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Effect of organic and bio- fertilizer on quality , grain yield and soil properties of soybean under rice based cropping system

Tran thi Ngoc Son[1], Vu van Thu, Luu Hong Man and H. Hiraoka[2]

ABSTRACT

The field experiment on soybean was conducted at Phuoc Thoi village, O Mon district, Cantho province with different fertilizer application doses to study the influence of organic and bio- fertilizer on the growth and grain yield of soybean and soil fertility. The experimental results showed that the application of organic and bio-fertilizer could be substantiated for the N inorganic fertilizer to an extent of 40 kg N ha^{-1} while the agronomic traits and grain yield of soybean were examined as compared to the control (conventional dose applied by farmers). The quality nutrient contents and uptake of soybean with reference to N, P, and K and soil available P and K were significantly improved by the application of composted paddy straw and inoculants viz., SB 83 (*Rhizobium fredii*) and SB 177 (*Bradyhrizobium sp*).

Key words : soybean, inoculant, compost, nutrients

INTRODUCTION

Mono rice cultivated areas highly account for agricultural production areas. In the delta, rice area is developed in 3,760,600 ha while the soybean crop is estimated only 14,500 ha, groundnut 16,300 ha and maize 17,100 ha which equal to 0.39 %, 0,43 % and 0.45 % as compared to rice (Statistic Board General 1999). Practically, the monoculture and heavy application of chemical fertilizers may cause depletion of certain nutrients in soil and certain others would generally accumulate in excess resulting in nutrient imbalance which effects the soil productivity. Among the means available to achieve sustainability in agricultural production, organic manure and bio-fertilizer play an important role because they possess many desirable soil properties and exert beneficial effect on the soil physical, chemical and biological characteristics. However, the most optimum organic and bio-fertilizer doses as well as their effectiveness for upland crops have not been studied well. Regarding to this item, an attempt has been addressed to study the influence of organic and bio-fertilizers on soybean under rice-based cropping system.

MATERIALS AND METHODS

The experiment was conducted in farmer' s fields at Thoi Trinh hamlet, Phuoc Thoi village, O Mon district, Cantho province during Spring- Summer season of 2000. The soil pH was 5.64 (1:1 H_2O). Soil nutrient components were: organic carbon 1.03 %, total nitrogen 0.108 %, total P 0.00158 %; total K: 1.85 %, available N: 0.277 meq/100g of soil, available P: 2.282ppm, available K: 0.22 meq/100g of soil. Soybean variety MTD 176 was used in a randomized complete block design with three replications. The treatment details are presented in Table 1:

Table 1. Experiment treatments

No.	Soybean (Spring- Summer) N - P_2O_5 - K_2O Kg/ha
T1	100- 60 -30
T2	60-60-30
T3	30-60-30
T4	00-60-30
T5	Inoculants + 60-60-30
T6	Inoculants + 30-30-30
T7	Compost + 60-60-30
T8	Compost + 30-60-30
T9	Inoculants + 00-00-00
T10	Compost + 00-00-00
T11	Compost + inoculants +30-60-30

[1] Cuu Long Delta Rice Research Institute, OMon, Can Tho, Vietnam

[2] Japan International Research Center for Agricultural Sciences,Tsukuba, Ibaraki 305-8686, Japan

The N, P, K fertilizers were applied in the form of urea, single super phosphate and muriate of potash, respectively. The composted paddy straw was incoporated in the soil one day prior to sowing at the rate of 2 t / ha. The inoculants viz., SB 83 (*Rhizobium fredii*) and SB 177 (*Bradyhrizobium sp*.) were inoculated in soybean seed samples at the ratio of 1:10 (1g inoculants and 10 g of soybean seeds). One third of the N and full dose of P_2O_5, K_2O were applied basally. The remaining two third dose of N was applied at 20 and 35 days after sowing (DAS). The soybean seeds were sown adopting a plant spacing of 40 x 20 cm, 3 plants/hill (plant population = 375,000 plants/ha). Cultural practices and plant protection measures were implemented as conventional recommendation.

Plant height, no. of soybean leaves and SPAD value were measured at two weeks interval beginning, from two weeks and four weeks after sowing, respectively.

Soil samples were collected from the field before experiment. Then the soil samples were also collected from each plot at soibean harvesting.

Plant samples were collected at soibean harvesting. The plant were washed with diluted H_2SO_4 (0.1 %), then rinsed with distilled water, air-dried and then oven dried at 60^oC for 12 hours. The dried straw and grain samples were ground in mechanical grinder, then stored. Uptake of nutrients viz., N, P, K was calculated by multiplying the content (%) of the nutrients with the respective weights of dry matter of the plant samples at harvesting stage. The data obtained from the present investigation were subjected to statistical scrutiny

RESULTS AND DISCUSSIONS

1. Plant height

Mean value of plant height varied from 23.2 to 27.7 cm at two WAS (Table 2). Among treatments, the highest plant height was obtained under T7 (Compost + 60-60-30), then T8 (compost + 30-60-30). However, there was no significant difference due to treatmental influence. The similar trend was recorded at 28 DAS. The lowest plant height of soybean was recorded under T4 (00-60–30) at 42 DAS. The highest plant height obtained under T7 (Compost + 60-60-30), then T1 (100-60–30) at 56 DAS.

Table *2* Treatmental influence on the plant height of soybean at different stages

No.	Treatments	14 DAS	28 DAS	42 DAS	56 DAS
T1	100- 60–30	24.27 ab	52.60 abc	92.67 bcd	102.5c
T2	60- 60-30	25.47 ab	50.73 abc	90.67 ad	99.6 c
T3	30-60–30	25.87 ab	51.87 abc	89.50 ad	92.9 abc
T4	00-60-30	26.33 ab	48.60 ab	79.53 a	83.3 a
T5	I + 60-60-30	25.87 ab	52.13 abc	92.27 bcd	98.7 c
T6	I + 30-30-30	25.87 ab	54.13 bc	90.13 ad	95.9 bc
T7	C + 60-60-30	27.67 b	57.93 c	99.87 d	103.5 c
T8	C + 30-60-30	26.73 ab	53.0 0 abc	94.80 cd	97.7 c
T9	I + 00 -00-00	23.20 a	48.93 abc	84.93 abc	87.2 ab
T10	C + 00 - 00- 00	23.87 ab	44.67 a	81.07 ab	86.7 ab
T11	C + I +30-60-30	25.60 ab	47.07 ab	88.33 ad	94.1 bc
	LSD 5%	3.66	8.03	10.8	9.37
	CV (%)	8.5	9.2	7.1	5.8

C: composted paddy straw; I: Inoculants SB 83 (*Rhizobium fredii*) and SB 177 (*Bradyhrizobium sp*)
The treatment means with the same letter are not significantly different using LSD at 5 %

2. The SPAD value

The SPAD value varied from 28.60 to 33.70 at 28 DAS (Table 3). The highest value was obtained under application of highest nitrogen dose T1 (100-60-30) following by T7 (Compost + 60-60-30) and T2 (60-60-30). This reason could be attributed to the higher initial nitrogen application which would enhance the soybean growth and translocation of nitrogen to the leaves sufficiently, and favorably induced chlorophyll formation. At six weeks after sowing, the mean value of SPAD ranged from 38.33 to 41.03. Except the two treatments viz., T4 (00-60-30) and T9 (Compost + 00–00-00). Remaining treatments were comparable to each other. There were no significant differences between inorganic fertilizer

application alone and composted paddy straw and inoculants combined with inorganic fertilizer at 56 DAS, except treatments viz., T2 (60-60-30), T3 (30-60-30) and T4 (00-60-30). This could be attributed to the mineralization which has been taken place during the course and led to the enhancement of solubilization of nitrogen in the soil and N nutrient released from composted paddy straw led to an increase in SPAD value under lower inorganic fertilizer dose combined with composted paddy straw. At 56 DAS, application of inoculants and compost obtained the higher SPAD value as compared to treatments without application. This may be due to the activity of *Rhizobium fredii* micro-organism helping in enhancement of N fixation process

Table *3:* Treatmental influence on the SPAD value of soybean at different stages

No.	Treatments	28 DAS	42 DAS	56 DAS
T1	100-60-30	33.70 e	41.03c	41.40 a
T2	60-60-30	32.63 de	39.93abc	39.67 b
T3	30-60-30	31.53 cd	39.03 abc	39.23 b
T4	00-60-30	28.60 a	38.77 ab	38.67 bc
T5	I + 60-60-30	31.53 cd	39.63 abc	41.67 a
T6	I + 30-30-30	30.73 bc	39.73 abc	41.63 a
T7	C + 60-60-30	32.67 de	39.40abc	41.37a
T8	C + 30 -60-30	30.67 bc	39.87 abc	41.03 a
T9	I + 00-00-00	29.07 a	38.33 a	40.27 a
T10	C + 00-00-00	29.67 ab	39.10 abc	41.10 a
T11	C + I + 30-60-30	31.37 cd	39.60 abc	41.30a
	LSD 5%	1.44	1. 89	1.72
	CV	12.7	12.8	12.5

C: composted paddy straw; I : Inoculants SB 83 (*Rhizobium fredii*) and SB 177 (*Bradyhrizobium sp*)
The treatment means with the same letter are not significantly different using LSD at 5 %

3. Yield and yield components

The highest plant height from the pod was recorded under T7 (compost + 60-60-30) following by T1 (100-60-30) and T5 (Inoculants + 60-60-30) (Table 4 and Fig.1). Three treatments namely T4 (00-60-30), T9 (Inoculants+ 00-00-00) and T10 (compost + 00-00-00), obtained plant height value lower than control significantly. Remaining treatments obtained the same plant height to control T1 (100-60-30).

Number of pods/plant of four treatments viz., T2 (60- 60–30), T5 (Inoculants + 60-60-30), T7 (compost + 60-60-30) and T8 (compost + 30-60–30) were on par with control T1 (100-60-30). The remaining treatments showed lower value than control T1 (100-60-30)

Number of seeds/pod of two treaments viz., T4 (00-60-30) and T10 (compost + 00-00-00) was recorded lower value than control T1 (100-60-30). The remaining treatments were on a par to control T1 (100-60-30)

The highest 100-grain weight value was obtained under T7 (compost + 60-60-30) and the lowest under T9 (Inoculants+ 00-00-00). However, there were no significant different in 100-grain weight among treatments, except T9 (Inoculants+ 00-00-00).

Grain yield values of soybean varied from 1.86 to 2.50. The highest yield was recorded in treatment T1 (100-60-30) which was on a par with T2 (60-60-30), T5 (Inoculants + 60-60-30), T6 (Inoculants + 30-30-30), T7 (compost + 60-60-30) and T11 (Compost + Inoculants + 30-60-30). It showed that the lower dose of inorganic fertilizer conjunction with composted paddy straw or Inoculants could achieve same grain yield of soybean under rice-based cropping system.
is is in line with the finding by Ramaswami and Son (1993), Son and Ramaswami (1997).

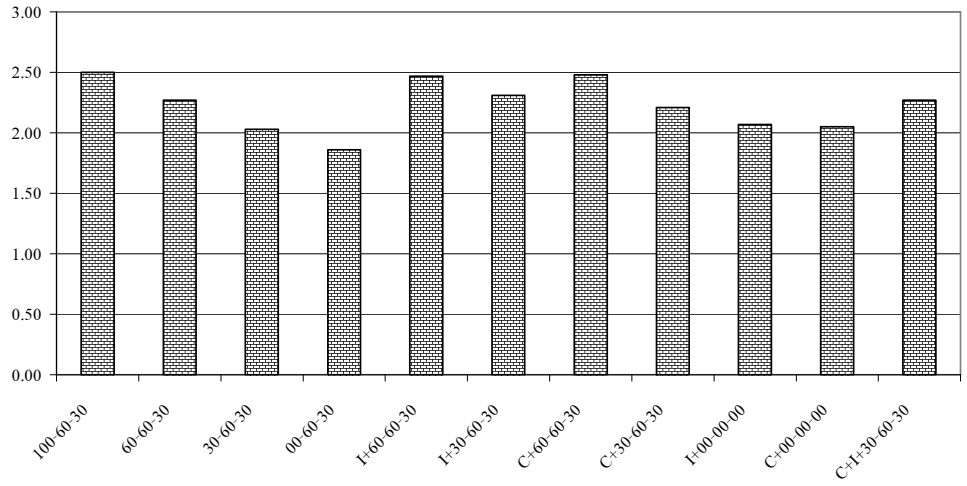

Table *4:* Treatmental influence on yield and yield components of soybean

No.	Treatments	Plant height from pod (cm)	No. of pods/plant	No. of seeds/pod	100-grain weight (g)	Grain yield (T ha^{-1})
T1	100-60-30	78.40d	25.07d	2.23b	15.967 ab	2.500 d
T2	60-60-30	75.17ad	23.33cd	2.23 b	16.533 ab	2.287 bcd
T3	30-60–30	74.53 ad	20.33 ab	2.10 ab	16.333 ab	2.033 ab
T4	00-60-30	65.60ab	19.30 a	2.03 a	16.133 ab	1.860 a
T5	I + 60-60-30	77.07 cd	24.03 cd	2.20 b	16.567 ab	2.467 cd
T6	I + 30-30-30	72.20 ad	21.27 abc	2.20 b	15.967 ab	2.307 bcd
T7	C + 60-60-30	79.50d	24.73 d	2.20 b	16.833 b	2.480 cd
T8	C + 30–60-30	73.23 ad	23.00 bcd	2.23 b	16.333 ab	2.207 bc
T9	I + 00–00-00	66.37 abc	20.33 ab	2.10 ab	15.667 a	2.067 ab
T10	C + 00–00-00	64.33a	20.37 ab	2.03 a	15.900ab	2.047 ab
T11	C + I + 30-60-30	69.57ad	21.50 abc	2.20 ab	15.833 ab	2.300 bcd
	LSD 5%	9. 57	2.6	0.15	0. 936	0.236
	CV %	7.8	6.9	4.0	3.5	6.5

C: composted paddy straw; I : Inoculants SB 83 (*Rhizobium fredii*) and SB 177 (*Bradyhrizobium sp*)
The treatment means with the same letter are not significantly different using LSD at 5 %

4. Quality nutrient content in soybean grain

Nitrogen content in grain: the N content in soybean grain was the highest due to the application of composted paddy straw + 60-60-30 kg NPK (T7). The treatment T1 (100-60–30) indicated the lowest N content application of composted paddy straw and inoculants increased the N content in soybean by 5.26 to 9.78 % over control for T9 (I + 00-00-00) and T7 (C + 60-60-30), respectively (Table 5).

Nitrogen content in straw: the mean value of N content in soybean straw varied from 0.6629 to 0.7367 %. The lowest value recorded under treatment T1 (100-60–30). However, there was no significant difference among the treatments.

Phosphorus content in grain: the P content in soybean grain was the highest due to the application of composted paddy straw + 30-60-30 (T8). The treatment T1 (100-60–30) obtained the lowest P content. Application of composted paddy straw and inoculants increased the P content in soybean by 0.86 to 9.86 per cent over control for T9 (I + 00-00-00) and T8 (C+ 30-60-30), respectively.

Phosphorus content in straw: the mean value of P content in soybean straw ranged from 0.1013 to 0.1333 per cent. The lowest value was recorded under treatment T10 (C+ 00- 00–00). The application of composted paddy straw and inoculants incresead the P

content in straw of soybean by 2.70 to 21.5 per cent over control for T11 (C+I+30-60-30) and T8 (C+ 30-60-30), respectively.

Potassium content in grain: the K content in soybean grain was recorded the highest due to the application of composted paddy straw + 30-60-30 (T8). The treatment T1 (100-60–30) obtained the lowest K content. Application of composted paddy straw and inoculants incresead the K content in soybean by 11.88 to 23.81 per cent over control for T5 (I+60-60-30) and T8 (I+ 30-60-30), respectively.

Potassium content in straw: the mean value of K content in soybean straw ranged from 2.073 to 2.323 %. The lowest value was recorded under treatment T10 (C+ 00-00–00) . There was no significant increment due to application of composted paddy straw and inoculates, probably due to low dose of composted paddy straw

Table *5* : Treatmental influence on nutrient content (%) in grain and straw of soybean crop

No.	Treatments	Nutrient content in Soybean grain			Nutrient content in soybean straw		
		N	P	K	N	P	K
T1	100- 60 -30	5.31a	0.3143 a	2.003 a	0.6629 a	0.1097 ab	2.253 cde
T2	60 - 60 - 30	5.68b	0.3360 a	2.173 bc	0.7367 a	0.1200 ad	2.140 abc
T3	30 - 60 -30	5.65 b	0.3353 a	2.293 cd	0.7136 a	0.1327 d	2.223 be
T4	00-60-30	5.71 b	0.3233 a	2.303 de	0.7213 a	0.1303 cd	2.210 be
T5	I+60-60-30	5.71 b	0.3317 a	2.380 def	0.6947 a	0.1187 ad	2.150 ad
T6	I+30- 30-30	5.72 b	0.3420 a	2.413 def	0.6935 a	0.1050 ab	2.113 ab
T7	C+60-60-30	5.83 b	0.3377 a	2.377 def	0.7281 a	0.1137 ad	2.157 ad
T8	C+30 -60-30	5.61ab	0.3453 a	2.480 f	0.7273 a	0.1333 d	2.113 ab
T9	I +00 -00-00	5.59ab	0.3170 a	2.447 f	0.6938 a	0.1087 ab	2.077 a
T10	C+00 - 00- 00	5.81 b	0.3407 a	2.440 ef	0.7264 a	0.1013 a	2.073 a
T11	C+I +30 -60-30	5.68 b	0.3247 a	2.393 def	0.6637 a	0.1127 abc	2.270 de
	LSD 5%	0.292	0.0327	0.122	0.1407	0.0174	0.109
	CV %	3.00	5.80	3.10	11. 08	8.80	3.00

C: composted paddy straw; I : Inoculants SB 83 (*Rhizobium fredii*) and SB 177 (*Bradyhrizobium sp*)
The treatment means with the same letter are not significantly different using LSD at 5 %

5. Soil properties

All the treated plots with organic manure and biofertilizer were recorded higher pH value than control and NPK alone (Table 6). The increment in pH was to the tune of 0.193 to 0.330 units over control. This could be ascribed to the fact that the decomposition of organic waste released Ca and Mg nutrient which could slightly increase the soil pH (Ramaswami and Son 1996)

In general, the electrical conductivity of soil was markedly influenced by treatments. However, the EC of soil was attended at suitable level for crop growth.

Organic carbon was obtaine maximum value under treatment T7 (C+60-60-30) and significantly different from control T1 (100-60-30) (Table 6). A build up of organic carbon due to organic waste +NPK application from 0.034 to 0.067 % might be due to the inorganic fertilizer supplying the needed energy and nutrient for the decomposition of complex organic matter and converting them to mineralized organic colloids which are added to the soil organic matter reserves and rapid multiplication in the microbial population.

Soil available nitrogen: Marked changes were observed on soil available nitrogen due to influence of treatments. Higher soil N value observed under T7 (C+60-60-30). This was due to the inherent N content of the waste material incorporated and transformation during composting and after application in the soil. The available P was found to be higher under T7 (C +60-60-30) and T8 (C +30-60-30). The organic acids released during decomposition of organic influence pH from stable complexes or chelates with cations responsible from P fixation, then increase P availability. The application of organic manure significantly reduced the fixation of added as well as native P, making P more available to plant. (Ghosh et al. 1981, Son and Ramaswami 1997).

Table *6* Treatmental influence on soil nutrient availability of soybean at harvest stage

No.	Soybean (Spring- Summer)	pH	EC	Organic carbon (%)	Nutrient availability	
					N P (ppm)	meq/100 g
T1	100-60-30	5.247 a	0.237 a	1.033 ab	0.327 a	2.2823 a
T2	60-60-30	5.243 a	0.257 abc	1.067 ab	0.270 a	1.9907 a
T3	30-60-30	5.273 a	0.257 abc	1.067 ab	0.277 a	3.9773 ab
T4	00-60-30	5.293 a	0.283 c	1.000 ab	0.247 b	2.8083 abc
T5	I + 60-60-30	5.267 a	0.277 c	1.067 ab	0.257 a	2.8083 abc
T6	I + 30- 30-30	5.550 c	0.240 a	1.000 ab	0.347 a	3.3930 abc
T7	C + 60-60-30	5.540 c	0.273 bc	1.100 b	0.337 a	4.8543 c
T8	C + 30-60-30	5.440 bc	0.257 abc	0.900 a	0.280 a	4.8830 c
T9	I + 00-00-00	5.560 c	0.2153 abc	1.000 ab	0.303 a	2.6040 ab
T10	C + 00-00-00	5.577 c	0.243 ab	1.033 ab	0.277 a	2.8377 abc
T11	C + I +30-60-30	5.567 c	0.233 a	1.000 ab	0.337 a	4.6497 bc
	LSD 5%	0.131	0.028	0.158	0.092	1.864
	CV %	1.40	6.60	9.10	17.7	33.2

C: composted paddy straw; I : Inoculants SB 83 (*Rhizobium fredii*) and SB 177 (*Bradyhrizobium sp*)
The treatment means with the same letter are not significantly different using LSD at 5%

6. Treatmental influence on uptake by soybean grain

N uptake :The uptake of N by soybean grain was found to be influenced by the different treatments (Table 7). Among treatments, the application of composted paddy straw (T7) showed the highest N uptake. This could be attributed to the effectiveness of the material in increasing the yield and soil fertility. Incorporation of organic waste enhanced N uptake in soybean grain by 6.03 % over control T1 (100-60-30). This is in line by previous works (Narayanamma et al. 1985; Sharma and Mittra 1888 ; Thanikachalam and Rangarajan 1992).

P uptake: Significant differences were noticed in uptake of P due to different treatments. The highest P content was observed under application of composted paddy straw (T7). An increase of 6.74 % for P uptake over NPK alone of T1 (100-60-30) (Table 7). This is in accordance with the finding by Sharma and Mittra (1991)

K uptake: Marked variations were observed in K uptake by soybean due to influence of the treatments. There were significant differences in K uptake among treatments. Application of inoculants and composted paddy straw showed substantially higher K uptake. The uptake of K was enhanced to the extent of 17.76 % over T1 (100-60-30). This result was also noticed by Sharma and Mittra (1990).

Table 7 : Treatmental influence on nutrient uptake of soybean grain at harvest stage (Kg/ha)

No.	Soybean (Spring- Summer)	Nutrient uptake in soybean grain		
		N	P	K
T1	100-60–30	132.7 de	7.863 cde	50.10 ab
T2	60-60-30	129.7 cde	7.670 be	49.72 ab
T3	30-60–30	114.6 ab	6.827 abc	46.56 a
T4	00-60-30	106.1 a	5.997 a	42.90 a
T5	I + 60-60-30	140.7 e	8.177 de	58.72 c
T6	I + 30-30-30	131.9 de	7.907 cde	55.7 bc
T7	C + 60-60-30	144.5 e	8.393 e	59.00 c
T8	C + 30-60-30	123.7 bcd	7.633 be	54.78 bc
T9	I + 00-00-00	115.6 abc	6.533 ab	50.51 ab
T10	C + 00-00-00	118.7 ad	6.990 ad	49.95 ab
T11	C+ I +30-60-30	130.8 de	7.467 be	55.08 bc
	LSD 5%	13.22	1.109	6.75
	CV %	6.20	8.80	7.70

C: composted paddy straw; I : Inoculants SB 83 (*Rhizobium fredii*) and SB 177 (*Bradyhrizobium sp*)
The treatment means with the same letter are not significantly different using LSD at 5%

CONCLUSION

The fertilizer dose for soybean could be recommended at the rate of 60-60-30 kg NPK / ha combined with composted paddy straw or inoculants or both composted paddy straw and inoculants which could be obtained the same yield and agronomic characteristics of soybean as well as T1 (100-60-30) which farmers have done. However, the application of organic and bio -fertilizer could be substantiated for the N inorganic fertilizer to an extent of 40 kg N ha^{-1} while the agronomic traits and grain yield of soybean were comparable to the control (conventional dose applied by farmers). The contents and uptake of soybean with reference to N, P, and K and soil available P and K were significantly improved by the application of composted paddy straw and inoculants viz., SB 83 (*Rhizobium fredii*) and SB 177 (*Bradyhrizobium sp*)

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SUMMARY IN VIETNAMESE

Nghiên cứu ảnh hưởng của bón phân hữu cơ và sinh học trên phẩm chất , năng suất và đặc tính lý hóa đất đậu nành nền đất lúa

Thí nghiệm về đậu nành luân canh với lúa được thực hiện tại xã Phước Thới thuộc huyện Ô Môn tỉnh Cần thơ với các nghiệm thức bón phân khác nhau để tìm hiểu về ảnh hưởng của phân hữu cơ và sinh học trên sinh trưởng và năng suất của đậu và đặc tính lý hóa đất do luân canh và phân bón. Kết quả thí nghiệm cho thấy cây họ đậu có đóng góp vào độ phì của đất. Bón phân hữu cơ và sinh học cho cây đậu nành có thể giảm được khoảng 40 kg N hóa học / ha trong khi đó các đặc tính nông học và năng suất của cây trồng không khác biệt với lượng phân đối chứng (nông dân). Hàm lượng đạm và hấp thu N, P, K của cây trồng và N , P hữu dụng trong đất được nâng lên một cách có ý nghĩa do bón phân vi sinh SB 83 (Rhizobium fredii) và SB 177 (Bradyhrizobium sp) so với đối chứng.
