Chapter V

Results of the field experiment

5.1 Climate pattern during the experimental period

The climate of the experiment site is characterized by a dry and rainy season under influence of the monsoon regime. Hot and wet condition of rainy season normally starts from May to November, while the relatively cool weather during the dry season occurs from December to January. A short period of dry season, which occurs regularly from late July to mid August, often cause drought. The annual average rainfall during the experiments was 1,097 mm in 2005 and the annual rainfall received in 2003 was 791mm and rainfall in 2004 was 924 mm. An average monthly precipitation ranges from 4-241 millimeters and 85% of the rainfall was concentrated during June to October (Figure 5.1).

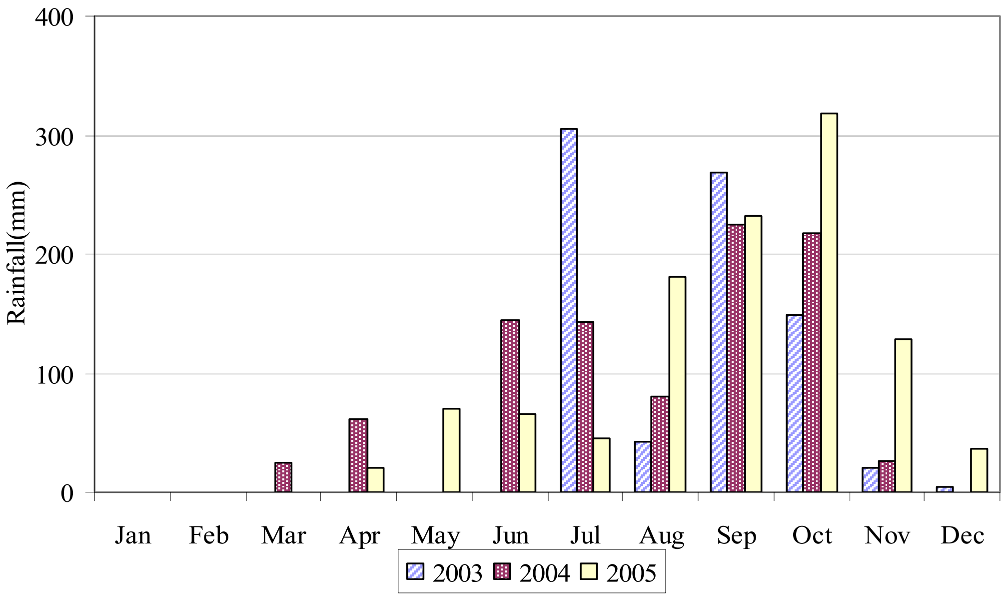


Figure 5.1 Distribution of rainfall in CARDI, 2003-05

(Source: CARDI, 2003-05)

The rainy season starts with the onset of Monsoon in May and attains its peak in June and July when heavy rainfall (241 mm/month) is experienced (Figure 5.1). The dry season and early wet season rainfall is usually very low. Temperature fluctuated during the experiment period (Figure 5.2 and 5.3).The average temperature in 2003 temperature ranged from 26°C to 36°C. The average temperature in 2004 and 2005 were similar from ranged from 29°C to 33°C.

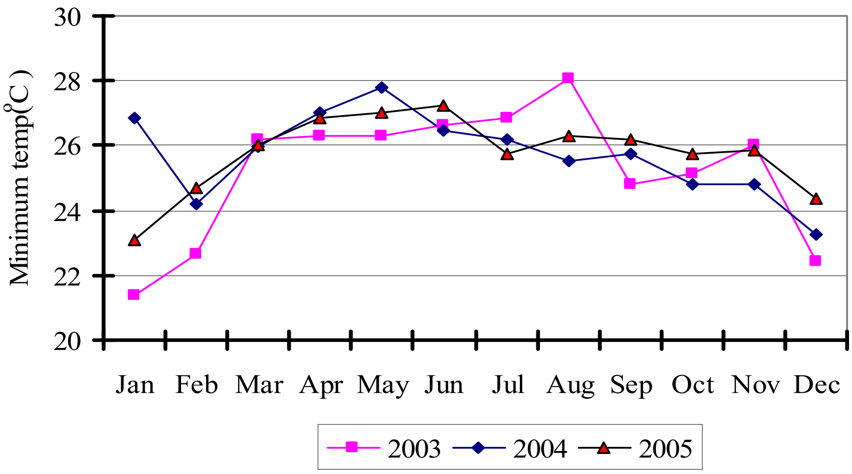


Figure.5.2. Average minimum temperature in CARDI, 2003-05

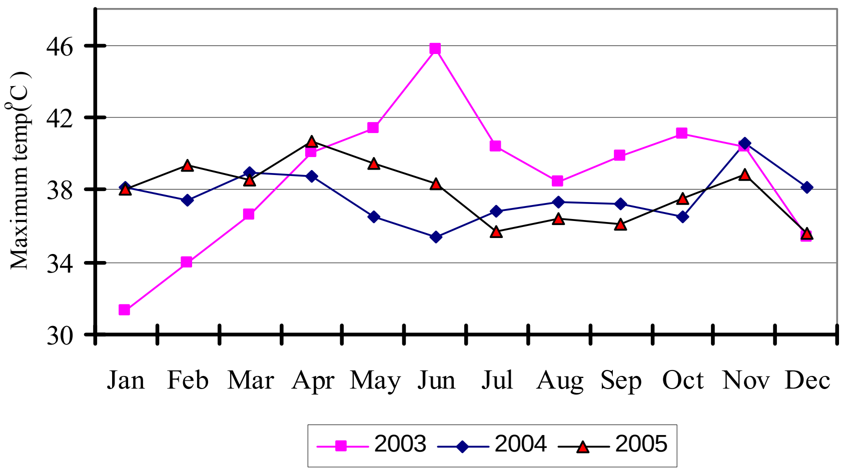


Figure.5.3 Average maximum temperature in CARDI, 2003-05

(Source: CARDI, 2003-05)

5.2 Crops Analysis

5.2. 1 Rice- Rice- Rice-Rice-Rice pattern

Fertilizer application significantly affected ($p \leq 0.01$) plant growth (Table 5.1). Growing plant without fertilizer produce lower panicle number, shorter plant and extended days of 50% of flowering compared to treatment with fertilizer. As the soil known to be poor in fertility, therefore rice crops weakly developed and much delayed to days of 50 % flowering about 5 to 10 days (Table 5.2) and less panicle about 2 to 4 tillers per hill (Table 5.3), the time of harvesting was also delayed when inorganic fertilizer was not applied. The highest plant high was crop5 (91cm) and the lowest plant high was crop4 (58 cm) (Figure 5.4). Plant grown without fertilizer was 11.2 cm plant high shorter compared to treatment applied fertilizer (Figure 5.5). Residue also effect significantly to plant high. Without residue plant high shorter compared treatment applied residue (Figure 5.6)

Similarity, plant grown without fertilizer produces low grain yield and straw yields all crops cycle. Grain and straw yield responded significantly ($p \leq 0.01$) to applied fertilizer to all cropping seasons (Table 5.1). The grain yield when fertilizer applied was ranged between 1.57 to 4.39 t/ha. Without fertilizer the average grain yield ranged between 0.65 to 2.26 t/ha. The low yield of rice crop was crops 2 and crop 4, due to insufficient rainwater at early cropping season (Table 5.4). The soils also poor in fertility, therefore rice crops weakly developed.

Grain yield with rice straw incorporation respond significantly ($p \leq 0.01$) and increase grain yield overall of crop between with and without rice straw added to the crop about 0.28 t/ha (Table 5.4). When residue (rice straw) was applied alone increased rice grain yield about 0.5 t/ha. When residues were applied in combinations with fertilizer grain yield increased from 0.5 to 2.4 t/ha (Table 5.4).

When fertilizer applied the average straw yield was 3.85 t/ha compared with treatment without fertilizer average straw yield was 2.1 t/ha (Table 5.5).

ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่
Copyright © by Chiang Mai University
All rights reserved

Table 5.1 Analysis of variance of grain yield and yield component crop2, 3, 4, and5

Source	50% flower	Plant height(cm)	Panicle/hill	Grain yield(t/ha)	Straw yield(t/ha)
Crop(A)	**	**	**	**	**
Fertilizer(B)	**	**	**	**	**
A X B	**	ns	**	**	*
Residue(C)	ns	*	ns	**	ns
A X C	ns	ns	ns	ns	ns
B X C	ns	ns	ns	ns	ns
A X B X C	ns	ns	ns	ns	ns
CV%	3.83	4.70	15.33	15.22	18.27
	2.65	5.83	13.87	13.65	25.71
	2.86	4.64	11.50	17.86	20.64

** Significant at p≤0.01;* significant at p≤0.05; ns: not significant

Table 5.2 Effect of interaction between crop and fertilizer on days to 50% flowering of rice crop2, 3, 4, and 5

	Fertilizer application	
Crops	F+	F0
Crop2	78d	89a
Crop3	73e	79d
Crop4	82c	87ab
Crop5	87ab	85b
		$LSD_{0.05} = 2.38$

Different letters indicated significantly different of means by LSD (p≤0.05)

F+= treatment with fertilizer; F0= treatment without fertilizer

ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่
Copyright © by Chiang Mai University
All rights reserved

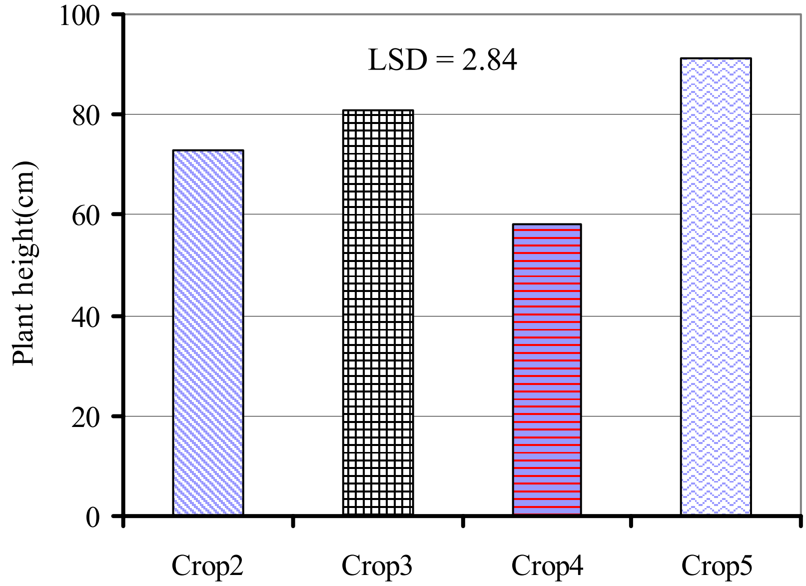


Figure 5.4 Effect of crop on plant height rice crop2, 3, 4, and 5

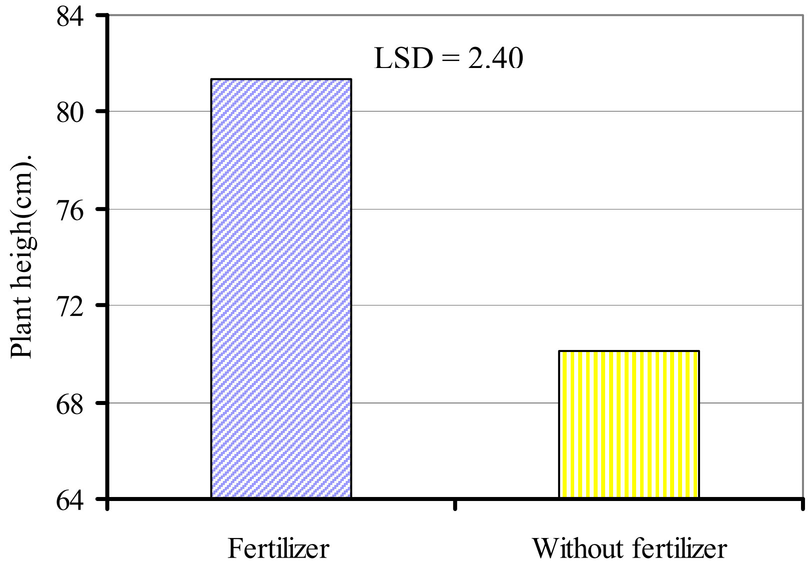


Figure 5.5 Effect of fertilizer on plant height rice crop 2, 3, 4, and 5

All rights reserved

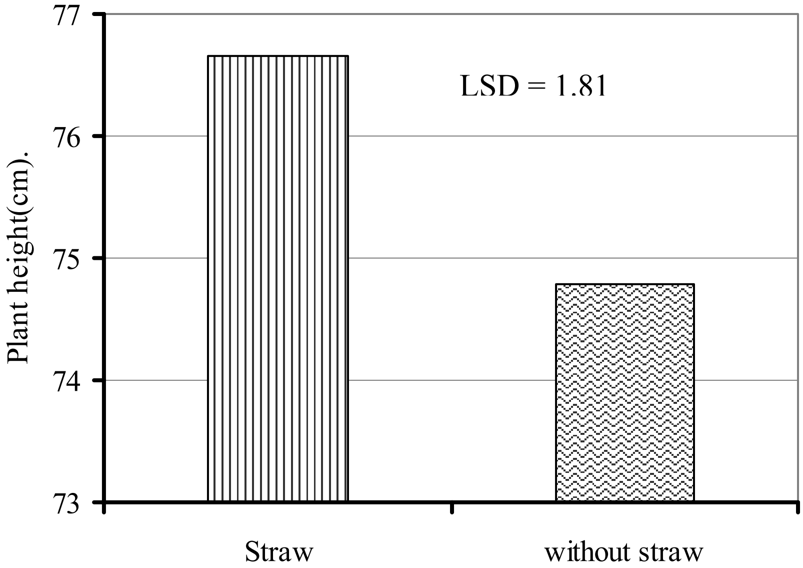


Figure 5.6 Effect of residue on plant height rice crop2, 3, 4, and 5

Table 5.3 Effect of interaction between crop and fertilizer on number of panicle/hill of rice crop 2, 3, 4, and 5

	Fertilizer application	
Crop	F+	F0
Crop2	11a	4d
Crop3	7b	5c
Crop4	8b	4d
Crop5	11a	7b
		LSD $_{0.05}$ = 1.25

Different letters indicated significantly different of means by LSD ($p \leq 0.05$)

F+= treatment with fertilizer; F0= treatment without fertilizer

ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่
Copyright © by Chiang Mai University
All rights reserved

Table 5.4 Effect of interaction between crop and fertilizer on rice yield (t/ha) of rice crop2, 3, 4, and 5

	Fertilizer application	
Crop	F+	F0
Crop2	1.77d	0.70e
Crop3	3.43b	1.86d
Crop4	1.57d	0.65e
Crop5	4.39a	2.26c
		$LSD_{0.05} = 0.30$

Different letters indicated significantly different of means by LSD ($p \leq 0.05$)

F+= treatment with fertilizer; F0= treatment without fertilizer

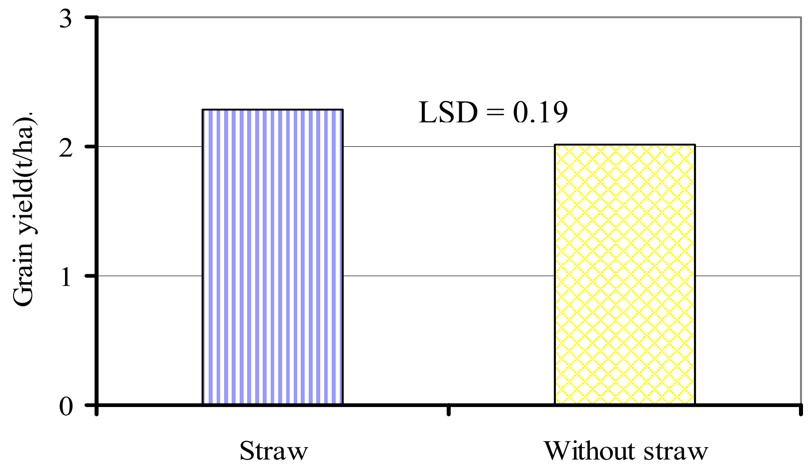


Figure 5.7 Effect of rice straw on grain yield (t/ha) of rice of rice crop 2, 3, 4, and 5

Table 5.5 Effect of interaction between crop and fertilizer on straw yield (t/ha) of rice crop2, 3, 4, and 5

	Fertilizer application	
Crop	F+	F0
Crop2	3.80b	2.53c
Crop3	3.97b	2.14c
Crop4	2.29c	1.23d
Crop5	5.19a	2.50c
		$LSD_{0.05} = 0.82$

Different letters indicated significantly different of means by LSD ($p \leq 0.05$)

F+= treatment with fertilizer; F0= treatment without fertilizer

ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่
Copyright © by Chiang Mai University
All rights reserved

5.2.2 Rice-Mung bean- Rice- Mung bean- Rice pattern

5.2.2.1 Rice growth and yield (crop 3 and 5)

Fertilizer application significantly affected ($p \leq 0.01$) plant growth (Table 5.6). Growing plant without fertilizer produce low panicle number, short plant and extended days of 50% of flowering compared to treatment with fertilizer. Crop3 have earlier days to 50% flowering than crop5 about 10 days (Figure 5.8). Also, crop3 has plant high shorter than crop5 (Figure 5.9).The average plant height when fertilizer applied was 93.44 cm compared with treatment no fertilizer average plant height was 85.02 cm (Figure 5.10).

Crop5 produce number of panicle per hill more than crop3 (Figure 5.11).Similarity, the average number of panicle when applied fertilizer was 10 panicles per hill higher compared treatment with treatment no fertilizer was 8 panicles per hill (Figure 5.12).

Grain and straw yields responded significantly ($p \leq 0.01$) to fertilizer applied to all cropping seasons (Tables 5.6). The average grain yield with fertilizer was 4.04 t/ha compared without fertilizer treatment average gain yield was 2.94 t/ha (Figure 5.13).Grain yield with residue incorporation were increased overall of crops but no significant between with and without residue added to the crop (Table 5.6).

The average straw yield with applied fertilizer was 4.80 t/ha compared to straw yield without fertilizer average yield was 3.13 t/ha respectively (Figure 5.14).

The straw incorporation to the soil responded significantly by increasing the straw yield about 0.63 t/ha ($p \leq 0.05$) against the treatments without application of straw (Figure 5.15)

ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่
Copyright © by Chiang Mai University
All rights reserved

Table 5.6 Analysis of grain yield and yield component of rice crop3 and 5

Source	50% flower	Plant height(cm)	Panicle/hill	Grain yield(t/ha)	Straw yield(t/ha)
Crop(A)	**	**	**	ns	ns
Fertilizer(B)	ns	**	**	**	**
A X B	ns	ns	ns	ns	ns
Residue(C)	ns	ns	ns	ns	*
A X C	ns	ns	ns	ns	ns
B X C	ns	ns	ns	ns	ns
A X B X C	ns	ns	ns	ns	ns
CV%	2.11	4.44	20.73	19.42	33.05
	2.85	5.25	14.20	16.04	26.93
	1.40	5.64	13.24	21.99	21.22

** Significant at p≤0.01; * significant at p≤0.05; ns: not significant

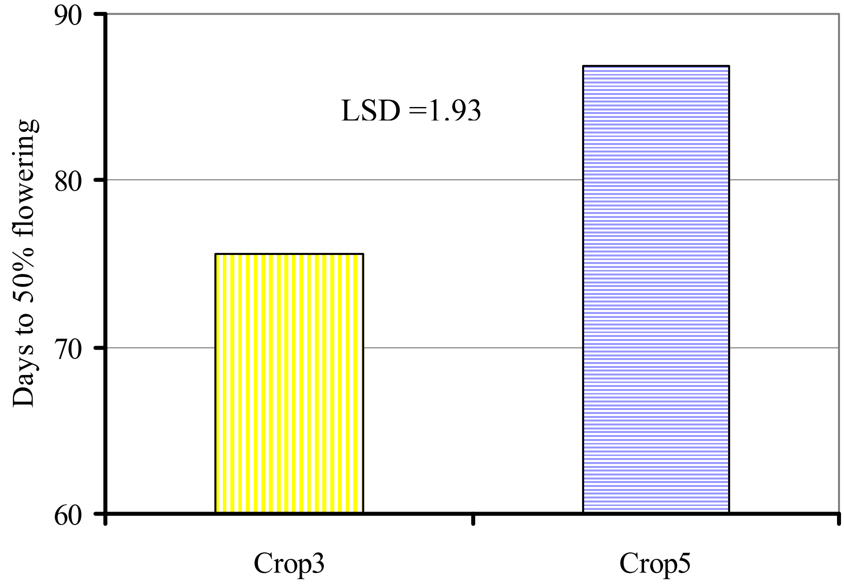


Figure 5.8 Effect of crop on days to 50% flowering of rice crop 3 and 5

Copyright © by Chiang Mai University
All rights reserved

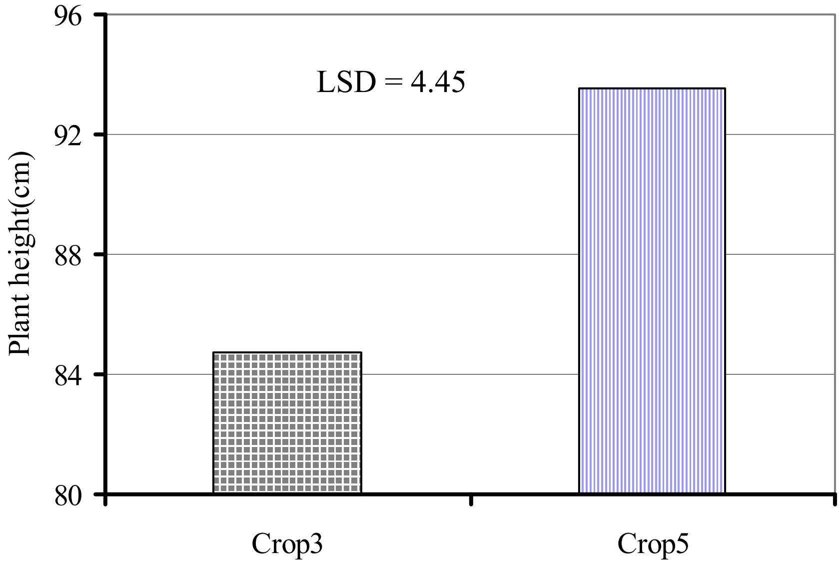


Figure 5.9 Effect of crop on plant height of rice crop 3 and 5

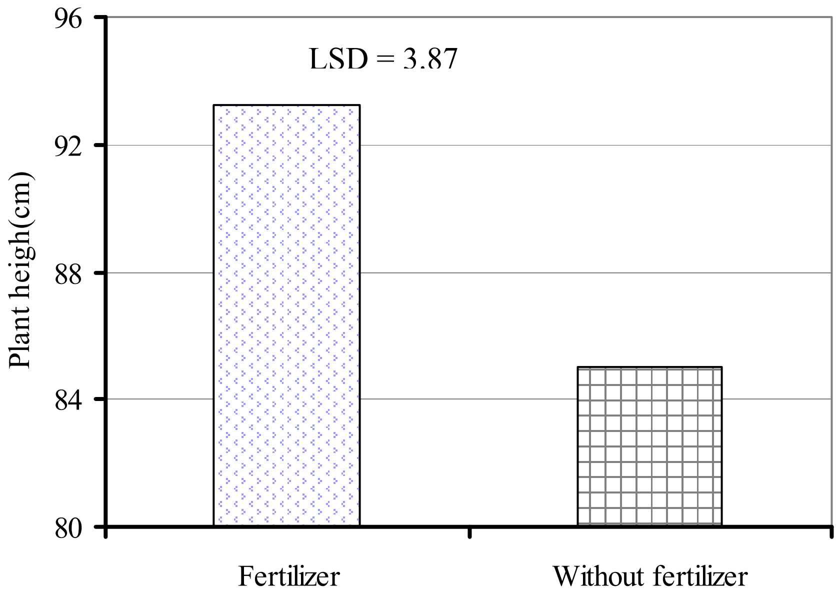


Figure 5.10 Effect of fertilizer on plant height of rice crop 3 and 5

Copyright ... University
All rights reserved

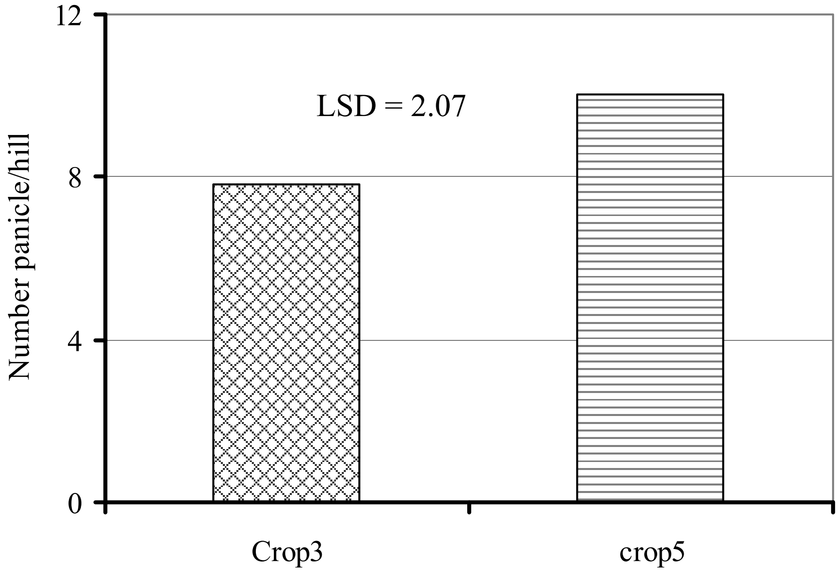


Figure 5.11 Effect cop on number of panicle per/hill of rice crop3 and 5

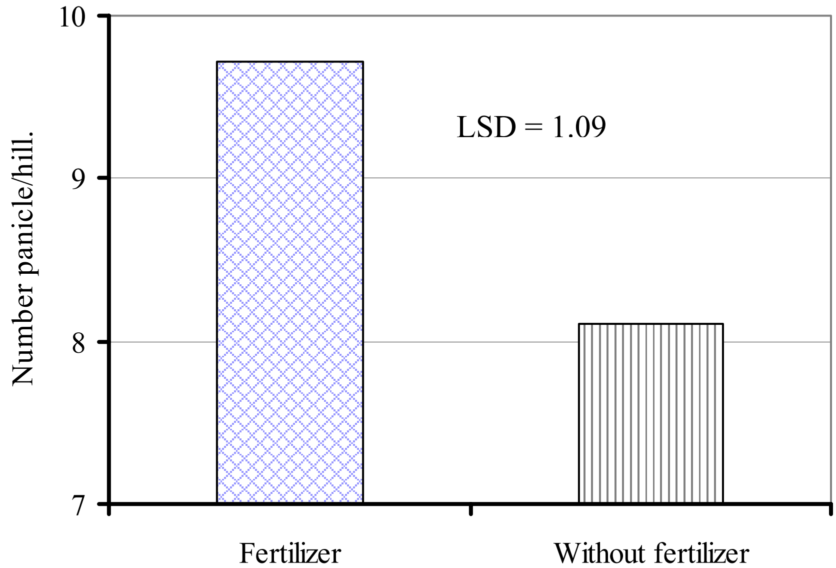


Figure 5.12 Effect of fertilizer on panicle/hill of rice of rice crop3 and 5

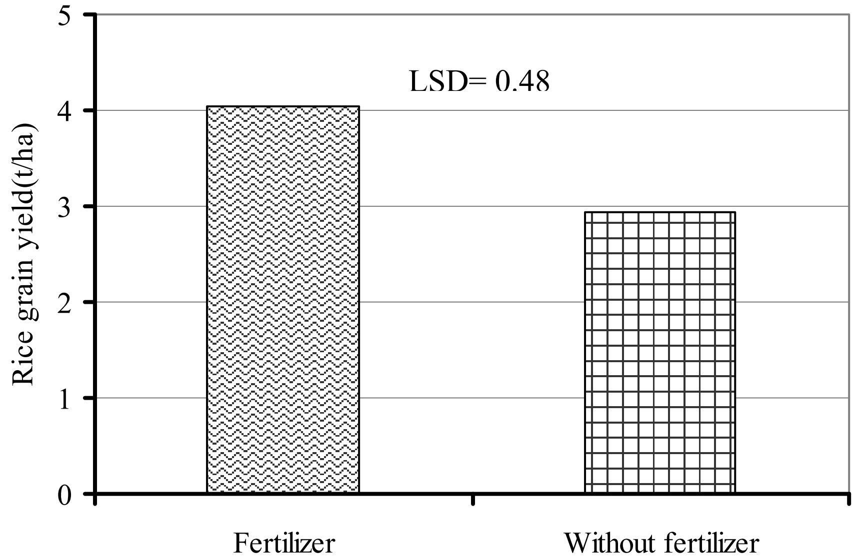


Figure 5.13 Effect of fertilizer on grain yield (t/ha) of rice crop3 and 5

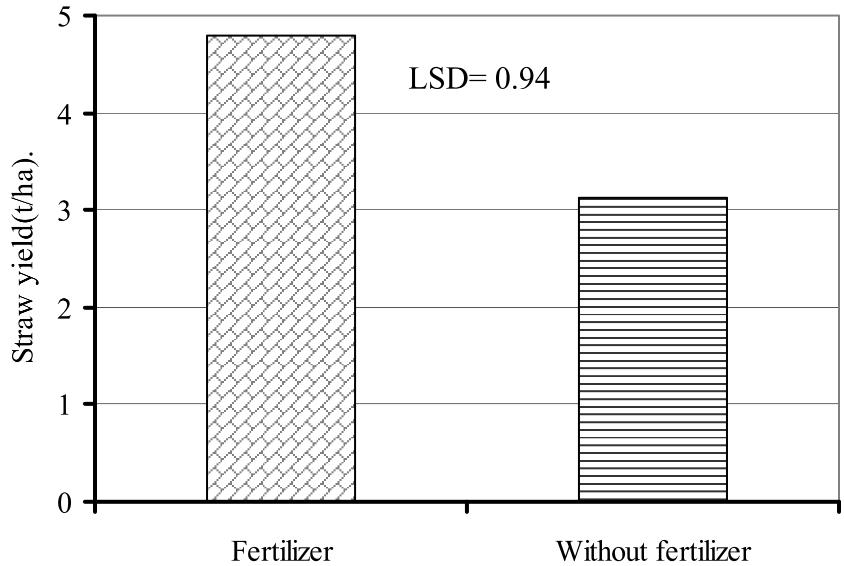


Figure 5.14 Effect of fertilizer on straw yield (t/ha) of rice crop3 and 5

Copyright © by Chiang Mai University
All rights reserved

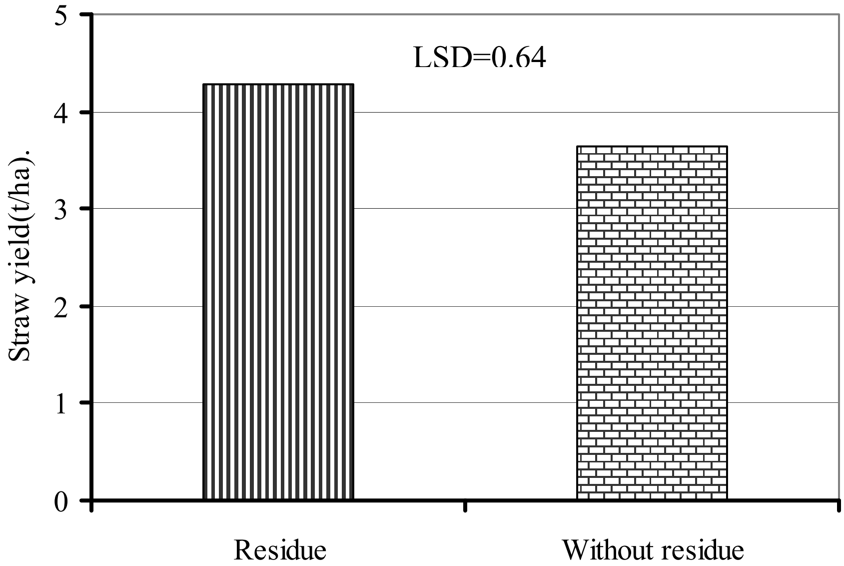


Figure 5.15 Effect of residue on straw yield (t/ha) of rice crop3 and 5

5.2.2.2 Mung bean growth (crop2 and 4)

Plant growth respond significantly ($p \leq 0.01$) to fertilizer application (Table 5.7). Growing mungbean without fertilizer produce lesser number pods per plant, shorter plant, and delay the days of 50% flowering. Without fertilizer application delays 50% flowering days by 7 days compared with fertilizer applied treatments (Figure 5.16). Crop4 has earlier days to 50% flowering than crop2 about 5 days (Figure 5.17)

The fertilizer application increased plant height by 9 cm in comparison to no fertilizer application (Figure 5.18). Crop4 had plant height shorter than crop2 (Figure 5.19).

Similarity, plants grown with fertilizer produces more pods per plant about 4 pods per plant compared with treatments without applied fertilizer (Figure 5.20).

Grain and dry biomass yields of mung bean responded significantly ($p \leq 0.01$) to fertilizer applied to all cropping seasons (Table 5.7). The average grain yield of

ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่
Copyright © by Chiang Mai University
All rights reserved

mung bean with fertilizer applied was 0.29 t/ha and without fertilizer treatment average grain yield was 0.06 t/ha (Table 5.8).

Generally, crops yield of mung bean very low due drought in the early stage and flash flood in flowering stage and finally also attacked by bird damage the pod in the productive stage.

Grain yield of mung bean also responded significantly ($p \leq 0.01$) to residue. With residue applied average grain yield was 0.25 t/ha compared without residue average yield was 0.11 t/ha (Table 5.8). When residue (rice straw) was applied alone increased grain yield of mung bean only 0.07 t/ha. But, when residue (rice straw) applied in combinations with fertilizer grain yield increased about 0.3 t/ha (Table 5.8.).

Dry biomass yield of mung bean with fertilizer application was 0.40 t/ha compared treatment without fertilizer application dry biomass was 0.14 t/ha (Table 5.9)

Table 5.7 Analysis of variance of grain yield and yield component of mung bean crop2 and 4

Source	50% flower	Plant height(cm)	Pod/plant	Grain yield(t/ha)	Dry biomass(t/ha)
Crop(A)	*	**	ns	**	*
Fertilizer(B)	**	**	**	**	**
A X B	ns	ns	ns	*	**
Residue(C)	ns	ns	ns	**	ns
A X C	ns	ns	ns	*	ns
B X C	ns	ns	ns	ns	ns
A X B X C	ns	ns	ns	*	ns
CV%	7.96	11.71	26.99	27.24	94.86
	7.66	21.53	16.53	42.54	46.63
	13.61	13.23	35.58	57.60	59.16

** Significant at $p \leq 0.01$; * significant at $p \leq 0.05$; ns: not significant

ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่
Copyright © by Chiang Mai University
All rights reserved

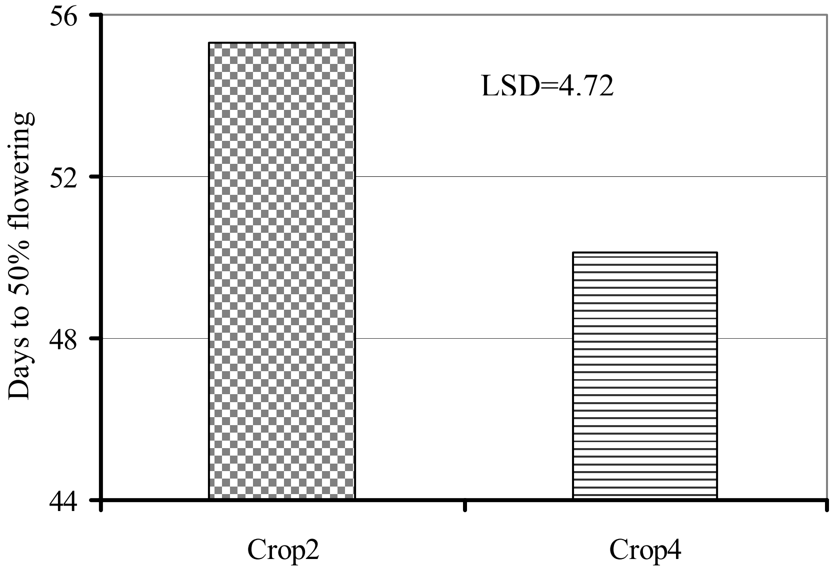


Figure 5.16 Effect of crop on days to 50% flowering of mung bean crop2, 4

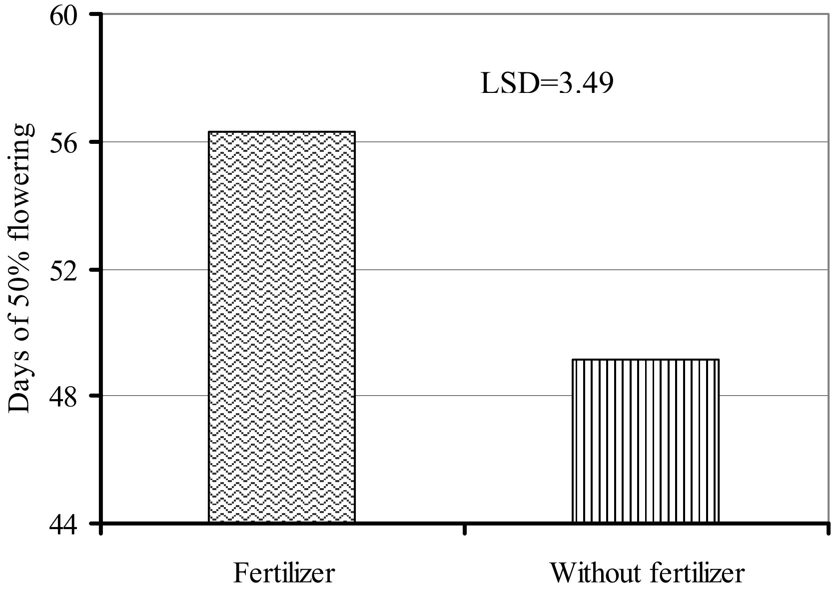


Figure 5.17 Effect of fertilizer to days of 50% flowering of mung bean crop2, 4

Copyright University
All rights reserved

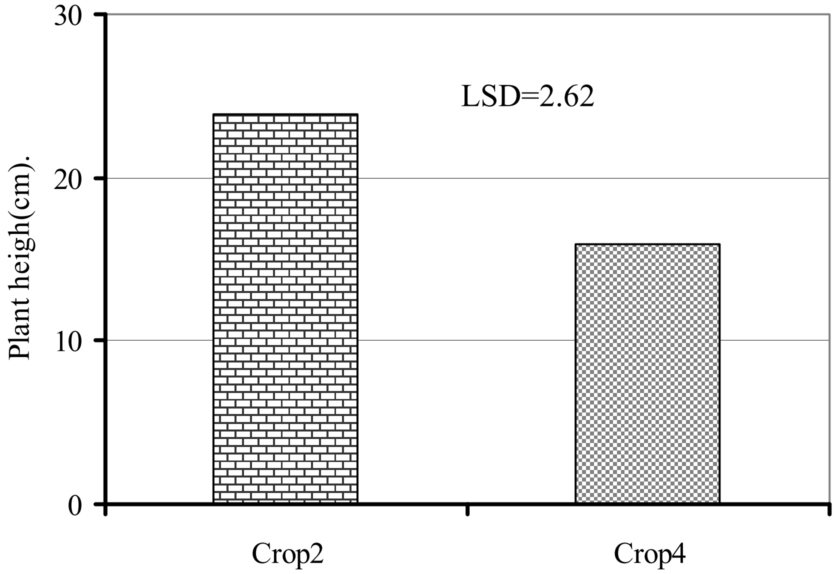


Figure 5.18 Effect of crop on plant height of mung bean crop2 and 4

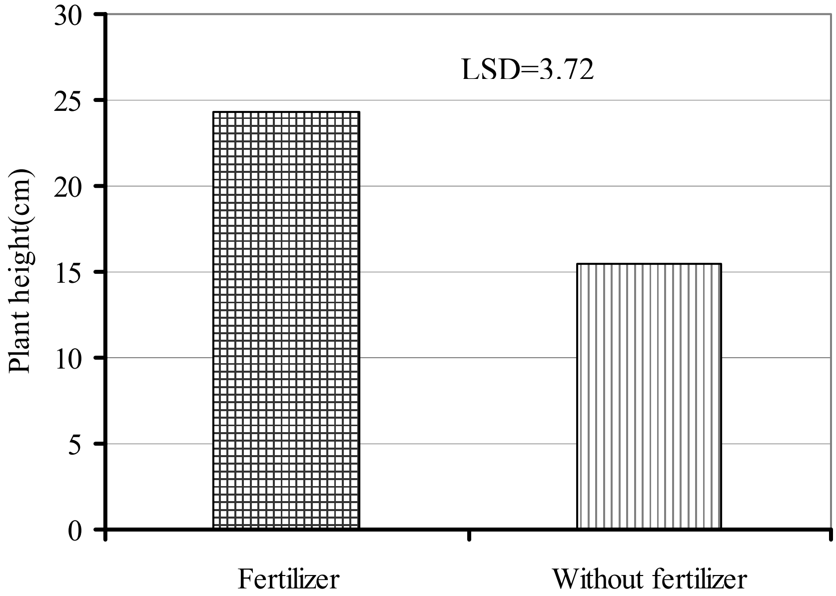


Figure 5.19 Effect of fertilizer on plant high of mung bean crop2 and 4

Copyright by Chiang Mai University
All rights reserved

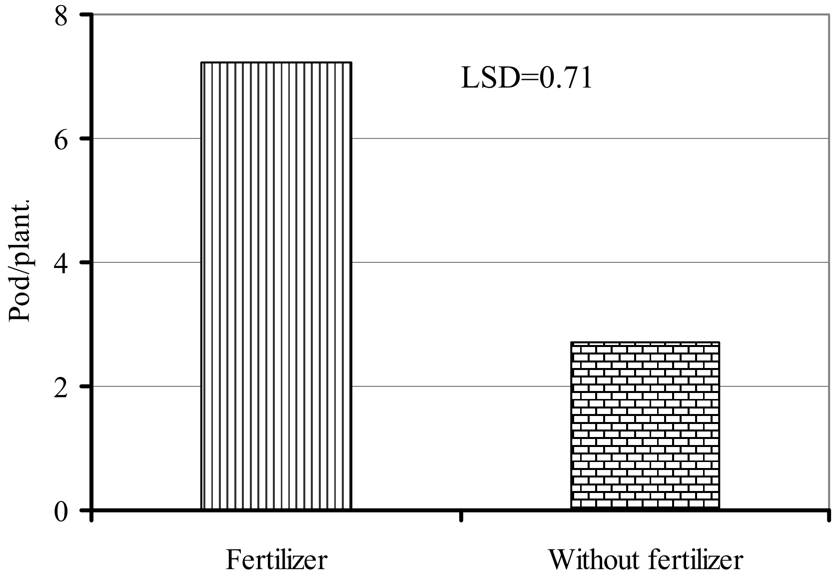


Figure 5.20 Effect of fertilizer on pod/plant of mungbean crop 2 and 4

Table 5.8 Effect interaction between crop, fertilizer, and residue on grain yield (t/ha) of mung bean crop2 and 4

Crop	Fertilizer application	Residue application R+	R0	Mean Crop
Crop2	F+	0.41a	0.36b	
	F0	0.11b	0.04b	0.23a
Crop4	F+	0.38a	0.01b	
	F0	0.09b	0.01b	0.12b
Mean F	F+	0.40a	0.19a	
	F0	0.10b	0.03b	
				$LSD_{0.05}$= 0.15

Different letters indicated significantly different of means by LSD ($p \leq 0.05$);

F+ =fertilizer; F0= without fertilizer; R+ = residue, R0 = without residue

ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่
Copyright © by Chiang Mai University
All rights reserved

Table 5.9 Effect of interaction between crop and fertilizer on dry biomass (t/ha) of mung bean crop2 and 4

	Fertilizer application	
Crop	F+	F0
Crop2	0.71a	0.23b
Crop4	0.09bc	0.05c
		$LSD_{0.05} = 0.17$

Different letters indicated significantly different of means by LSD ($p \leq 0.05$)

F+= treatment with fertilizer; F0= treatment without fertilizer

5.2.3 Rice-Maize- Rice-Maize-Rice pattern

5.2.3.1 Rice growth (crop3 and5)

Plant growth responded significantly ($p \leq 0.01$) to fertilizer application (Table5.10). Growing plants without fertilizer produce lower number panicles per hill, shorter plant, and delay the days to 50% flowering. Without fertilizer applied plant delay day to 50% flowering by 4 days (Table 5.11). Crop3 has plant high shorter than crop5 (Figure 5.21). Without fertilizer applied plant grown has plant high shorter than treatment with applied fertilizer (Figure 5.22).

Similarity, without fertilizer plant produce few number of panicle per hill when compared treatment with applied fertilizer (Table 5.12).Also plants grown without fertilizer produces low grain yield and straw yield.

Grain and straw yields responded significantly ($p \leq 0.01$) to fertilizer applied to all cropping seasons (Table 5.10). The average grain yield with fertilizer applied was 4.55 t/ha compared with treatment without fertilizer application the average grain yield was 2.70 t/ha (Figure 5.23)

The average straw yield was 5.46 t/ha when fertilizer applied and the average grain without fertilizer was 2.89 t/ha (Figure 5.24).

ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่
Copyright © by Chiang Mai University
All rights reserved

Straw incorporation to the soil responded significantly (p≤0.05) and increase straw in average 0.61 t/ha compared with treatment without applied straw (Figure 5.25).

Table 5.10 Analysis of variance of grain yield and yield component crop3 and 5

Source	50% flower	Plant height(cm)	Panicle/hill	Grain yield(t/ha)	Straw yield(t/ha)
Crop(A)	**	**	**	ns	ns
Fertilizer(B)	ns	**	**	**	**
A X B	**	ns	**	ns	ns
Residue(C)	ns	ns	ns	ns	*
A X C	ns	ns	ns	ns	ns
B X C	ns	ns	ns	ns	ns
A X B X C	ns	ns	ns	ns	ns
CV%	5.48	2.93	17.64	8.31	14.57
	4.11	3.46	11.85	18.09	17.09
	2.96	5.79	13.91	16.83	20.67

** Significant at p≤0.01; * significant at p≤0.05; ns: not significant

Table 5.11 Effect of interaction between crop and fertilizer on days to 50% flowering

	Fertilizer application		
Crop	F+	F0	
Crop3	76.87c	74.25c	
Crop5	88.25a	83.5b	
			$LSD_{0.05} = 4.04$

Different letters indicated significantly different of means by LSD (p≤0.05)

F+= treatment with fertilizer; F0= treatment without fertilizer

ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่
Copyright © by Chiang Mai University
All rights reserved

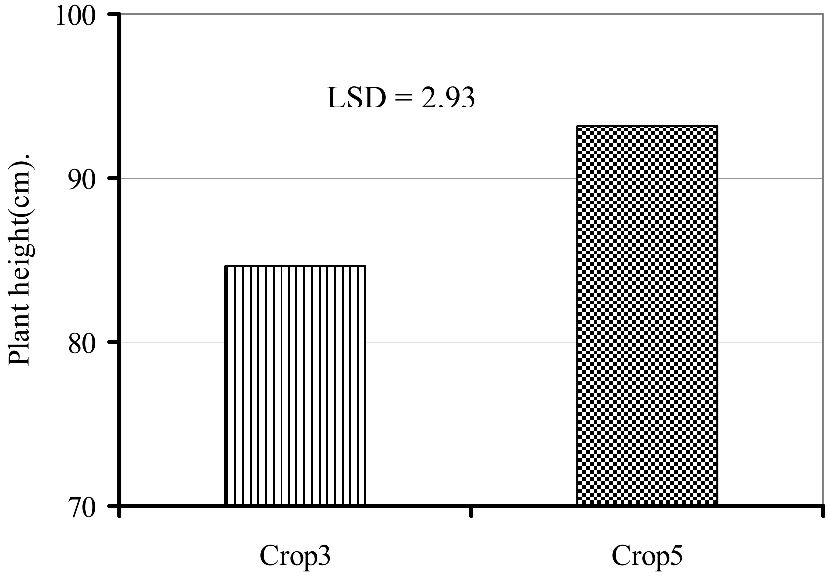


Figure 5.21 Effect of crop on plant height of rice crop3 and 5

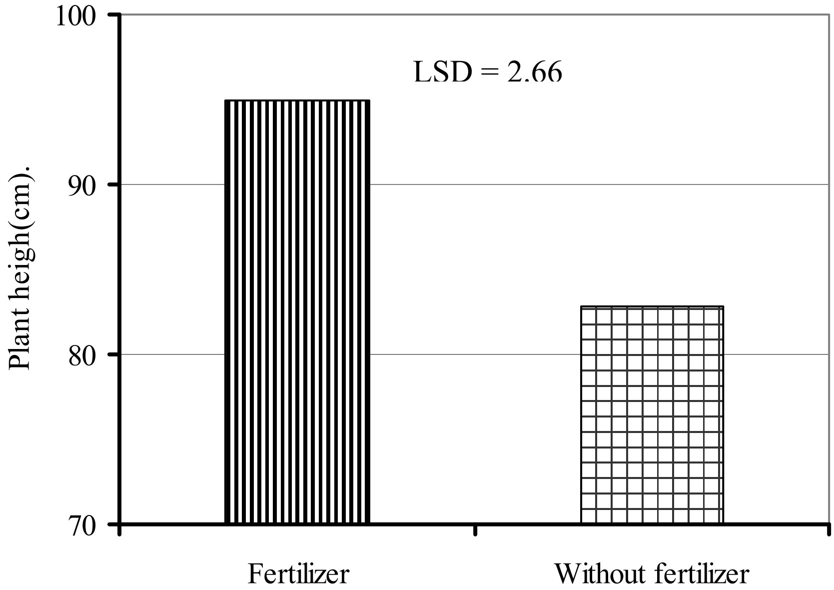


Figure 5.22 Effect of fertilizer on plant high of rice crop3 and 5

Table 5.12 Effect of interaction between crop and fertilizer on number of panicle/hill of rice crop3 and 5

	Fertilizer application	
Crop	F+	F0
Crop3	8.12b	6.36c
Crop5	12.88a	7.72b
		LSD $_{0.05}$ =1.24

Different letters indicated significantly different of means by LSD ($p \leq 0.05$)

F+= treatment with fertilizer; F0= treatment without fertilizer

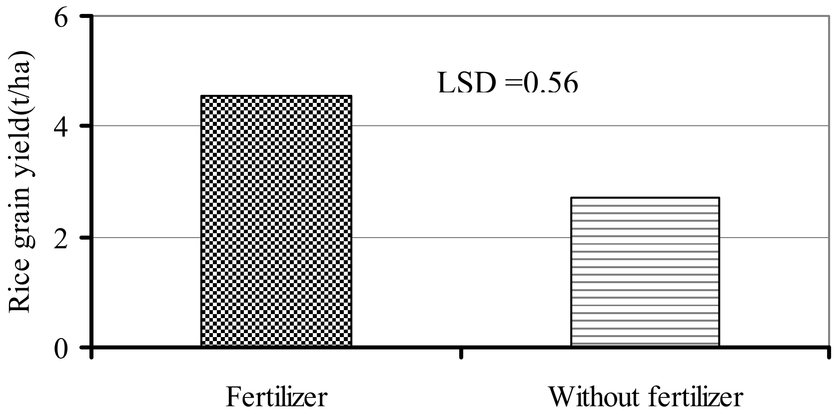


Figure 5.23 Effect of fertilizer on grain yield (t/ha) of rice crop3 and 5

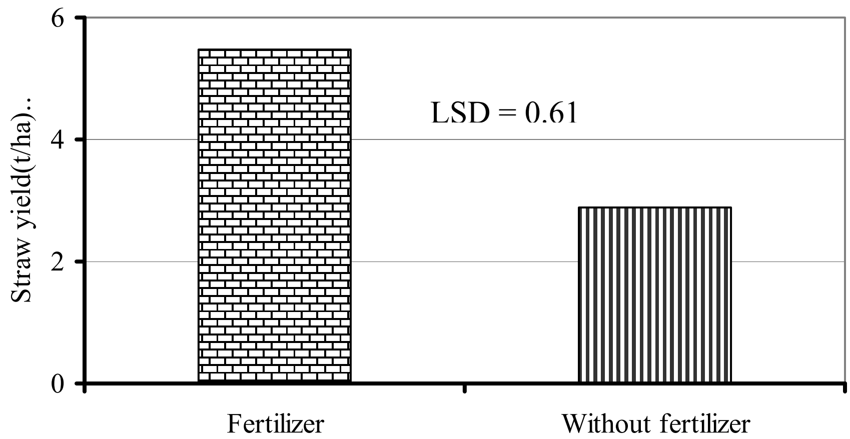


Figure 5.24 Effect of fertilizer on straw yield (t/ha) of rice crop3 and 5

ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่
Copyright by Chiang Mai University
All rights reserved

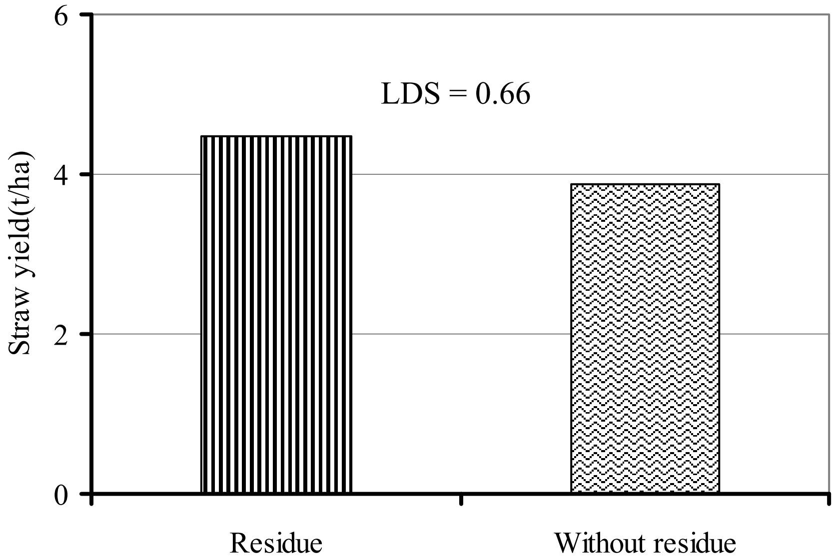


Figure 5.25 Effect of residue on straw yield (t/ha) of rice crop3 and 5

5.2.3.2. Maize growth (crop2 and 4)

Fertilizer application responded significantly ($p \leq 0.01$) plant growth (Table 5.13). Growing maize without fertilizer produces shorter plant, low grain yield, and dry biomass (Table 5.14). Without fertilizer plant high shorter about 38cm compared with treatment applied fertilizer (Figure 5.26).

Grain yields responded significantly ($p \leq 0.01$) to fertilizer applied to. Without fertilizer applied crop could not produce the reasonable yield (Table 5.14).

The average grain yield of maize is found 0.6 t/ha with fertilizer application but it 0.10 t/ha without application of fertilizer (Table 5.14). However, grain yield is still poor even after the application of fertilizer. The main reason for the low yield was drought during early stage of plant growth and water logging conditions during flowering stage. The adjacent fields were continuously irrigated for rice crops and the sub-surface drainage in the maize plot was poor. Therefore, root development was severely affected and the biomass and production was low.

ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่
Copyright © by Chiang Mai University
All rights reserved

Residue also responded significantly (p≤0.01) to crop yield. With residue applied average grain yield 0.25 t/ha compared with without residue applied the average yield was 0.11 t/ha (Table 5.14).

Crop4 has dry biomass less than crop2 (Figure 5.27).Yield of dry biomass also responded significantly to fertilizer (p≤0.01). Without fertilizer yield of dry biomass was 0.91 t/ha less than treatment with applied fertilizer (Figure 5.28).

Table 5.13Analysis of variance of grain yield and yield component of maize crop2 and 4

Source	Plant height(cm)	Grain yield (t/ha)	Dry biomass (t/ha)
Crop(A)	ns	ns	*
Fertilizer(B)	**	**	**
A X B	ns	ns	ns
Residue(C)	ns	**	ns
A X C	ns	**	ns
B X C	ns	**	ns
A X B X C	ns	**	ns
CV%	18.38	78.76	42.68
	21.00	45.87	45.27
	14.04	28.26	34.57

** Significant at p≤0.01; * significant at p≤0.05; ns: not significant

ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่
Copyright © by Chiang Mai University
All rights reserved

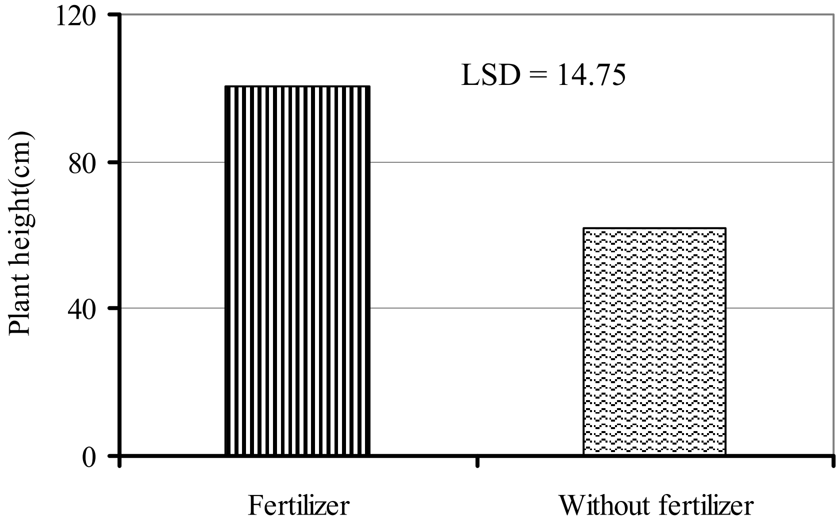


Figure 5.26 Effect of fertilizer on plant height of maize crop2 and 4

Table 5.14 Effects interaction of crop, fertilizer, and residue on grain yield (t/ha) of maize

Crop	Fertilizer application	Residue application R+	Residue application R0	Mean	Mean crop
Crop2	F+	0.50b	0.43b	0.47a	
	F0	0.00c	0.00c	0.00b	
Mean		0.25	0.22		0.23a
Crop4	F+	0.86a	0.32b	0.60a	
	F0	0.13c	0.05c	0.10b	
		0.50	0.19		0.35a
Mean F	F+	0.68a	0.38b	0.53a	
	F0	0.07c	0.03c	0.05b	
Mean R		0.33a	0.23b		
					$LSD_{0.05}$ = 0.12

Different capital letters indicated significantly different of means by LSD ($p \leq 0.05$)

F+=fertilizer, F0= without fertilizer; R+=fertilizer; R0= without fertilizer

ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่
Copyright © by Chiang Mai University
All rights reserved

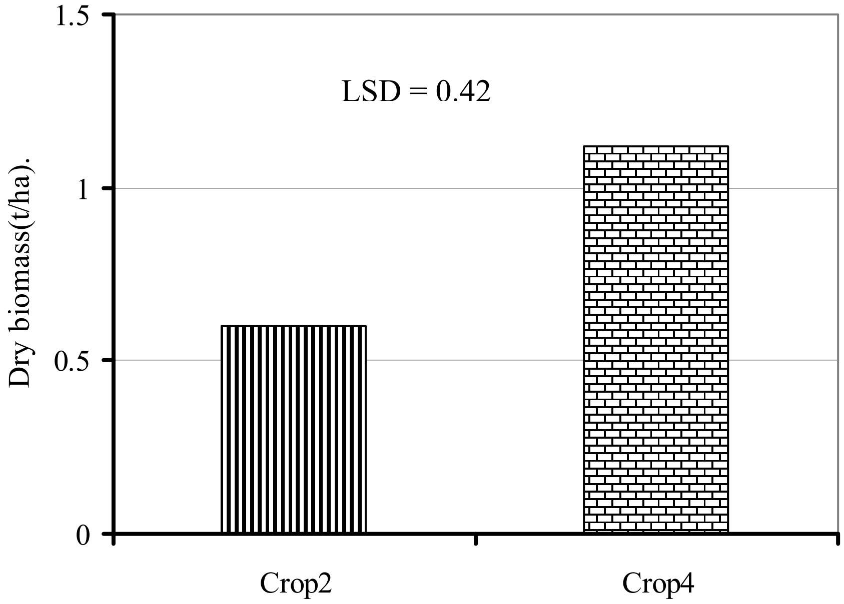
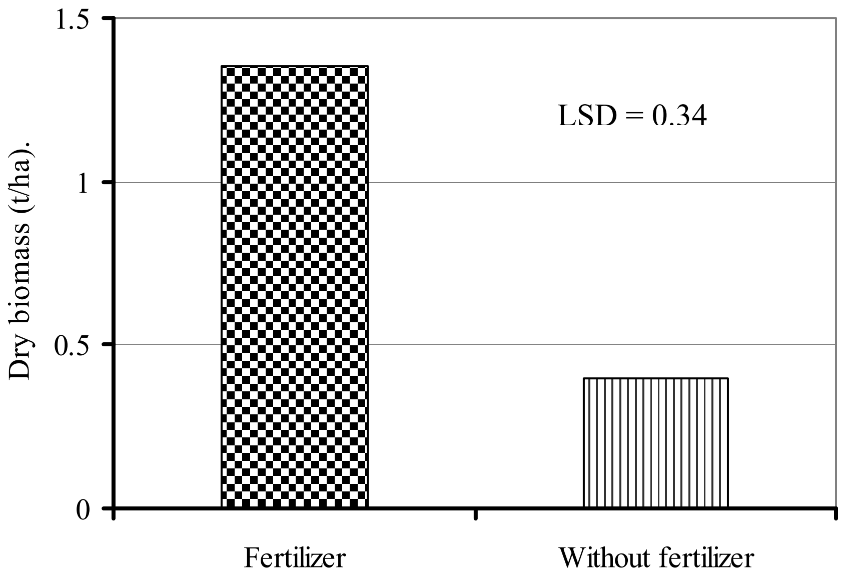


Figure 5.27.Effect of crop on dry biomass (t/ha) of maize crop2 and 4



Copyright by Chiang Mai University
All rights reserved

Figure 5.28 Effects fertilizer on dry biomass (t/ha) of maize crop2 and 4

5.3 Crops yield and gross margin

The gross margin analysis was performed to investigate the economic efficiency of rice cropping system. For rice based cropping system rice- rice double cropping system produces the higher yield than other two systems: rice-mungbean and rice-maize (Table 5.15).

Worksheet for deriving average gross margin for rice, mungbean and maize per hectare is presented in Table 5.16, 17, 18, 19, 20, and 21. The gross margin is calculated including major variable cost and production. The price of all the inputs were as per actual.

The summary of gross margin each cropping pattern presented in Table 5.22. The gross margin in early wet rice (rice-rice pattern) with fertilizers applied combination along with residue treatment get more gross margin than the treatments with only fertilizer, only residue, and without any fertilizer or residue. Similarity for wet season rice (rice-rice pattern) the treatment with applied fertilizer combined with residue get more gross margin than the treatments with only applied fertilizer, only residue, and without any applied fertilizer or residue (Table 5.22).

In early wet season mung bean (mung bean-rice pattern) with applied fertilizer combination with residue get higher gross margin than treatments applied only fertilizer, and only residue. Without any fertilizer or residue applied mung bean production get negative gross margin (Table 5.22). Similar pattern is also found in the wet season rice (mung bean-rice pattern) treatment with applied fertilizer in combination with residue get more gross margin than treatment applied with only fertilizer, only residue, and without any fertilizer or residue applied (Table 5.22).

For the early wet season maize (maize-rice) all treatments get negative gross margin. For the wet season rice (maize-rice) treatment applied with fertilizer in combination with residue get more gross margin than other treatments with only fertilizer, only residue, without any fertilizer or residue applied (Table 5.22). Maize-rice cropping pattern maize has negative gross margin all treatments. However the

ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่
Copyright © by Chiang Mai University
All rights reserved

wet season rice more gross margin than other two cropping patterns of rice-rice and mung bean- rice (Table 5.22).

When the gross margin (GM) is compared within these three systems, the highest GM (7,101,680 Riel) was obtained in the rice-mung bean system. While, the moderate GM (6,590,240Riel) was obtain in the rice-rice system and lowest GM (4,882,090 Riel) was obtain in the rice-maize system (Table.5.22).

Among three cropping patterns rice-mung bean double cropping is found more profitable (GM) and suitable option for rainfed lowlands where supplementary irrigation system is available.

The rice yield is higher in rice-rice pattern, but due to low price of rice it is not found profitable against rice mung bean pattern. Rice-maize pattern is least profitable than the other two systems because of maize nor producing suitable yield and thus receiving a negative GM.

Table 5.15 Average crops yield from experiment in each cropping pattern

Cropping part tern	Grain yield(t/ha)			
	F+ R+	F+R0	F0R+	F0R0
Rice-rice				
EWS. rice	1.66	1.22	1.325	0.45
WS. rice	4.02	2.74	2.67	2.88
Mungbean-rice				
EWS mungbean	0.40	0.19	0.10	0.03
WS rice	4.15	3.95	3.32	2.57
Maize-rice				
EWS maize	0.68	0.38	0.07	0.03
WS rice	4.78	4.32	2.76	2.64

F+ =fertilizer; F0= without fertilizer; R+ = residue, R0 = without residue

ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่
Copyright © by Chiang Mai University
All rights reserved

Table 5.16 Worksheet for deriving gross margin for rice production (with fertilizer)

Item	Quantity	Unit	Price/unit (R)	Value (R)
Average land area	10,000	m^2		
Yield	1,660.0	kg	500	830000
Variable cost:				
Seed	40.00	kg	1,600	64000
Urea	97.64	kg	1,000	97640
DAP	28.40	kg	1,000	28400
KCL	41.60	kg	1,500	62400
Land preparation				78000
Total variable cost				330440
Gross margin				499,560

Not: Calculation based on unite price per commodity in Phnom Penh, Cambodia, in 2005 (1U$ = 4075 Riel)

GM overall mean of yield * price of paddy/kg (Riel/kg).GM = GR-VC

Table 5.17 Worksheet for deriving gross margin for rice production (without fertilizer)

Item	Quantity	Unit	Price/unit (R)	Value (R)
Average land area	10,000	m^2		
Yield	1,325.0	kg	500	662500
Variable cost:				
Seed	40.00	kg	1,600	64000
Urea	0.00	kg	0	0
DAP	0.00	kg	0	0
KCL	0.00	kg	0	0
Land preparation				78000
Total variable cost				142000
Gross margin				520,500

Not: Calculation based on unite price per commodity in Phnom Penh, Cambodia in 2005.(1U$= 4075 Reil)

GM overall mean of yield * price of paddy/kg (Riel/kg).GM = GR-VC

ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่
Copyright © by Chiang Mai University
All rights reserved

Table 5.18 Worksheet for deriving gross margin for mung bean production (with fertilizer)

Item	Quantity	Unit	Price/unit (R)	Value (R)
Average land area	10,000	m^2		
Yield	400.0	kg	2800	1120000
Variable cost:				
Seed	20.00	kg	3,000	60000
Urea	97.64	kg	1,000	97640
DAP	28.40	kg	1,000	28400
KCL	41.60	kg	1,500	62400
Land preparation				78000
Total variable cost				326440
Gross margin				793,560

Not: Calculation based on unite price per commodity in Phnom Penh, Cambodia in 2005. (1U$= 4075Riel)

GM overall mean of yield * price of mung bean/kg (Riel/kg).GM = GR-VC

Table 5.19 Worksheet for deriving gross margin for mung bean production (without fertilizer)

Item	Quantity	Unit	Price/unit (R)	Value (R)
Average land area	10,000	m^2		
Yield	100.0	kg	2800	280000
Variable cost:				
Seed	20.00	kg	3,000	60000
Urea	0.00	kg	0	0
DAP	0.00	kg	0	0
KCL	0.00	kg	0	0
Land preparation				78000
Total variable cost				138000
Gross margin				142,000

Not: Calculation based on unite price per commodity in Phnom Penh, Cambodia in 2005.1U$= 4075Riel

GM overall mean of yield * price of mung bean /kg (Riel/kg).GM = GR-VC

ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่
Copyright © by Chiang Mai University
All rights reserved

Table 5.20 Worksheet for deriving gross margin for maize production (with fertilizer)

Item	Quantity	Unit	Price/unit (R)	Value (R)
Average land area	10,000	m^2		
Yield	680.0	kg	510	346800
Variable cost:				
Seed	35.00	kg	6,000	210000
Urea	97.64	kg	1,000	97640
DAP	28.40	kg	1,000	28400
KCL	41.60	kg	15,000	624000
Land preparation				78000
Total variable cost				1038040
Gross margin				-691,240

Not: Calculation based on unite price per commodity in Phnom Penh, Cambodia in 2005.(1U$= 4075)

GM overall mean of yield * price of maize/kg (Riel/kg).GM = GR-V

Table 5.21 Worksheet for deriving gross margin for maize production (without fertilizer)

Item	Quantity	Unit	Price/unit (R)	Value (R)
Average land area	10,000	m^2		
Yield	65.0	kg	510	33150
Variable cost:				
Seed	40.00	kg	6,000	240000
Urea	0.00	kg	0	0
DAP	0.00	kg	0	0
KCL	0.00	kg	0	0
Land preparation				78000
Total variable cost				318000
Gross margin				-284,850

Not: Calculation based on unite price per commodity in Phnom Penh, Cambodia in 2005. 1U$ = 4075 Riel

GM overall mean of yield * price of maize/kg (Riel/kg).GM = GR-VC

ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่
Copyright © by Chiang Mai University
All rights reserved

Table 5.22 Summary of gross margin in each pattern

Cropping pattern	Gross margin(Riel)				
Rice-Rice	F+ R+	F+R0	F0R+	F0R0	Total
EWS rice	499,560	279,560	520,500	83,000	1,382,620
WS rice	1,679,560	1,039,560	1,190,500	1,298,000	5,207,620
Grain total					*6,590,240*
Mungbean-Rice					
EWS mungbean	793,560	191,560	142,000	-68,000	1,059,120
WS rice	1,744,560	1,642,060	1,515,500	1,140,500	6042,620
Grain total					*7,101,680*
Maize-rice					
EWS maize	-691,240	-315,190	-284,850	-129,250	-1420,530
WS rice	2,059,560	1,829,560	1,235,500	1,178,000	6,302,620
Grain total					*4,882,090*

Not: Calculation based on unite price per commodity in Phnom Penh, Cambodia in 2005. 1U$ = 4075 Riel

ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่
Copyright © by Chiang Mai University
All rights reserved