CHAPTER 5

RESULTS OF EXPERIMENT

Results of field experiment conducted at Huong Ho village in order to study the effect of phosphorous fertilizer application on mungbean will be presented in this chapter. In addition, economic analysis will be shown at the end of the chapter.

5.1 Effects of liming and phosphorous fertilizer application on available phosphorous, exchangeable Al^{3+} and soil pH

Five soil sub-samples (0-20 cm depth) at five crossed locations in the experimental field were taken before liming, and applying phosphorous in order to analyze chemical components. Analysis result is presented in Table 10.

It was found that cation exchangeable capacity (CEC), Ca^{2+}, and Mg^{2+} in the soil were low while the soil pH was 4.24 which indicated acid condition. Exchangeable aluminum of 0.76meq/100g was remarkably high whereas available phosphorous (3.39 ppm) was low and nitrogen content was quite low. These characters were similar to those were found in field survey.

Table 10. Chemical characteristics of soil in experimental site, Huong Ho, 1998

pH	N(%)	AvaiP	K_2O(%)	Ca^{2+*}	Mg^{2+*}	Al^{3+*}	CEC*
4.24	0.045	3.39	7.6	4.8	1.6	0.76	15.5

*AvaiP = available phosphorous (ppm), *= meq/100g soil. Result prior to application of lime and phosphorous fertilizer*

Analysis results of soil chemical properties after liming and application of phosphorous fertilizer (Figure 5.1) indicate that both phosphorous application and liming increased soil pH, available phosphorous and reduced exchangeable Al^{3+}. Liming at

amount of 1300 kg ha^{-1} without phosphorous fertilizer application increased soil pH from 4.24 to 5.55. Available phosphorous in the soil was slightly increased from 3.39 to 3.86ppm while exchangeable Al^{3+} reduced strongly from 0.76 down to 0.385meq/ 100g soil. Analysis results also demonstrated the more phosphorous fertilizer was applied the more available phosphorous and soil pH increase. However, rate of available phosphorous increase is slow when phosphorous fertilizer was added more than 75 kg P_2O_5 ha^{-1}.

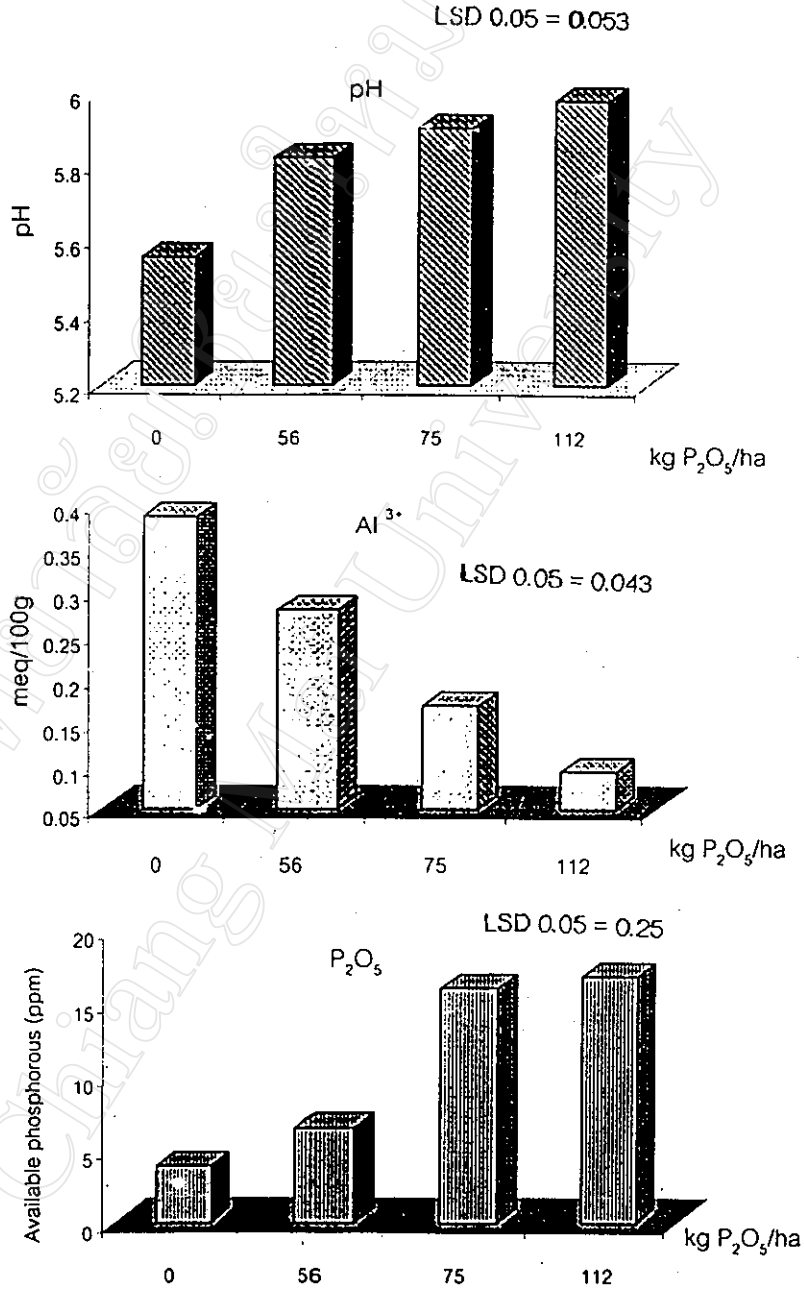

Figure 5.1 Changes of available P, pH, and exchangeable Al^{3+} in the experimental soil after liming and applying phosphorous fertilizer.

5.2 Response of mungbean bio-mass to phosphorous fertilizer application

5.2.1 Above ground dry matter

Significant differences at 1% level of above ground dry matter among different phosphorous fertilizer treatments at three growth stages of mungbean and all mungbean varieties were found (Table 11). Generally, above ground dry matter of different mungbean varieties positively increased when phosphorous fertilizer levels were added. Above ground dry matter increased remarkably when 56 and 75 kg P_2O_5 ha^{-1} were applied in all growth stages (Table 12). However, significant phosphorous fertilizer×variety interaction in above ground dry matter at three growth stages of was not found.

Table 11. Analysis of variance of above ground dry matter

Source of variation	Growth stage		
	30 DAS (V4)	55 DAS (R4)	65 DAS (R6)
Phosphorous (A)	**	**	**
Variety (B)	**	**	**
A×B	NS	NS	NS
CV (%)	23.02	29.07	23.57
LSD 0.05	63.28	526.55	448.74

** = Significance at 1% level, NS = Non significant

Table 12. Effect of phosphorous fertilizer on average above ground dry matter by phosphorus fertilizer in V4, R4 and R6 (mg/plant)

P fertilizer level Kg P_2O_5 ha^{-1}	Growth Stage		
	30 DAS (V4)	56 DAS (R4)	65 DAS (R6)
0	576.2 d	5137.3 d	5568.4 d
56	689.5 c	6362.8 c	6931.3 c
75	821.0 b	8526.3 b	8535.8 b
112	891.2 a	9436.0 a	9328.8 a
LSD 0.05	63.28	526.55	448.74

Comparison result of above dry matter among varieties is presented in Table 13. There were two significantly different groups of variety in average above ground dry matter. Lang and V87-13 have lower above ground dry matter than those of VC 27-68A and V 41-52.

Table 13. Average above ground dry matter by variety in V4, R4 and R6 (mg/plant)

Variety	Growth Stage		
	30 DAS (V4)	56 DAS (R4)	65 DAS (R6)
Lang	664.0 a	6294.7 a	6511.4 a
V 87-13	703.7 a	6611.5 a	7278.3 b
VC 27-68A	797.3 b	8329.9 b	8082.5 c
V41-52	812.8 b	8226.8 b	8194.7 c
LSD 0.05	63.28	526.55	448.74

5.2.2 Root dry weight

Analysis of variance results (Table 14) indicate significant differences among different phosphorous treatments and variety treatments at three growth stages of mungbean of root dry weight.

Table 14. Analysis of variance of root dry weight

Source of variation	Growth stage		
	30 DAS (V4)	55 DAS (R4)	65 DAS (R6-8)
Phosphorous (A)	**	**	**
Variety (B)	**	**	**
A×B	NS	NS	NS
CV (%)	19.23	19.32	22.73
LSD 0.05	18.638	93.565	145.89

** = Significance at 1% level, NS = Non significant

Figure 5.2 presents root dry weight differently responded to phosphorous fertilizer in three growth stages of mungbean. It is shown that root dry weight weakly responded to phosphorous fertilizer at V4 while it has great response to phosphorous fertilizer at R4

and R6. Table 15 also show that the average root dry weight increases significantly when phosphorous fertilizer was added in three growth stages.

Table 15. Effect of phosphorous fertilizer on average root dry weight in three stages of mungbean growth (mg/plant)

P fetilizer level Kg P_2O_5 ha^{-1}	Growth Stage		
	30 DAS (V4)	56 DAS (R4)	65 DAS (R6)
0	133.3 c	1149.8 d	1500.5 d
56	161.0 bc	1308.8 c	1777.7 c
75	174.6 ab	1522.8 b	2243.8 a
112	185.3 a	1650.2 a	2243.8 a
LSD 0.05	18.638	93.565	145.89

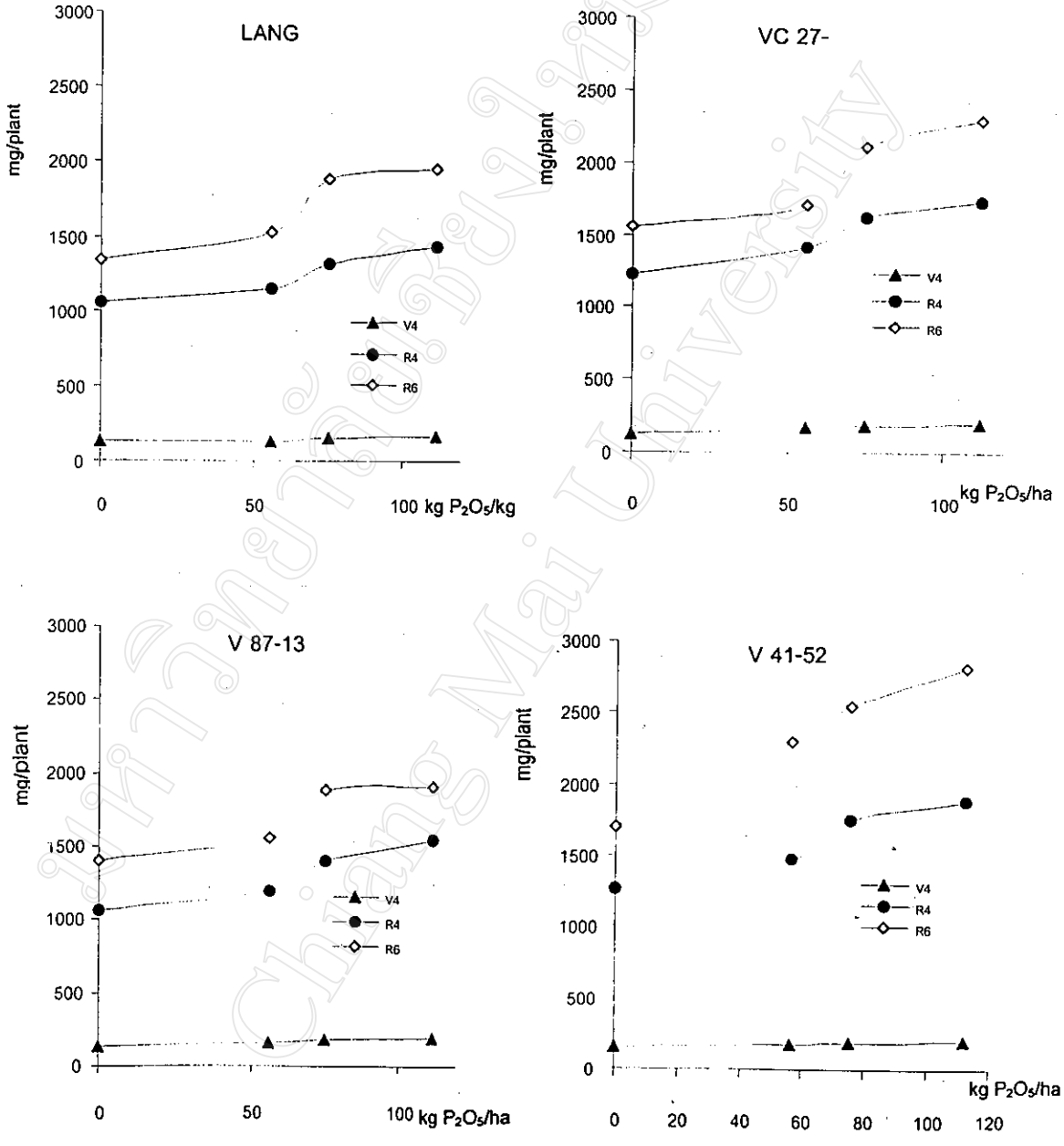

Figure 5.2 Response of root dry weight to phosphorous fertilizer application rates

V4, R4, R6 = Root dry weight per plant at V4, R4, R6 respectively

Comparison of average root dry weight among varieties in three growth stages is shown in Table 16. It is shown that average root dry weight of VC 27-68A and V 41-52 were higher than those of Lang and V 87-13. This result is similar to that of above ground bio-mass. Figure 5.2 demonstrates varieties responded in root dry weight when phosphorous fertilizer was applied in three growth stages. The highest root dry weight was obtained in R4 for all varieties.

Table 16. Average root dry weight by variety in V4, R4 and R6 (mg/plant)

Variety	Growth Stage		
	30 DAS (V4)	56 DAS (R4)	65 DAS (R6)
V 41-52	812.8 b	8226.8 b	8194.7 c
VC 27-68A	797.3 b	8329.9 b	8082.5 c
V 87-13	703.7 a	6611.5 a	7278 b
Lang	664.0 a	6294.7 a	6511.4 a
LSD 0.05	18.638	93.565	145.89

5.3 Response of number of nodule to phosphorous fertilizer

Analysis of variance results (Table 17) indicate that there is significant difference variety×phosphorous fertilizer interaction found in two growth stages of mungbean.

Table 17. Analysis of variance of number of nodule in V4 and R4

Source of variation	Growth stage	
	30 DAS (V4)	55 DAS (R4)
Phosphorous (A)	**	**
Variety (B)	**	**
A×B	**	**
LSD 0.05	0.367	0.589
CV (%)	22.39	20.79

** = Significance at 1% level

Generally, increasing phosphorous fertilizer increased number of nodule of both V4 and R4 stages of all varieties (Figure 5.3). However, V41-52 and VC 27-68A showed greater response in number of nodule to phosphorous fertilizer than those of V 87-13 and Lang, particularly in R4 stage. In V4 stage, the V 87-13 has better response of number of nodule than that of R4 stage.

On the average at V4 stage the maximum number of nodule obtained from V41-52, VC 27-68A, V 87-13 and Lang are at 75, 112, 75 and 56 kg respectively. At R4 stage the maximum number of nodule obtained from 112 P_2O_5 ha^{-1}.

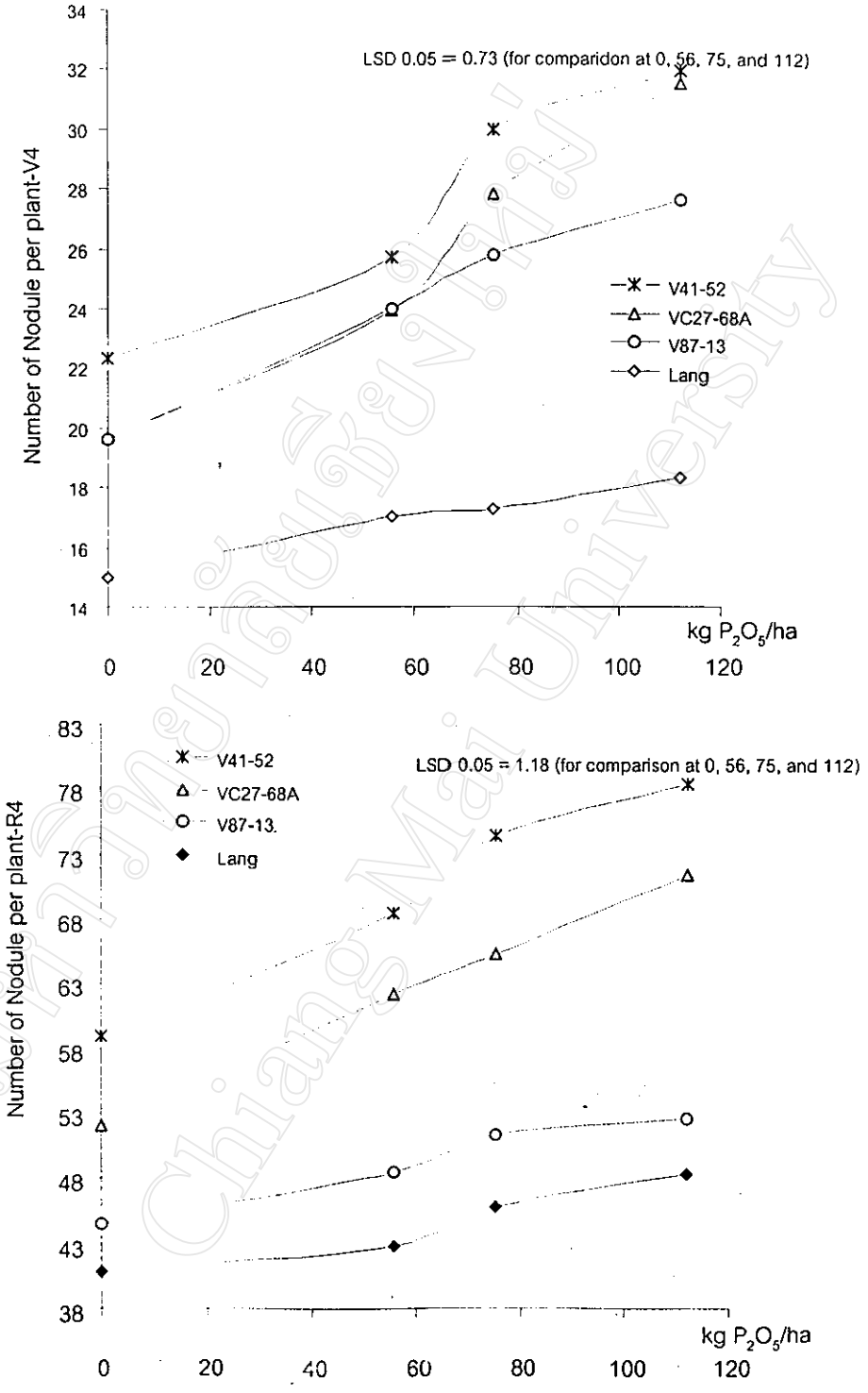

Figure 5.3 Response of number of nodule of different mungbean varieties to P fertilizer application rates in V4 and R4

5.4 Response of plant height to phosphorous fertilizer application

Analysis of variance results of plant height (Table 18) show that there is significant in variety×phosphorous fertilizer interaction at V4 and R4. Significant difference in both varieties and phosphorous fertilizer application rates is also found in all growth stages.

Table 18. Analysis of variance of plant height of mungbean at three stages of growth

Source of variation	Growth stage		
	30 DAS (V4)	55 DAS (R4)	65 DAS (R6)
Phosphorous (A)	**	**	**
Variety (B)	**	**	**
A×B	**	**	NS
LSD 0.05	0.1933	0.2389	0.735
CV (%)	12.82	7.69	5.90

** = Significance at 1% level, NS= non significant

Generally, increasing P fertilizer increased plant height of three V4, R4 and R6 stages of all varieties (Figure 5.4). Nevertheless, plant height of all varieties has weak response to phosphorous fertilizer than those of R4 and R6. Besides, V41-52 and VC 27-68A showed greater response in plant height to P fertilizer than those of V 87-13 and Lang, particularly in R4 and R6 stage.

On the average at V4 stage the maximum plant height obtained from V41-52, VC 27-68A, V 87-13 and Lang are at 75, 112, 56 and 56 kg P_2O_5 ha^{-1} respectively. At R4 stage the maximum plant height obtained from V41-52, VC 27-68A, V 87-13 and Lang are at 75, 75, 56 and 75 kg P_2O_5 ha^{-1} respectively. At R6 stage the maximum plant height obtained from V41-52, VC 27-68A, V 87-13 and Lang are at 112, 75, 75 and 75 kg P_2O_5 ha^{-1} respectively (Figure 5.4).

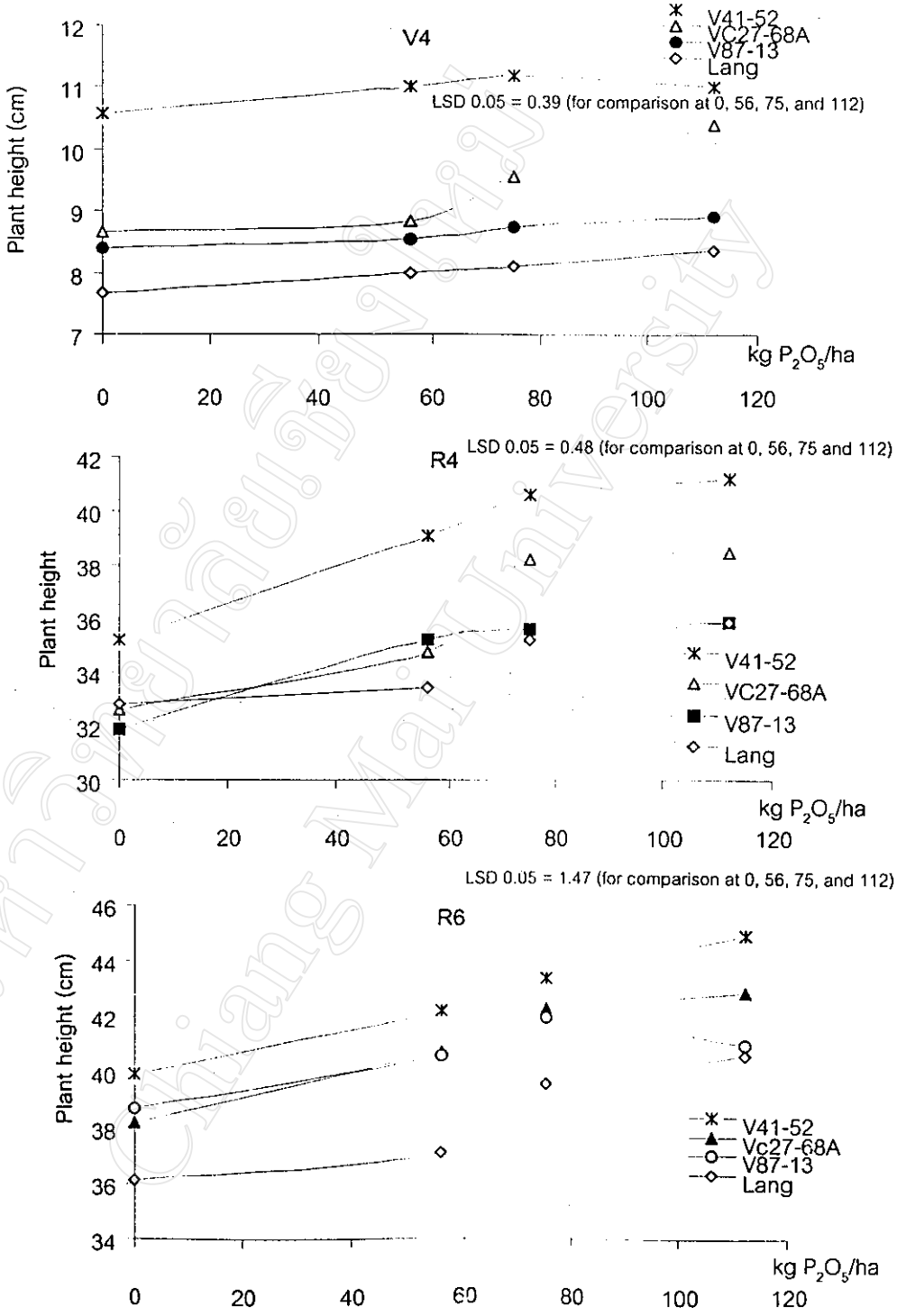

Figure 5.4 Response of plant heights of mungbean different varieties to P fertilizer application rates in V4, R4 and R6.

5.5 Response of yields and yield components to phosphorous fertilizer application rates

Analysis of variance results (Table 19) show that there is variety×phosphorous fertilizer interaction in number pod per plant, number seed per pod, 100-seed weight and seed yield.

Table 19. Analysis of variance of seed yield, number pod per plant, number seed per pod and 100-seed weight

Source of variation	Yield components			
	No.pod/plant	No.seed/pod	100-seed weight	Seed yield
Phosphorous (A)	**	**	**	**
Variety (B)	**	**	**	**
A×B	**	**	**	**
LSD 0.05	0.345	0.300	0.052	50.849
CV (%)	11.50	16.51	10.91	14.49

** = Significance at 1% level

5.5.1 Number of pod per plant

Generally speaking, increasing phosphorous fertilizer application level increased number of pod per plant of all varieties. On the average the maximum number of pod per plant were obtained at 75 kg P_2O_5 ha^{-1} which corresponded to 23.04, 21.94 and 19.06 of V41-52, VC 27-68A and Lang respectively. V 87-13 gave maximum number of pod per plant at 112 kg P_2O_5 ha^{-1} which was 22.33 pod per plant. Besides, V41-52 and VC 27-68A showed greater response in number pod per plant to phosphorous fertilizer than that of Lang, (Figure 5.5).

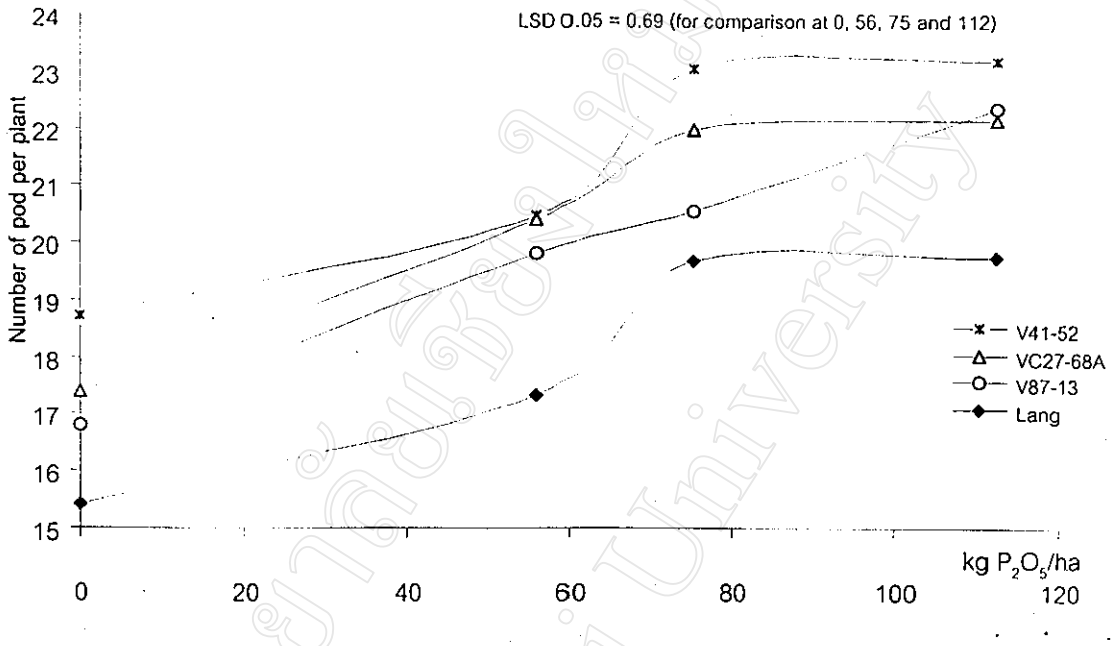

Figure 5.5 Response of number pod per plant of different mungbean varieties to P fertilizer application rates

5.5.2 Number of seed per pod

Generally, increasing phosphorous fertilizer application level increased number of seed per pod of all varieties. On the average the maximum number of seed per pod were obtained at 56 kg P_2O_5 ha^{-1} which corresponded to 11.43, 10.40 and 7.67 of V41-52, V 87-13 and Lang respectively. VC 27-68A gave maximum number seed per pod at 75 kg P_2O_5 ha^{-1} which was 11.8 seed per pod. V 41-52 showed greater response in number seed per pod to phosphorous fertilizer than those of VC 27-68A, V 87-13 and Lang (Figure 5.6).

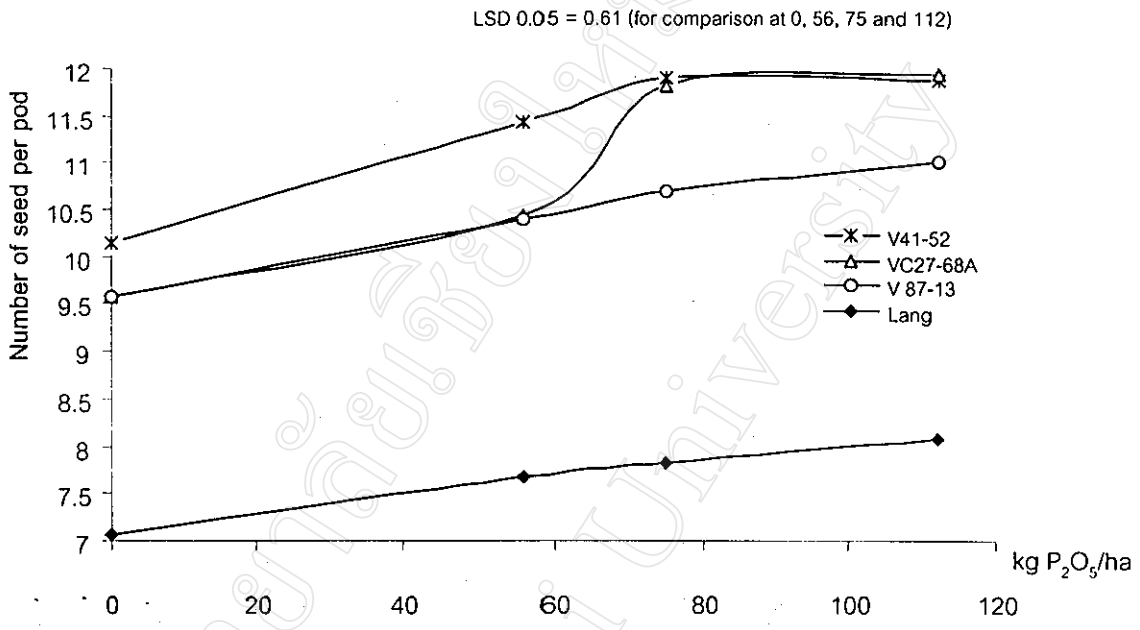

Figure 5.6 Number seed per pod in response to phosphorous fertilizer application rates

5.5.3 100-seed weight

Generally, increasing phosphorous fertilizer application level increased 100-seed weight of all varieties. On the average the maximum 100-seed weight were obtained at 75 kg P_2O_5 ha^{-1} which corresponded to 7.12, 7.03, and 6.03 gram of V41-52, VC 27-68A, and V 87-13 respectively. Lang gave maximum 100-seed weight at 112 kg P_2O_5 ha^{-1} which was 5.82 gram. V 41-52 and VC 27-68A showed greater response in 100-seed weight to phosphorous fertilizer than those of V 87-13 and Lang (Figure 5.7).

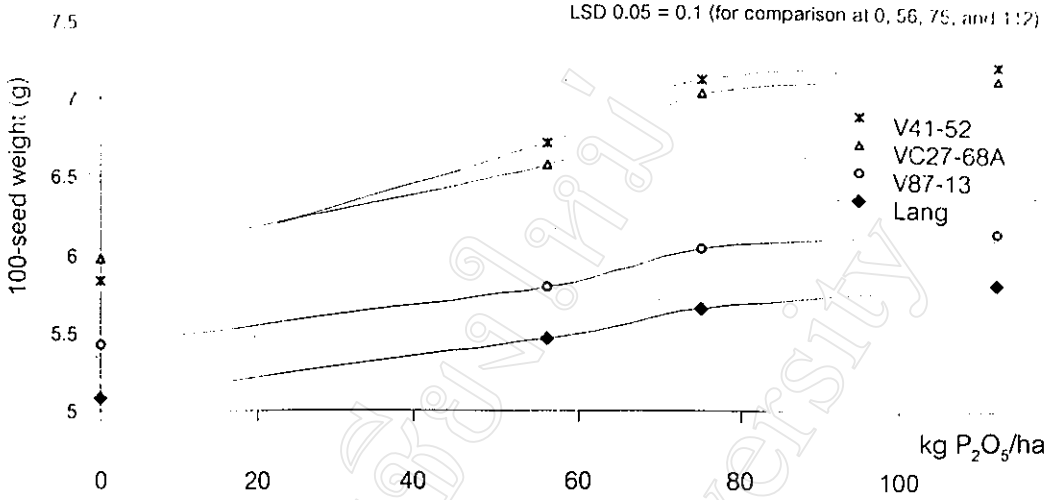

Figure 5.7 Response of 100-seed weight of different mungbean varieties to phosphorous fertilizer application rates

5.5.4 Response of seed yield to phosphorous fertilizer

Generally, increasing phosphorous fertilizer application level increased seed yield of all varieties. On the average the maximum seed yield were obtained at 75 kg P_2O_5 ha^{-1} which corresponded to 1847, 1797, 1531 and 1535 kg of V41-52, VC 27-68A, V 87-13 and Lang respectively. V 41-52 and VC 27-68A showed greater response in seed yield to phosphorous fertilizer than those of V 87-13 and Lang (Figure 5.8)

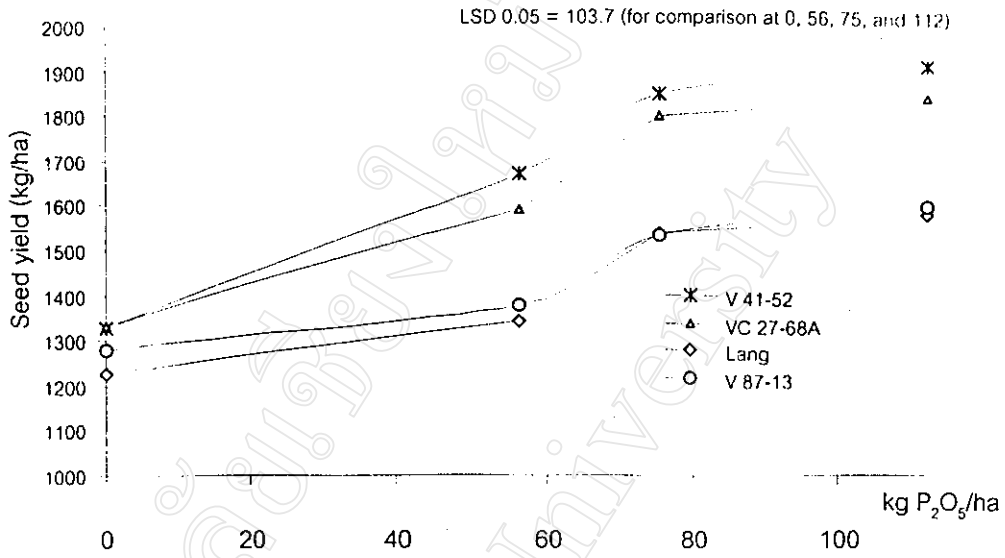

Figure 5.8 Response of seed yield of different mungbean varieties to phosphorous fertilizer application rates

5.6 Response of N, P, K content in the youngest fully expanded leave (YFEL) of mungbean to P fertilizer application rates

Analysis of variance results (Table 20) demonstrate significant phosphorous×variety interaction nitrogen concentration of YFEL. On the average, N% and P% concentration in YFEL steadily increased when phosphorous fertilizer increased Analysis result also shows that there is significant difference in N% and P% in YFEL among phosphorous fertilizer and variety. V 41-52 and VC 27-68A gave greater N% and P% in YFEL than those of V87-13 and Lang (Table 21 and Figure 5.9).

Although significant difference in K% was found at level 5% (Table 22), it is no significant difference in K% among 56, 75 and 112 kg P_2O_5 ha^{-1} (Table 22).

Table 20. Analysis of variance of nitrogen, potassium and phosphorous concentration in the youngest fully expended leaves (YFEL) at vegetative stage, V4

Source of variation	Chemical content in YFEL		
	N%	P%	K%
Phosphorous (A)	**	**	*
Variety (B)	**	**	NS
A×B	**	NS	NS
LSD 0.05	0.036	0.0152	0.0536
CV (%)	14.73	13.86	5.86

** = Significance at 1% level, *= significance at 5% level, NS = Non significant

Table 21. Response of average concentration of phosphorous of YFEL to phosphorous fertilizer at V4 (%).

Variety	Phosphorous level application (kg P_2O_5 ha^{-1})				
	0	56	75	112	Mean
V 41-52	0.3100	0.3567	0.4033	0.4383	0.3771 b
VC 27-68A	0.3133	0.3467	0.4033	0.4400	0.3758 b
V 87-13	0.3000	0.3100	0.3567	0.4133	0.3450 a
Lang	0.3067	0.3200	0.3533	0.3800	0.3400 a
Mean	0.3075 a	0.3333 b	0.3792 c	0.4179 d	

LSD0.05 of mean = 0.0152

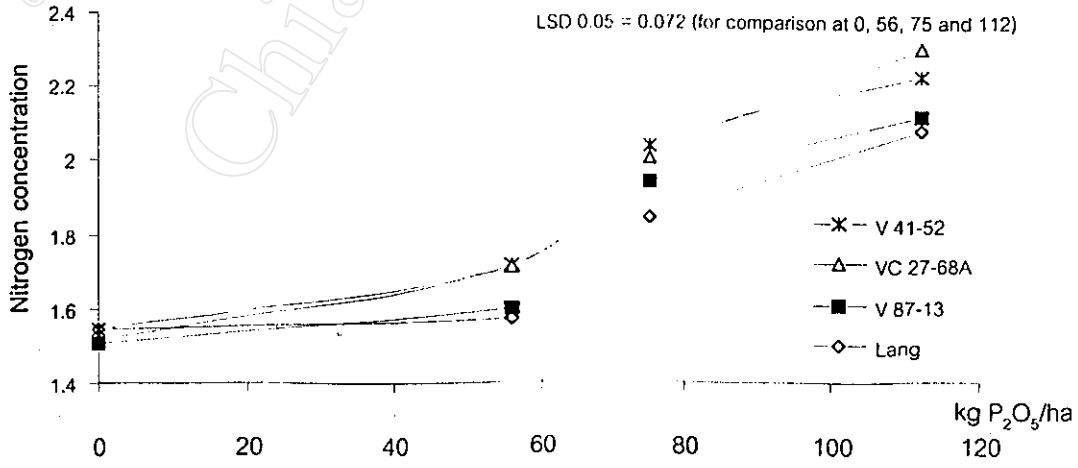

Figure 5.9 Response of nitrogen concentration in YFEL to different phosphorous fertilizer application rates

Table 22. Response of average concentration of potassium of YFEL to phosphorous fertilizer at V4 (%)

Variety	Phosphorous level application				
	0	56	75	112	Mean
V 41-52	1.5400	1.6333	1.6500	1.6667	1.6225 a
VC 27-68A	1.5433	1.6067	1.6333	1.6367	1.6050 a
V 87-13	1.3967	1.6300	1.6300	1.6600	1.5792 a
Lang	1.4600	1.6033	1.6500	1.7167	1.6075 a
Mean	1.4850 b	1.6258 a	1.6342 a	1.6692 a	

LSD0.05 of mean = 0.488

5.7 Economic consideration

Figure 5.10 present comparison results that demonstrate no significant difference between means of gross margin at 75 kg P_2O_5 ha^{-1} in all varieties. The highest mean of gross margin obtained was at 75 kg P_2O_5 ha^{-1} in V41-52. Significant difference among varieties is also found. Among gross margins of various varieties, V 41-52 and VC 27-68A always gave greater gross margin than those of Lang and V 87-13 at all levels of phosphorous fertilizer application (Figure5.10 and Table 23).

Table 23. Average gross margin comparison among different treatments (1,000VND ha^{-1})

Variety	Phosphorous fertilizer level (kg P_2O_5 ha^{-1})				
	0	56	75	112	Mean
V 41-52	7,538	9,563	10,464	10,633	9549 c
VC 27-68A	7,581	8,679	10,114	10,138	9128 b
V 87-13	7,199	7,369	8,278	8,432	7820 a
Lang	6,817	7,131	8,301	7,983	7578 a
Mean	7284 a	8186 b	9289 c	9296 c	

Mean followed by the same letter (a,b,c) is not significant difference at 5% level. LSD 0.05 for mean = 349.15

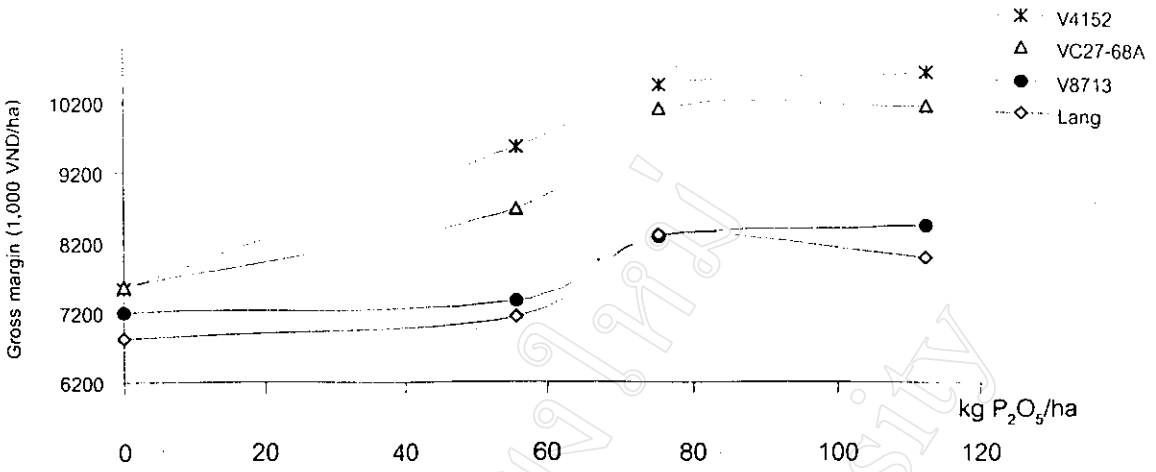

Figure 5.10 Relationship between gross margin and different phosphorous fertilizer application levels

In terms of economic efficiency of added capital investment, Table 24 show that there is strong decrease in return to capital when V 87-13 and Lang (local variety) is invested more phosphorous fertilizer. However, return to capital slightly decrease in V 41-52 and VC 27-68A. V 41-52 have fairly high return to capital (6.39) when applied at 75 kg P_2O_5 ha^{-1}. Table 24 also indicate that return to labor of V 41-52 and VC 27-68A is often higher than those of V 87-13 and Lang in all levels of phosphorous fertilizer application. Besides, application of phosphorous fertilizer increased return to labor steadily in all varieties. V 41-52 gave the highest increase of return to labor.

Table 24. Economic consideration for different treatments (1,000 VND per ha)

Treatment Variety	P	Gross Revenue	Variable Cost	Gross Margin*	Fix Cost	R to [1]Labor	R to[2] Capital
V 41-52	0	9387	1749	7538	1028	209.27	6.65
V41-52	56	8026	2456	9563	1039	212.96	6.34
V 41-52	75	12927	2463	10464	1042	231.12	6.39
V 41-52	112	13389	2756	10633	1049	234.88	5.70
VC 27-68A	0	9330	1749	7581	1028	210.58	6.68
VC 27-68A	56	11123	2444	8679	1039	196.47	5.78
VC 27-68A	75	12577	2463	10114	1042	222.98	6.19
VC 27-68A	112	12984	2756	10138	1049	223.37	5.45
V 87-13	0	8938	1749	7199	1028	199	6.35
V 87-13	56	9648	2279	7369	1039	169.59	4.96
V 87-13	75	10722	2444	8278	1042	186.71	5.14
V 87-13	112	11172	2749	8423	1049	185.85	4.61
Lang	0	8566	1749	6817	1028	187.42	6.02
Lang	56	9396	2265	7131	1039	168.21	4.81
Lang	75	10745	2444	8301	1042	187.27	5.16
Lang	112	10720	2737	7983	1049	179.42	4.40

(1) = return to labor, (2) = return to capital,* Result of T test is following: P = 0.0000, Standard Error =189.45, T=44.94

Gross Revenue (GR) = Seed yield × Price of 1kg mungbean

Variable Cost (VC) = Labor + Land preparation + Seed + Lime + Phosphorous fertilizer

Gross margin (GM) = GR – VC

Fix cost (FC) = Land charge + Interest charge + Tax charge (see appendix 12 & 13)

Return to labor = (GM – FC + Labor cost)/ Labor cost

Return to Capital = (GM – FC + Cash cost)/ Capital cost