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RESPONSES OF SOME PROMISING HIGH-YIELDING RICE VARIETIES TO NITROGEN FERTILIZER

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ABSTRACT

The field experiment was laid out in a split-plot design with three replications at the CLRRI farm in the 2004 Wet and Dry seasons. In the Wet season, main plots consisted of five rates of nitrogen fertilizers i.e. control (0 kg N/ha), 30, 60, 90 and 120 kg N/ha. In the Dry season, five rates of nitrogen fertilizers were control (0 kg N/ha), 40, 80, 120, 160 kg N/ha. Subplots consisted of five rice varieties for both season i.e. OMCS2000, OM2718, OM3419, OM3238 and OM4872. Seed was applied at 100 kg/ha by row seeder. Phosphorus fertilizer was applied at 50 kg P_2O_5/ha at the time of final puddling. Potassium fertilizer was applied at 50 kg K_2O/ha at 7-8 DAS and 42 DAS.

The results of study showed that application of nitrogen fertilizer at 60 kg N/ha obtained the highest economical efficiency in the Wet season for all tested rice varieties. Further increase in the rate of nitrogen fertilizer beyond 90 kg N/ha gave a negative EENA value. In the Dry season, at 80 kg N/ha, EENA obtained the highest for all tested rice varieties. At higher nitrogen rates (120-160 kg N/ha), EENA values were lowest.

Key words: EENA value, response to nitrogen fertilizer

INTRODUCTION

The amounts of inorganic fertilizers consumption for rice crop in the Mekong delta area are around 400.000 tones of nitrogen, 180.000 tones of phosphorus and 120.000 tones of potassium every year. Most of these are imported and only small quantity is produced in the country (Tan 2005). Fertilizer use efficiency is low due mainly to losses through leaching, run off etc. According to Nguyen van Bo (2002), the amount of fertilizer losses is around 1.2-1.3 m tones out of the total fertilizer application (2 m tones).

In fact, fertilizers consumption is changing depending on rice variety used, soil condition and farmer practice. Although, there are specified fertilizer recommendations for each type of soils farmer still practice as their ways.

Nitrogen fertilizer recommendation for specific rice regions are suggested as: in the area of Tien and Hau rivers, nitrogen fertilizer dose ranges from 100 to 120 kg N/ha in dry season and 80 to 100 kg N/ha in wet season.

In acid sulphate soils such as Long Xuyen quadrangle, West Hau river and Dong Thap Muoi, N-fertilizer recommendation is lower than the area of alluvium soils *i.e.* 80-100 kg N/ha in dry season and 60 to 80 kg N/ha in wet season. Besides, a small area of the coastal region from Long An to Ca Mau, N-fertilizer recommendation is as low as 30-50 kg N/ha.

Actually, farmers in the Mekong delta prefer to apply nitrogen fertilizer more than recommendation dose. In many cases, they applied nitrogen fertilizer rather in wet than in dry season.

Normally, farmers divide fertilizers in to 3 to 4 times (even 6-7 times) to apply in a crop season. According to many recommendations, nitrogen fertilizer is suggested to apply by 3 times/crop depending upon the crop growth stage. With the longer crop duration (120 days), nitrogen fertilizer is applied at 10-15 day after sowing (DAS), 30-35 DAS and 65-70 DAS. Nowadays, with the short-duration rice genotypes (90-110 days) or the ultra-short genotypes (below 90 days), rates and times for nitrogen application are also changed. So far, we do not have a suitable fertilizer recommendation for the ultra-short rice genotypes (<90 days). However, recent

investigations suggested the time of nitrogen application for the ultra-short rice varieties as: 7-10 DAS, 18-22 DAS and 37-40 DAS (Pham sy Tan 2005).

Imbalanced fertilizers application, especially in wet season, created more severe diseases, lodging and resulting in low efficiency of nitrogen fertilizer application. According to Cassman et al. (1993), N-use efficiency under field conditions is less than 40%.

There is a large variable in the source and quantity of nitrogen fertilizer application depending on farmer field condition. The amount of nitrogen fertilizer application and supply from indigenous soils also depend on crop season (Pham sy Tan 1997). The author also emphasized that amount of nitrogen fertilizer application and amount of nitrogen supply from indigenous soil should be fit to meet plant demand. From another investigation Pham sy Tan et al. (2000) also concluded that adjusting amount of nitrogen application and indigenous nitrogen is a key factor to get higher yield of rice and sustainability. To maintain the current rice production in the delta, farmers have to change their nutrient management practices for insensitive rice system (Pham sy Tan 2000). High nitrogen application in combination with high temperature and relative humidity increased the red yellow disease severity (Cao van Phung and Luu hong Man, 2000).

According to Dilday (1988) and Hou (1988), quantity and time of nitrogen application affected head rice recovery percentage (HRR). Application of nitrogen fertilizer at two times (before sowing and 30 DAS) gave lower HRR % and 1000-grain weight than those of three times (before sowing, 30 and 60 DAS).

The objectives of this study are: (1) to study the response of five promising high-yielding rice varieties to various nitrogen levels; (2) to find out the best nitrogen level for five promising high-yielding rice varieties; and (3) to work out the economical efficacy of nitrogen application on five promising high-yielding rice varieties.

MATERIALS AND METHODS

Field experiment was carried out on research farm of Cuu Long Delta Rice Research Institute during 2004 *wet* season of the crop year and 2005 d*ry* season. The experiment was laid out in a split plot design with 3 replications. In wet season, main plots consisted of five rates of nitrogen fertilizers *i.e.* control (0 kg N/ha), 30, 60, 90 and 120 kg N/ha while in dry season, five rates of nitrogen fertilizers were control (0 kg N/ha), 40, 80, 120, 160 kg N/ha. Nitrogen fertilizer was used as urea form and divided into three times *i.e.* 25% of the total N dose was applied at 7 to 8 day after sowing (DAS), 50% at 22 DAS and the rest at 42 DAS. Subplots consisted of five rice varieties for both season *i.e.* OMCS2000, OM2718, OM3419, OM3238 and OM4872. Seed was applied at 100 kg/ha by row seeder. Phosphorus fertilizer was applied at 50 kg P_2O_5/ha at the time of final puddling. Potassium fertilizer was applied at 50 kg K_2O/ha at 7-8 DAS and 42 DAS.

Observations were taken up at different crop growth stages for plant height. Rice was harvested at physical ripen stage and processed for yield and yield components. The data related to each character were analyzed statistically by applying the technique of Analysis of Variance with the help of IRRISTAT software.

RESULTS AND DISCUSSIONS

Growth duration

In general, rice grown in wet season had shorter growth duration than those grown in dry season for 3-5 days (data showed in Table 1a and 1b). Among rice varieties, OMCS2000 exhibited the shortest growth duration in both seasons.

Application of nitrogen fertilizer increased rice growth duration over control. At the highest nitrogen rate (120 kg N/ha), crop growth duration increased 4-5 days in wet season and 7-10 days in dry season.

Table 1a: Effect of N fertilizer rates on growing duration (day) of five HYVs.

Variety (V)	Rates of N application (kg N/ha)					
	0	*30*	*60*	*90*	*120*	*V- MEAN*
OMCS2000	84 b	85 c	87 b	88 b	88 c	86
OM2718	86 a	87 ab	90 a	90 a	90 b	89
OM3419	87 a	88 a	90 a	90 a	92 a	89
OM3238	86 a	88 a	89 a	91 ab	91 ab	89
OM4872	86 a	86 bc	90 a	91 ab	91 ab	89
F- MEAN	86	87	89	90	90	88

CV(a) = 0.8% *CV(b) = 0.7%*

	LSD (5%)	LSD (1%)
2- F means at each V	1.1	1.5
2- V means at each F	1.0	1.4

Table 1b: Effect of N fertilizer rates on growing duration (day) of five HYVs

Variety (V)	Rates of nitrogen application (kg N/ha)					
	0	*40*	*80*	*120*	*160*	*G- MEAN*
OMCS2000	85 b	91 b	93 d	93 d	95 c	92
OM2718	91 a	93 a	95 bc	95 c	97 b	94
OM3419	91 a	93 a	96 ab	97 b	99 a	95
OM3238	91 a	93 a	97 a	99 a	100 a	96
OM4872	91 a	93 a	94 cd	96 c	100 a	95
P- MEAN	90	93	89	90	90	95

CV(a) = 1.6% *CV (b) = 0.7%*

	LSD (5%)	LSD (1%)
2- P means at each G	1.6	2.2
2- G means at each P	1.0	1.4

Plant height

The data on plant height recorded at different growth stages of rice are presented in Table 2a and 2b.

Among rice varieties, OMCS2000 produced shorter plant height as compared to the other varieties. There were non significant differences in term of plant height among varieties OM2718, OM3419, OM3238 and OM4872. These results were consistency in both wet and dry seasons. The data also indicated that five tested rice varieties grown in dry season produced higher plant height than those grown in wet season.

Application of nitrogen fertilizer significantly increased plant height over control for all tested varieties. The result is true for both *Wet* and *Dry* season.

Table 2a: Effect of N fertilizer rates on plant high (cm) of five HYVs.

Variety (V)	Rates of N application (kg N/ha)					
	0	*30*	*60*	*90*	*120*	*V- MEAN*
OMCS2000	86 a	89 a	91 a	91 b	94 b	90 b
OM2718	88 a	95 a	95 a	99 a	103 a	96 a
OM3419	90 a	94 a	96 a	97 ab	99 ab	95 a
OM3238	90 a	95 a	98 a	98 ab	100 ab	96 a
OM4872	90 a	94 a	95 a	99 a	102 a	96 a
F- MEAN	89	93	95	97	100	95

CV(a) = 5.3% *CV (b) = 4.1%*

	LSD (5%)	LSD (1%)
2- F means at each V	7	10
2- V means at each F	6	9
2- V means	3	4
2- F means	4	6

Table 2b: Effect of N fertilizer rates on plant high (cm) of five HYVs

Variety (V)	Rates of nitrogen application (kg N/ha)					
	0	*40*	*80*	*120*	*160*	*G- MEAN*
OMCS2000	78 b	91 b	93 b	94 a	95 a	90 b
OM2718	86 a	97 a	98 ab	98 a	97 a	95 a
OM3419	85 a	97 a	97 ab	96 a	98 a	95 a
OM3238	87 a	93 ab	95 ab	97 a	99 a	94 a
OM4872	87 a	91 b	99 a	96 a	99 a	94 a
P- MEAN	85	93	95	97	98	94

CV(a) = 5.1% *CV (b) = 2.9%*

	LSD (5%)	LSD (1%)
2- P means at each G	5.7	7.9
2- G means at each P	4.5	6.1
2-G means	2.0	2.7
2-P means	4.0	5.8

Number of panicles per square meter

In general, OMCS2000 rice variety produced the lowest panicle number per square meter as compared to the other genotypes in both wet and dry seasons.

The influences of nitrogen fertilizer on number of panicles per square meter in wet season are given in Table 3a. Application of nitrogen fertilizer significantly increased number of panicles per square meter over control. There was a significant increase in number of panicles per square meter with increase in each successive level of fertilizers up to 60 kg N/ha. Further increase in the rate of nitrogen fertilizer from 90 to 120 kg N/ha did not significantly increase number of panicles per square meter. In this season, OM3238 gave the highest number of panicles per square meter as compared to other varieties.

The influences of nitrogen fertilizer on number of panicles per square meter in dry season are given in Table 3b-1 and Table 3b-2. Except OMCS2718, other tested rice varieties produced more number of panicles per square meter with increase in each successive level of nitrogen fertilizer. However, significant difference in number of panicles per square meter over control was recorded only at higher level of nitrogen fertilizer (120 kg N/ha). OM2718 rice variety produced the highest number of panicles per square meter as compared to the other varieties.

Table 3a: Effect of N fertilizer rates on number panicles per square meter of five HYVs

Variety (V)	Rates of N application (kg N/ha)					
	0	*30*	*60*	*90*	*120*	*V- MEAN*
OMCS2000	421 b	486 c	541 b	469 a	467 b	477 c
OM2718	439 b	583 b	591 b	521 a	515 ab	530 b
OM3419	423 b	597 b	599 b	506 a	529 ab	531 b
OM3238	517 a	657 ab	675 a	530 a	566 a	589 a
OM4872	445 ab	704 a	597 b	538 a	541 ab	565 a
F- MEAN	449	605	601	513	524	538

CV(a) = 10.2% *CV (b) = 8.2%*

	LSD (5%)	LSD (1%)
2- F means at each V	80	109
2- V means at each F	73	97
2- V means	32	43
2- F means	46	67

Table 3b-1: Effect of N fertilizer rates on number panicles/m^2 of five HYVs

Variety (V)	Rates of nitrogen application (kg N/ha)					
	0	***40***	***80***	***120***	***160***	***G- MEAN***
OMCS2000	467 a	477 a	530 a	597 a	485 c	511 b
OM2718	479 a	557 a	590 a	648 a	643 a	583 a
OM3419	509 a	499 a	515 a	567 a	608 ab	540 ab
OM3238	498 a	526 a	573 a	609 a	562 abc	554 ab
OM4872	465 a	545 a	606 a	583 a	503 bc	541 ab
P- MEAN	484	521	563	601	560	546

CV(a) = 19.0% *CV (b) = 11.8%*

Table 3b-2: Effect of N fertilizer rates on number panicles/m^2 of five HYVs (P x G).

Fertilizer (P)	Penicles/m^2					
	OMCS2000	OM2718	OM3419	OM3238	OM4872	P- MEAN
0N	467 a	479 b	509 a	498 a	465 a	484 b
40N	477 a	557 ab	499 a	526 a	545 a	547 ab
80N	530 a	590 ab	515 a	573 a	606 a	537 ab
120N	597 a	648 a	567 a	609 a	583 a	601 a
160N	485 a	643 a	608 a	562 a	503 a	560 ab
G- MEAN	484	583	540	554	541	546

CV(a) = 19.0% *CV (b) = 11.8%*

Number of filled grains per panicle

In general, OMCS2000 obtained the lowest filled-grain number as compared to the other varieties in both wet and dry season.

The effects of nitrogen fertilizer on number of filled-grains per panicle in wet season are given in Table 4a. There was a significant increase in number of filled-grains per panicle with increase in each successive level of fertilizers up to 60 kg N/ha. Further increase in the rate of nitrogen fertilizer from 90 to 120 kg N/ha reduced filled-grain of rice. There were non significant differences in number of filled-grain per panicle among five tested rice varieties. However, application of nitrogen fertilizer at 60 kg N/ha, OM3238 produced a lower filled-grain number than those of the other rice varieties.

The effects of nitrogen fertilizer on number of filled-grains per panicle in dry season are given in Table 4b. There was a significant increase in number of filled-grains per panicle with increase in each successive level of fertilizers up to 80 kg N/ha. Further increase in the rate of nitrogen fertilizer from 120 to 160 kg N/ha reduced filled-grain of rice. There was no significant difference in number of filled-grains among the tested rice varieties.

Table 4a: Effect of N fertilizer rates on number of filled grains per panicle of five HYVs

Variety (V)	Rates of nitrogen application (kg N/ha)					
	0	*30*	*60*	*90*	*120*	*V- MEAN*
OMCS2000	58 a	60 a	78 a	64 a	57 a	63
OM2718	56 a	58 a	75 a	59 ab	47 a	59
OM3419	60 a	62 a	78 a	52 b	53 a	61
OM3238	56 a	61 a	58 b	52 b	48 a	55
OM4872	56 a	58 a	79 a	63 a	54 a	62
F- MEAN	57	60	73	58	52	60

CV(a) = 11.6% *CV (b) = 9.5%*

	LSD (5%)	LSD (1%)
2- F means at each V	10	14
2- V means at each F	9	13

Table 4b: Effect of N fertilizer rates on number of filled grains/panicles of five HYVs

Variety (V)	Rates of nitrogen application (kg N/ha)					
	0	*40*	*80*	*120*	*160*	*V- MEAN*
OMCS2000	34.6 b	41.3 b	49.2 a	49.2 a	46.6 a	44.2
OM2718	37.9 ab	48.1 a	47.4 a	52.4 a	45.2 a	46.2
OM3419	37.0 ab	49.2 a	51.0 a	47.2 a	42.8 a	45.4
OM3238	39.6 ab	41.6 b	47.1 a	45.5 a	49.6 a	44.7
OM4872	43.2 a	41.3 b	47.1 a	45.9 a	45.9 a	44.7
F- MEAN	38.5	44.3	48.4	48.0	46.0	45.0

CV(a) = 11.3% *CV (b) = 8.3%*

	LSD (5%)	LSD (1%)
2- F means at each V	7.0	9.6
2- V means at each F	6.2	8.3

Unfilled-grain percentage (%)

The influences of nitrogen fertilizer on unfilled-grain percentage in wet season are given in Table 5a. There was an increasing trend in unfilled-grain percentage with increase in each successive level of fertilizers up to 60 kg N/ha. Application of nitrogen fertilizer at 90 or 120 kg N/ha gave a significant difference in unfilled-grain percentage over control. Among tested rice varieties, OM3419 and OM3238 produced a higher unfilled-grain percentage. OMCS2000 gave the lowest unfilled-grain percentage.

The influences of nitrogen fertilizer on unfilled-grain percentage in dry season are given in Table 5b. The effects of nitrogen fertilizer on unfilled-grain percentage of five rice varieties were in a same pattern in wet season. It means that increasing in the level of nitrogen fertilizer indicated increasing trend in unfilled-grain percentage. Among tested rice varieties, OMCS2000 and OM2718 produced a higher unfilled-grain percentage. OM3238 exhibited the lowest unfilled-grain percentage.

Table 5a: Effect of N fertilizer rates on percentage of unfilled grains (%) of five HYVs

Variety (V)	Rates of nitrogen application (kg N/ha)					
	0	*30*	*60*	*90*	*120*	*V- MEAN*
OMCS2000	21.0 b	19.5 b	23.4 b	22.6 c	27.5 b	22.8 c
OM2718	23.5 ab	26.3 a	25.6 ab	28.9 b	33.9 a	27.7 b
OM3419	25.1 ab	29.7 a	29.3 a	36.0 a	36.3 a	31.3 a
OM3238	27.4 a	27.9 a	28.5 a	33.9 a	36.9 a	30.9 a
OM4872	23.6 ab	28.2 a	23.7 b	29.1 b	34.0 a	27.7 b
F- MEAN	24.1	26.3	26.1	30.1	33.7	28.1

CV(a) = 17.9% *CV (b) = 9.8%*

	LSD (5%)	LSD (1%)
2- F means at each V	5.8	8.1
2- V means at each F	4.5	6.0
2- V means	2.0	2.7
2- F means	4.2	6.1

Table 5b: Effect of N fertilizer rates on Percentage of unfilled grains (%) of five HYVs

Variety (V)	Rates of nitrogen application (kg N/ha)					
	0	*40*	*80*	*120*	*160*	*V- MEAN*
OMCS2000	15.8 b	24.6 a	26.3 b	28.6 b	36.6 a	26.4
OM2718	21.3 a	27.4 a	26.3 b	34.2 a	37.0 a	29.2
OM3419	22.9 a	24.0 a	28.5 b	36.6 a	38.8 a	30.1
OM3238	24.0 a	26.9 a	34.1 a	35.7 a	37.5 a	31.7
OM4872	23.5 a	24.8 a	33.3 a	34.7 a	34.7 a	30.8
F- MEAN	21.5	25.5	29.7	34.0	37.6	29.7

CV(a) = 8.1% *CV (b) = 6.5%*

	LSD (5%)	LSD (1%)
2- F means at each V	3.5	4.8
2- V means at each F	3.2	4.4

1000-grain weight

The effects of nitrogen fertilizer on 1000-grain weight are given in Table 6a and Table 6b.

Application of nitrogen fertilizer had no effect on 1000-grain weight of rice in both wet and dry seasons.

In wet season, OMCS2000 produced higher 1000-grain weight then OM3419, OM3238, OM2718 and OM4872, orderly.

Table 6a: Effect of N fertilizer rates on 1000-grain weight (g) of five HYVs.

Variety (V)	Rates of nitrogen application (kg N/ha)					
	0	*30*	*60*	*90*	*120*	*V- MEAN*
OMCS2000	28.30 a	28.50 a	28.00 a	27.83 a	27.33 a	27.99 a
OM2718	26.20 c	26.00 c	26.30 c	25.67 b	25.83 cd	26.00 c
OM3419	26.93 b	26.90 b	27.30 b	26.20 b	26.50 b	26.77 b
OM3238	26.27 c	26.30 bc	26.67 c	25.97 b	26.17 bc	26.27 c
OM4872	26.43 bc	26.07 c	26.23 c	25.83 b	25.40 d	25.99 c
F- MEAN	26.83	26.75	26.90	26.30	26.25	26.61

CV(a) = 1.0% *CV (b) =1.4 %*

LSD (5%) LSD (1%)

2- F means at each V	0.59	0.80
2- V means at each F	0.61	0.82
2- V means	0.27	0.37
2- F means	0.22	0.3

Table 6b: Effect of N fertilizer rates on 1000 grain weight (g) of five HYVs (P x G)

Fertilizer (P)	1000 grain weight (gr)					
	OMCS2000	*OM2718*	*OM3419*	*OM3238*	*OM4872*	*F- MEAN*
0N	26.5 a	24.5 a	25.8 a	25.4 a	24.4 a	25.3 a
40N	26.5 a	25.1 a	26.0 a	25.3 a	24.7 a	25.5 a
80N	26.5 a	24.5 a	26.2 a	24.6 a	25.0 a	25.4 a
120N	26.2 a	24.4 a	26.0 a	25.5 a	24.5 a	25.3 a
160N	26.0 a	24.4 a	25.3 a	25.2 a	24.3 a	25.0 a
V- MEAN	26.4	24.6	25.9	25.2	24.6	25.3

CV(a) = 2.3% *CV (b) =1.9 %*

	LSD (5%)	LSD (1%)
2- V means at each F	0.79	1.06
2- V means	0.35	0.47

Grain yield

The data on grain yield of rice in wet season are presented in Table 7a and Fig 1. Without or with a lower nitrogen fertilizer application (30 kg N/ha), there were non significant differences in terms of grain yield among tested rice varieties, but application of nitrogen fertilizer at 30 kg N/ha significantly increased in grain yield of rice over control. At 60 kg N/ha, OM3419 produced significantly higher grain yield than the control, whereas grain yield of the other genotypes was equal to the control. There was an increase in grain yield with increase in each successive level of fertilizers up to 60 kg N/ha. Further increase in the rate of nitrogen from 90 to 120 kg N/ha reduced grain yield of rice.

The data on grain yield of rice in dry season are presented in Table 7b and Fig 2. Without nitrogen fertilizer, OM3419, OM3238 and OM4872 produced higher grain yield than OMCS2000. However, at higher nitrogen fertilizer (40-120 kg N/ha), OM2718 produced a superior grain yield as compared to the other varieties. At 80 kg N/ha, all tested rice varieties offered the highest grain yield. Similarly to wet season, there were an increasing trend in grain yield with each increase in nitrogen application from 0 to 80 kg N/ha. Further increase in the rate of nitrogen fertilizer from 120 to 160 kg N/ha reduced grain yield while, OMCS2000 started reducing in grain yield at 80 to 120 kg N/ha. OM2718 obtained the highest grain yield as compared to OM3419, OM4872, OM3238 and OMCS2000.

Table 7a: Effect of N fertilizer rates on grain yield (T/ha) of five HYVs.

Variety (V)	Rates of nitrogen application (kg N/ha)					
	0	*30*	*60*	*90*	*120*	*V- MEAN*
OMCS2000	3.82 a	4.20 a	4.75 b	3.41 ab	3.45 a	3.93 a
OM2718	3.49 a	4.20 a	5.13 ab	3.12 b	2.92 ab	3.81 a
OM3419	3.68 a	4.24 a	5.41 a	3.36 ab	2.80 b	3.90 a
OM3238	3.67 a	4.40 a	5.20 ab	3.23 ab	2.77 b	3.85 a
OM4872	3.78 a	4.25 a	5.03 ab	3.72 a	3.28 ab	4.01 a
F- MEAN	3.69	4.26	5.11	3.37	3.05	3.89

CV(a) = 16.1% *CV (b) = 7.8%*

	LSD (5%)	LSD (1%)
2- F means at each V	0.69	0.97
2- F means	0.53	0.77

Table 7b: Effect of N fertilizer rates on rice grain yield (T/ha) of five HYVs.

Variety (V)	Rates of nitrogen application (kg N/ha)					
	0	*40*	*80*	*120*	*160*	*V- MEAN*
OMCS2000	3.20 b	4.84 ab	5.23 b	4.74 c	3.87 c	4.38
OM2718	3.43 ab	5.12 a	5.81 a	5.65 a	5.01 a	5.01
OM3419	3.75 a	4.68 b	5.43 b	5.20 b	4.82 a	4.78
OM3238	3.57 a	4.73 b	5.11 b	5.12 b	4.51 b	4.61
OM4872	3.69 a	4.77 b	5.03 b	5.25 b	4.83 a	4.77
F- MEAN	3.53	4.83	5.38	5.19	4.61	

CV(a) = 8.2% ***CV (b) = 3.9%***

	LSD (5%)	LSD (1%)
2- F means at each V	0.42	0.59
2- V means at each F	0.30	0.40

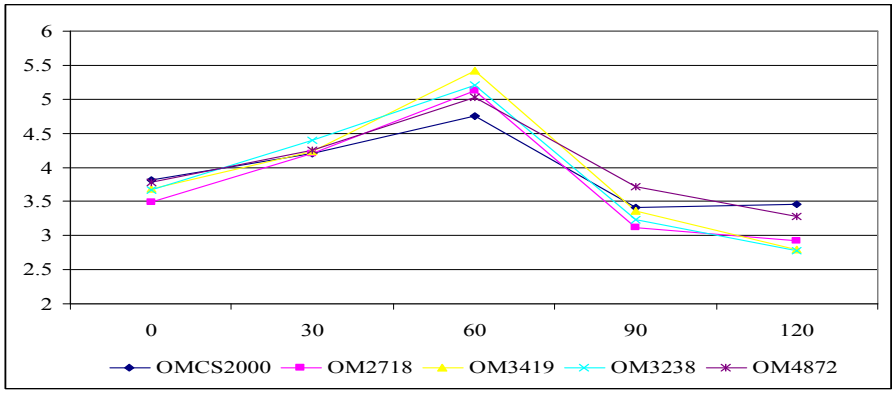

Fig 1. Efficacy of N fertilizer rates on grain yield of 5-HYVs, 2004 wet season

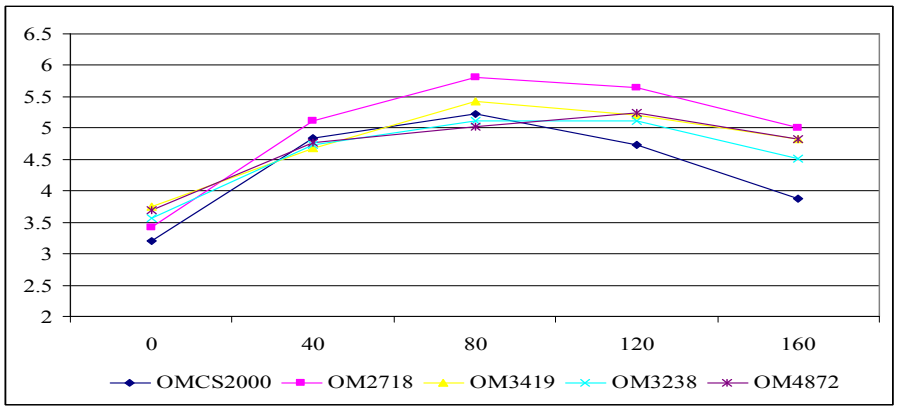

Fig 2. Efficacy of N fertilizer rates on grain yield of 5-HYVs, 2005 dry season.

Economical efficiency of nitrogen application

- *Wet season:* Application of nitrogen fertilizer at 60 kg N/ha obtained the best economical efficiency of nitrogen application (EENA) for all tested rice varieties. The OM3419 rice variety gave highest EENA (28.8 kg rice/ 1 kg N) then the OM2718, OM3238, OM4872 and OMCS2000. Further increase in the rate of nitrogen fertilizer beyond 90 kg N/ha gave a negative EENA value (Table 8a and Fig 3).

Table 8a. Investment efficiency of N fertilizer rates on five HYVs (kg rice/kg N)

Variety (V)	Rates of nitrogen application (kg N/ha)				
	0	*30*	*60*	*90*	*120*
OMCS2000	0	12.7	15.5	-4.6	-3.1
OM2718	0	23.7	27.3	-4.1	-4.8
OM3419	0	18.7	28.8	-3.6	-7.3
OM3238	0	24.3	25.5	-4.9	-7.5
OM4872	0	15.7	20.8	-0.7	-4.2

Table 8b: Investment efficiency of N fertilizer rates on 05 HYR varieties, (kg rice/kg N)

Variety (V)	Rates of nitrogen application (kg N/ha)				
	0N	*40N*	*80N*	*120N*	*160N*
OMCS2000	-	41.0	25.4	12.8	4.2
OM2718	-	42.3	29.8	18.5	9.9
OM3419	-	23.3	21.0	12.1	6.7
OM3238	-	29.0	19.3	12.9	5.9
OM4872	-	27.0	16.8	13.0	7.1

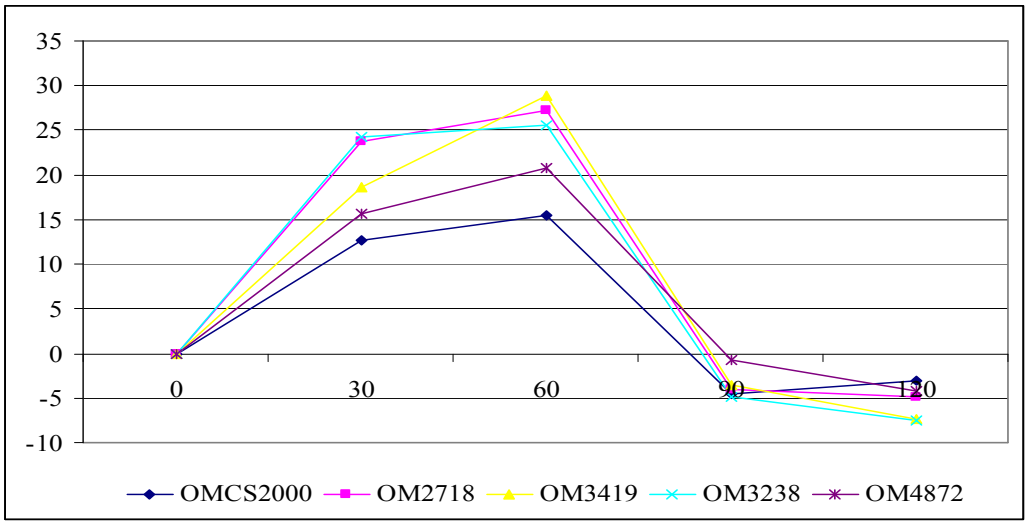

Fig 3. The investment efficiency of nitrogen fertilizer application levels, Wet-season 2004

The highest benefit due to nitrogen application was recorded at 60 kg N/ha. The OM3419 rice variety gave highest benefit (3.149.913 VNđ/ha) then the OM2718 (2.951.913 VNđ/ha). The OMCS2000 rice variety obtained the lowest benefit (1.389.913 VNđ/ha) (Table 9a).

Table 9a. Benefit due to apply N fertilizer, (VND/ha).

Variety (V)	Rates of nitrogen application (kg N/ha)			
	30	*60*	*90*	*120*
OMCS2000	507.957	1.389.913	-1886.130	-2.214.174
OM2718	1.233.957	2.951.913	-1.798.130	-2.126.174
OM3419	903.957	3.149.913	-1.688.130	-2.016.174
OM3238	1.277.957	2.709.913	-1.952.130	-3.292.174
OM4872	705.957	2.093.913	-1116.130	-1.444.174

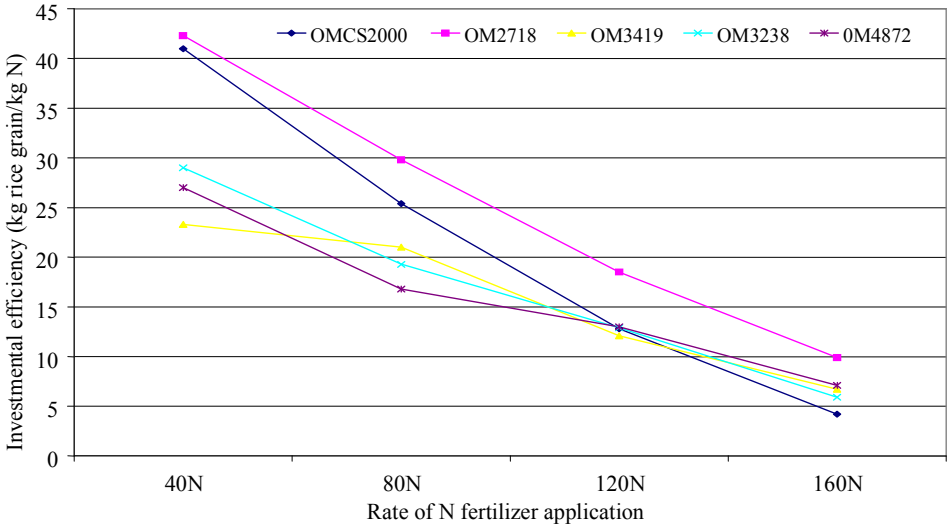

Fig 4. The investment efficiency of nitrogen fertilizer application levels, Dry season 2004-05

The results in Table 10a and Fig 5 showed that marginal benefit cost ratio (MBCR) of 5 rice varieties were the highest at the N fertilizer level of 60 kg/ha, ranging from 2.1 to 4.8.

Table 10a. Marginal benefit cost ratio (MBCR) of N fertilizer application levels.

Variety (V)	Rates of nitrogen application (kg N/ha)			
	30	*60*	*90*	*120*
OMCS2000	1.5	2.1	-1.9	-1.7
OM2718	3.8	4.5	-1.8	-1.6
OM3419	2.8	4.8	-1.7	-1.5
OM3238	3.9	4.1	-2.0	-2.5
OM4872	2.2	3.2	-1.1	-1.1

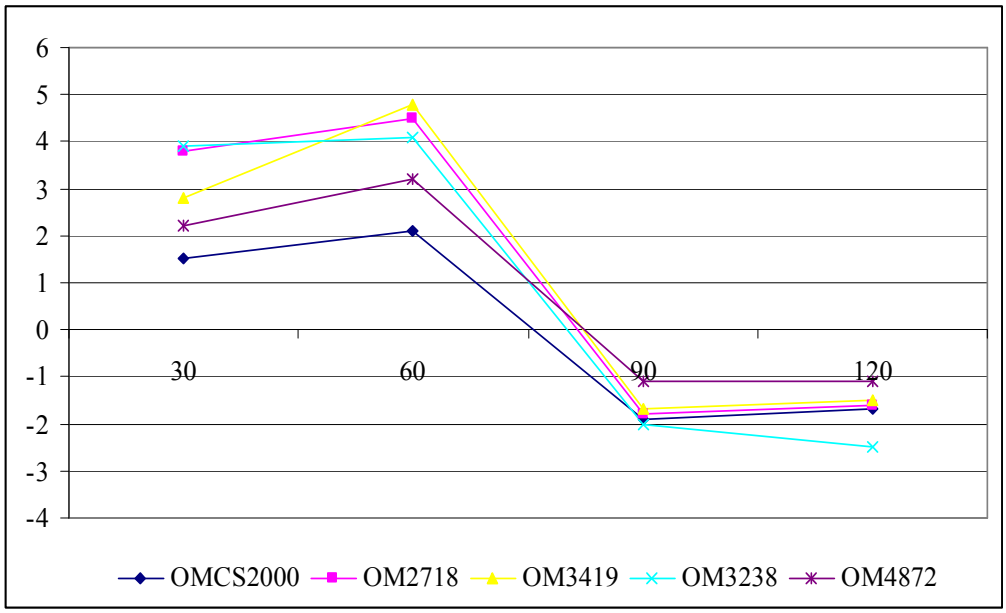

Fig 5. Marginal benefit cost ratio of nitrogen fertilizer application levels, 2004 wet season

- *Dry season:* At 40 kg N/ha, economical efficacy of nitrogen application (EENA) obtained the highest for all tested rice varieties. It ranged from 23.3 to 42.3 kg rice/1 kg N. At 80 kg N/ha, EENA value got lower than as compared to at level of 40 kg N/ha, ranging from 16.9-29.8 kg rice/1 kg N. At higher nitrogen rates (120-160 kg N/ha), EENA values were the lowest.

Benefit obtained was also much different depending upon the rate of nitrogen fertilizer, but application of nitrogen fertilizer at 80 kg N/ha brought the highest benefit for all rice varieties. The highest net income due to nitrogen application was recorded at 80 kg N/ha for OM2718 (4,802,000O VND/ha) then OMCS2000 (3,962,000 VND/ha), whereas the OM4872 had lowest net income at 80 kg N/ha (Table 10b).

Table 10b. Marginal benefit cost ratio (MBCR) of N fertilizer application levels.

Variety (V)	Rates of nitrogen application (kg N/ha)			
	40N	*80N*	*120N*	*160N*
OMCS2000	7.65	4.35	1.71	-0.12
OM2718	6.91	5.28	2.90	1.08
OM3419	3.91	3.43	1.55	0.41
OM3238	5.12	3.06	1.68	0.24
OM4872	4.70	2.53	1.74	0.50

The results in Table 10b showed that marginal benefit cost ratio (MBCR) of five rice varieties got the highest at the N fertilizer level of 40 kg/ha, ranging from 3.91 to 7.65, but investment fertilizer at level of 80 kg N/ha got the higher benefit as compared to other nitrogen levels (Table 9b and Fig 6).

Table 9b. Benefit due to apply N fertilizer, (VND/ha).

Variety (V)	Rates of nitrogen application (kg N/ha)				
	0N	*40N*	*80N*	*120N*	*160N*
OMCS2000	-	3.481	3.962	2.331	-0.212
OM2718	-	3.146	4.802	3.963	1.972
OM3419	-	1.777	3.122	2.115	0.748
OM3238	-	2.329	2.786	2.295	0.436
OM4872	-	2.137	2.306	2.379	0.916

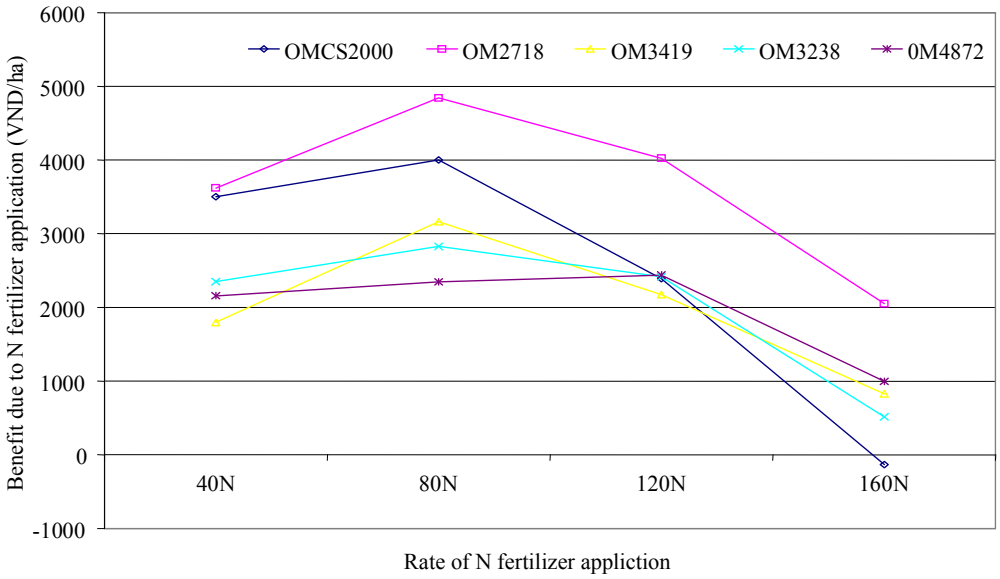

Fig 6. Economical efficiency of nitrogen fertilizer application levels, 2005 dry season

With the above advantages it suggested that application of nitrogen fertilizer at 80 kg N/ha is the best dose for rice in dry season.

CONCLUSIONS AND SUGGESTIONS

Conclusions

The important findings of the experiments are summarized below:

1. Plant height and crop duration of the tested rice varieties increased with increasing level of nitrogen. Plant height and crop duration of rice were higher in dry season than wet one.
2. Number of panicles/m^2 was highest at 60 kg N/ha and 120 kg N/ha in wet season and in dry season, respectively. In wet season, OM3238 exhibited the highest number of panicles/m^2 while, OM2718 produced the highest number of panicles/m^2 in dry season.
3. Number of filled-grains/panicle was highest at 60 kg N/ha in wet season and at 80 kg N/ha in dry season.
4. Unfilled-grain percentage was gradual increase with each increase in the rate of nitrogen fertilizer.
5. Grain yield of the tested rice varieties was the highest at 60 kg N/ha in wet season and at 80 kg N/ha in dry season. In wet season, OM3419 gave the highest grain yield at 60 kg N/ha while, OMCS2000 gave the lowest grain yield. In dry season, tOM2718 produced the highest grain yield.
6. Application of nitrogen fertilizer at 60 kg N/ha brought the highest net income in

wet season while, 80 kg N/ha was the best dose for rice in dry season.

Suggestions

Depending on the local condition and cultural practice applied, nitrogen recommendation doses are suggested for the tested rice varieties as followings:

- In wet season, nitrogen recommendation dose ranges from 60 to 80 kg N/ha.
- In dry season, nitrogen recommendation dose ranges from 80 to 100 kg N/ha.

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Đáp ứng của các giống cao sản đối với phân N

Chiều cao cây và thời gian sinh trưởng của 05 giống thí nghiệm tăng tỷ lệ thuận với lượng phân N đầu tư. Chiều cao cây và TGST của các giống thí nghiệm trong vụ HT thấp hơn so với vụ ĐX. Số bông/m^2 đạt cao nhất ở mức 60N trong vụ HT và 120N trong vụ ĐX. Giống OM3238 có số bông/m^2 cao nhất trong vụ HT, giống OM2718 đạt só bông/m^2 cao nhất trong vụ ĐX. Số hạt chắc/bông đạt cao nhất ở mức 60N trong vụ HT và mức 80N trong vụ ĐX. Tỷ lệ hạt lép tăng dần theo các mức tăng của phân N. Năng suất lúa của các giống thí nghiệm đạt cao nhất tại mức bón 60N trong vụ HT và 80N trong vụ ĐX. Trong vụ HT tại mức 60N giống OM3419 đạt NS cao nhất và thấp nhất là giống OMCS2000. Trong vụ ĐX giống OM2718 đạt năng suất cao nhất. Mức phân N bón đạt hiệu quả kinh tế cao nhất và hợp lý nhất là 60 kgN/ha trong vụ HT và 80 kgN/ha trong vụ ĐX cho vùng nghiên cứu hoặc những vùng có điều kiện tương tự.