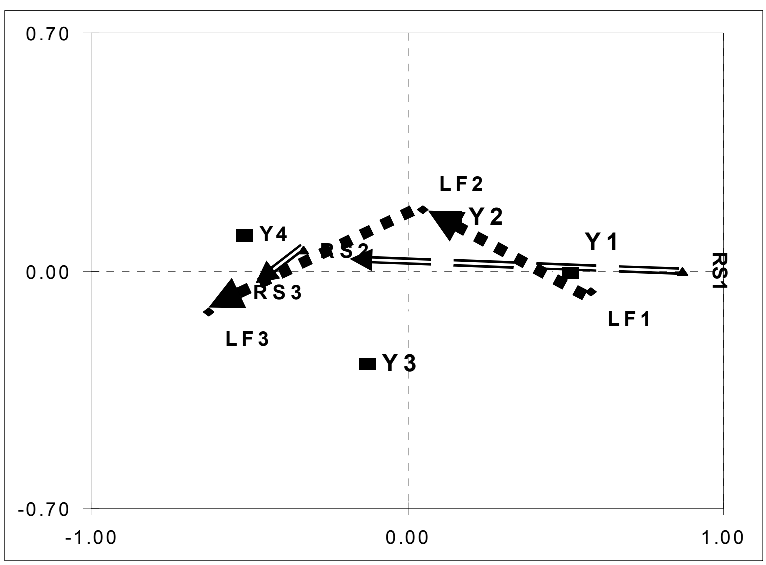

Figure 3. Correspondence analysis indicating effect of pest injury types in different nutrient management in RTDP monitoring farms. The axes were defined using classes of leaf folder (LF1, LF2, LF3), red stripe disease (RS1, RS2, RS3), and yield levels (Y1, Y2, Y3, Y4).

Table 2 Categorization of information used in the data analysis.

Variable	No. of created classes	Coded No.	Class range	Short label	No. of individuals
BS	3	1	137.92 to 463.75	BS1	28
		2	> 463.75 to 1137.5	BS2	28
		3	> 1137.5 to 3258	BS3	28
RS	3	1	0 to 36	RS1	28
		2	> 36 to 98.33	RS2	28
		3	> 98.33 to 312	RS3	28
SB	3	1	0	SB1	25
		2	> 0 to 0.5	SB2	29
		3	> 0.5 to 5.58	SB3	30
SR	3	1	0 to 0.2	SR1	27
		2	> 0.2 to 0.6	SR2	28
		3	> 0.6 to 2.08	SR3	29
GD	3	1	0.2 to 5.25	GD1	28
		2	> 5.26 to 8.75	GD2	28
		3	> 8.75 to 12.4	GD3	28
WM	3	1	0 to 16.88	WM1	28
		2	> 16.88 to 42.08	WM2	28
		3	> 42.08 to 305.21	WM3	28
LF	3	1	0 to 36.46	LF1	28
		2	> 36.46 to 85.42	LF2	28
		3	> 85.42 to 301.25	LF3	28
OT	3	1	0 to 59.58	OT1	28
		2	> 59.58 to 131.88	OT2	28
		3	> 131.88 to 454.38	OT3	28
WA	3	1	0 to 4.17	WA1	28
		2	> 4.17 to 46.67	WA2	28
		3	> 46.67 to 140	WA3	28
WB	3	1	0 to 10	WB1	28
		2	> 10 to 56.67	WB2	28
		3	> 56.67 to 144.17	WB3	28
IN	2	1	-IN	-IN	11
		2	+IN	+IN	73
FU	2	1	-FU	-FU	20
		2	+FU	+FU	64
HE	2	1	-HE	-HE	13
		2	+HE	+HE	71
FD	3	1	0F	0F	36
		2	NPK	NPK	48
		3	FFP	FFP	28
SE	2	1	WET	WET	28
		2	DRY	DRY	28
Y	4	1	1.23 to 2.8	Y1	21
		2	> 2.8 to 4.2	Y2	21
		3	> 4.2 to 5.39	Y3	21
		4	> 5.39 to 7.88	Y4	21

Table 3 Contingency table used in the analysis.

Variable	Short label	Yield levels			
		Y1	Y2	Y3	Y4
Diseases	BS1	1	3	9	15
	BS2	10	13	4	1
	BS3	10	5	8	5
	RS1	17	7	4	0
	RS2	2	9	8	9
	RS3	2	5	9	12
	SB1	8	6	7	4
	SB2	2	7	6	14
	SB3	11	8	8	3
	SR1	7	6	7	7
	SR2	5	6	10	7
	SR3	9	9	4	7
	GD1	2	5	8	13
	GD2	11	9	6	2
	GD3	8	7	7	6
Insects	WM1	3	7	7	11
	WM2	8	5	8	7
	WM3	10	9	6	3
	LF1	11	10	7	0
	LF2	7	9	5	7
	LF3	3	2	9	14
	OT1	11	5	8	4
	OT2	4	11	4	9
	OT3	6	5	9	8
Weed infestation	WA1	2	7	8	11
	WA2	8	5	9	6
	WA3	11	9	4	4
	WB1	3	6	10	9
	WB2	5	7	7	9
	WB3	13	8	4	3
Pesticide use	-IN	1	3	3	4
	+IN	20	18	18	17
	-FU	3	4	7	6
	+FU	18	17	14	15
	-HE	1	3	7	2
	+HE	20	18	14	19
Field types	0F	13	7	8	0
	NPK	4	8	2	14
	FFP	4	6	11	7
Season	DRY	20	14	2	0
(supplementary)	WET	1	7	19	21

Table 4 Correspondence analysis, relative weight and contribution to axes.

Variable (short label)	Axis 1			Axis 2		
	Coordinate	Square Cosines	Relative Contribution	Coordinate	Square Cosines	Relative Contribution
BS1	-0.76	0.95	9.10	-0.06	0.01	0.30
BS2	0.56	0.68	4.90	0.24	0.12	4.60
BS3	0.21	0.46	0.70	-0.18	0.34	2.50
RS1	0.87	0.93	11.70	0.00	0.00	0.00
RS2	-0.33	0.62	1.70	0.06	0.22	0.30
RS3	-0.54	0.99	4.60	-0.06	0.01	0.30
SB1	0.21	0.75	0.60	-0.12	0.25	1.00
SB2	-0.55	0.86	5.00	0.22	0.13	4.00
SB3	0.37	0.91	2.20	-0.11	0.09	1.10
SR1	-0.01	0.05	0.00	-0.04	0.32	0.10
SR2	-0.15	0.31	0.30	-0.21	0.60	3.40
SR3	0.16	0.35	0.40	0.23	0.68	4.50
GD1	-0.58	0.99	5.20	0.02	0.00	0.00
GD2	0.48	0.98	3.60	0.01	0.00	0.00
GD3	0.10	0.93	0.10	-0.02	0.06	0.00
WM1	-0.39	0.93	2.40	0.10	0.06	0.80
WM2	0.01	0.00	0.00	-0.13	0.53	1.30
WM3	0.38	0.95	2.30	0.03	0.01	0.10
LF1	0.58	0.88	5.20	-0.06	0.01	0.30
LF2	0.05	0.07	0.00	0.19	0.84	2.80
LF3	-0.63	0.83	6.20	-0.12	0.03	1.20
OT1	-0.38	0.94	2.30	-0.08	0.04	0.50
OT2	-0.16	0.82	0.40	-0.03	0.04	0.10
OT3	0.54	0.92	4.50	0.11	0.04	1.00
WA1	-0.45	0.95	3.20	0.04	0.01	0.10
WA2	0.05	0.04	0.00	-0.21	0.86	3.50
WA3	0.41	0.85	2.60	0.17	0.15	2.30
WB1	-0.34	0.77	1.80	-0.16	0.16	2.00
WB2	-0.20	0.93	0.60	0.05	0.06	0.20
WB3	0.54	0.92	4.50	0.11	0.04	1.00
-IN	-0.37	0.88	0.80	0.06	0.03	0.10
+IN	0.06	0.88	0.10	-0.01	0.03	0.00
-FU	-0.26	0.67	0.70	-0.18	0.31	1.80
+FU	0.08	0.67	0.20	0.06	0.31	0.60
-HE	-0.21	0.09	0.30	-0.55	0.61	11.10
+HE	0.04	0.09	0.10	0.10	0.61	2.00
0F	0.62	0.88	6.10	-0.23	0.12	4.20
NPK	-0.14	0.40	2.70	0.49	0.56	19.40
FFP	-0.21	0.33	0.70	-0.26	0.52	5.60

Table 4. continue ...

Variable (short label)	Axis 1			Axis 2		
	Coordinate	Square Cosines	Relative Contribution	Coordinate	Square Cosines	Relative Contribution
Y1	0.51	0.94	46.10	0.00	0.00	0.00
Y2	0.14	0.27	3.50	0.16	0.35	23.70
Y3	-0.13	0.19	3.20	-0.27	0.77	65.40
Y4	-0.52	0.92	47.30	0.11	0.04	11.00
*WET	0.88	0.91	-	0.28	0.09	
*DRY	-0.66	0.91	-	-0.21	0.09	
Inertia accounted for by axes			77.1 %			15 %

*: *supplementary observations*.

CONCLUSION

The analysis of this survey is just to provide an overview of the interaction between injury types and nutrient management, in which potential rice pests are identified, and the influence of nutrient management to injuries and yields. There are different rice pest profiles that go together with different levels of rice yield. Low rice yields are often in wet season and have strong link with high weed cover percentage, high incidence of brown spot, grain discoloration, whorl maggot and leaf feeding insects (except leaf folder). However, NPK management using chlorophyll meter and FFP fields tend to have high incidence of red stripe and leaf folder. The third crop survey data are under processing, hopefully we can identify main constraints for yield losses in the complex association of pests and nutrient management in RTDP farms.

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TÓM TẮT

Phân tích sự tương tác giữa dịch hại và quản lý dinh dưỡng trên mô hình nghiên cứu "khắc phục sự suy giảm năng suất luá" ở ĐBSCL

Số liệu về dịch hại được thu thập trong các vụ hè thu 1998, đông xuân 1998-1999, xuân hè 1999 tại các ruộng thí nghiệm nghiên cứu khắc phục sự suy giảm năng suất lúa tại huyện Ô môn, tỉnh Cần Thơ. Kết quả phân tích nhóm (correspondence analysis) của hai vụ đầu đưa ra một cách nhìn tổng thể về sự tương tác giữa dịch hại với các loại hình quản lý dinh dưỡng khác nhau. Nghiệm thức quản lý dinh dưỡng bằng máy đo diệp lục tố (SPAD-502) và ruộng sản xuất của nông dân thường xuất hiện sâu cuốn lá và bệnh vàng lá (giai đoạn chín sáp). Năng suất thấp thường đi cùng với nhiều cỏ dại, đốm nâu, lem lép hạt, ruồi đục lá và các loại sâu ăn lá khác. Số liệu của vụ xuân hè 1999 đang được tiếp tục xử lý với hy vọng tìm ra được các yếu tố giới hạn chính cho thiệt hại năng suất trong các loại hình quản lý dinh dưỡng khác nhau.