วารสารเกษตร 8(3) 243-251 (2535)

Journal of Agriculture 8(3) : 243-251 (1992)

EFFECTS OF CATTLE MANURE, CITY GARBAGE COMPOST AND INOCULATION UPON GROWTH AND SEED YIELD OF SOYBEAN CULTIVARS GROWN ON YASOTHON SOIL SERIES

Amnuaysilpa Suksri [1]

อิทธิพลของปุ๋ยคอก ปุ๋ยเทศบาล และการคลุกเชื้อไรโซเบียมต่อการเจริญเติบโตและผลผลิตเมล็ดของถั่วเหลือง ปลูกในดินชุดยโสธร

อำนวยศิลป์ สุขศรี [1]

บทคัดย่อ : การทดลองนี้ทำการทดลองในช่วงเดือนตุลาคม-ธันวาคม 2532 โดยปลูกพืชในดินชุดยโสธรที่แปลงทดลอง คณะเกษตรศาสตร์ มหาวิทยาลัยขอนแก่น เพื่อศึกษาอิทธิพลของปุ๋ยคอก ปุ๋ยอินทรีย์เทศบาล และการคลุกเชื้อไรโซเบียมต่อการเจริญเติบโต และผลผลิตของถั่วเหลือง โดยวางแผนการทดลองเป็น RCBD มี 4 ซ้ำ ถั่วเหลืองที่ใช้ 4 สายพันธุ์ คือ สจ.4, สจ.5, KKS 19-0-1, TGX 536-O2D โดยใช้ปุ๋ยอินทรีย์เทศบาลเลขที่ 2 และปุ๋ยคอก ในอัตรา 0 และ 3,750 กก./เฮกแตร์ เมล็ดถั่วเหลืองคลุกเชื้อ *Rhizobium japonicum* ก่อนปลูก.

ผลการทดลองพบว่า น้ำหนักแห้งของลำต้นและใบ และพื้นที่ใบของถั่วเหลือง 4 พันธุ์ ได้รับอิทธิพลของการคลุกเชื้อมากที่สุด และตามด้วยอิทธิพลของปุ๋ยอินทรีย์ทั้งสองชนิด ถั่วเหลืองที่ได้รับการคลุกเชื้อและปุ๋ยอินทรีย์มีการเจริญเติบโตของลำต้น, ใบ และพื้นที่ใบ สูงกว่าค่าสำหรับที่ไม่ได้รับการคลุกเชื้อและใส่ปุ๋ยอินทรีย์ การเจริญเติบโตของลำต้นของถั่วเหลืองที่ได้รับปุ๋ยอินทรีย์เทศบาลดีกว่าปุ๋ยคอก แต่การเจริญเติบโตของใบถั่วเหลืองที่ได้รับปุ๋ยคอกดีกว่าปุ๋ยอินทรีย์เทศบาล ดัชนีพื้นที่ใบ (LAI) ของถั่วเหลืองพันธุ์ สจ.5 สูงกว่า ตามด้วย สจ.4 และ KKS 19-0-1 และต่ำสุดในพันธุ์ TGX 536-02D ดัชนีพื้นที่ใบของทุกพันธุ์มีค่าต่ำกว่า 5 ผลผลิตเมล็ดของ สจ.5 สูงที่สุด ตามด้วย KKS 19-0-1 และ สจ.4 ผลผลิตเมล็ดต่ำสุดในพันธุ์ TGX 536-O2D โดยแยกเป็น 2,631, 2,497, 2,212 และ 1,908 กก./เฮกแตร์ ตามลำดับ.

ABSTRACT : This experiment was carried out during October-December 1990 on Yasothon soil, Faculty of Agriculture, Khon Kaen University, Khon Kaen, Thailand to investigate the effect of cattle manure, city garbage compost and inoculation upon growth and seed yield of four soybean cultivars. The experiment was laid out in a Randomized Complete Block Design (RCBD) with four replications. Soybean cultivars used were: SJ 4, SJ 5, KKS 19-0-1, and TGX 536-O2D. The organic manures used were: city garbage compost number 2 and cattle manure. Each of these organic

[1] Department of Agronomy, Faculty of Agriculture, Khon Kaen University, Knon Kaen 40002, Thailand.
[1] ภาควิชาพืชไร่, คณะเกษตรศาสตร์, มหาวิทยาลัยขอนแก่น, ขอนแก่น 40002.

manures was applied at the rate of 0 and 3,750 kg/ha. Inoculation was carried out with the use of *Rhizobium japonicum*. The plants were grown on a slightly acid Yasothon soil (Oxic Paleustult).

The results showed that stem, leaf dry weights, leaf areas per plant of the four soybean cultivars were affected most by rhizobium inoculation and organic manures added to the soil. The plants received rhizobium inoculation and organic manures gave significantly greater stem, leaf dry weights, leaf areas than those without. Stem growth was promoted most by city garbage compost whilst leaf growth was promoted most by cattle manure. Leaf area indices (LAI) were highest with the SJ5 followed by the SJ4, KKS 19-0-1 and the lowest was with the TGX 536-O2D. LAI values were not exceeded 5. The maximum value of LAI for high seed yields was discussed. Seed yields were highest with the SJ5 cultivar followed by KKS 19-0-01, SJ4 and the lowest was with the TGX 536-O2D, 2,631, 2,497, 2,212, and 1,908 kg/ha., respectively.

INTRODUCTION

Soybean (*Glycine max* L.) is one of the most important cash crops for the Thai economy. Generally, the cultivation of this crop is most popular in northern region and the Central Plain areas. A number of growers found this cash crop more reliable than some other cash crops due to its attractive prices in the market. Nevertheless, the amount of seed yields obtained in each year seems more or less inadequate supply. Although a number of reliable cultivars are available in the country e.g. SJ4, SJ5 and etc. This could possibly be due to the lack of wide-spreading technologies transferred to growers and perhaps to the less amount of published data available. Only just this decade that growers of soybean in Northeast Thailand have come across with this cash crop due to the high demand of seeds in the market. However, the cultivation of the crop on Northeast soils is not relatively simple due to the poor soil physico-chemical properties as a result of poor soil management during the past few decades. Therefore, it would be of imperative significance to carry out some experiments on this particular cash crop concerning growth and seed yield with respect to some soil amendment materials and also the manageable rhizobium inoculation. A number of published works has been advocated e.g. Vangnai and Niamsrichand (1979), Vangnai (1980), Henzell (1988), and Suksri *et al.* (1990).

MATERIALS AND METHODS

The experiment was carried out by means of sprinkler irrigation at the Experimental Farm, Faculty of Agriculture, Khon Kaen Univesity, Khon Kaen, Thailand during October, 1990-February, 1991. The experiment was laid in a 5 x 4 factorial arranged in a randomized complete block with four replications. The organic materials used were cattle manure and city garbage compost number 2. Each of these materials was used at the rates of 0 and 3,750 kg/ha. with and without inoculation *(Rhizobium japonicum)* for both organic materials (cf. Dept. of Agriculture). The soybean cultivars used were : SJ4, SJ5, KKS 19-0-1 and TGX 536-02D. The plants were grown on an acid Yasothon soil (Oxic Paleustult). The initial soil property values for pH, organic matter, total N, available P, exchangeable K were : 5.8%, 0.8%, 0.04%, 15 ppm, 28 ppm, respectively (Jackson, 1973). The soil used was ploughed twice followed by harrowing once. The plot size used was a 3 x 5 m. and the distances used were: 30 x 10 cm. between rows and within the row, respectively. Soybean seeds of the four cultivars were sown directly into the soil with and without inoculation where appropriate at the rate of 3-4 seeds per hill followed by the application of chemical fertilizer 12-24-12 (NPK) at the rate of 94 kg/ha. as basal dressing. The application of a herbicide (Lasso) was carried out after sowing of seeds. One week after emergence, seedlings were removed leaving only seedling per hill and organic manures were also applied to the plants. Irrigation water was given twice a week at the rate of approximately 56.25 m^3/hour (2-hour/week). Weeding was carried out twice by hand and the application of insecticide (Azodrin) was done three times throughout the experimental period. The technique of growth analysis (Sestak *et al.* 1971) was used to measure the changes in growth of the aerial plant parts. The plant samples were taken at days 63 and 77 after emergence. At each harvest, 9 plant samples were taken from each replication and 100 plants for the final seed yield. Leaf areas were measured by Leaf Area Meter (Model no.AAC-400, Hayashi Denko Co., Ltd., Japan). The plant materials were dried in an oven at 80 °C for four days and then weighed out for dry weights. The data obtained were statistically analyzed.

RESULTS AND DISCUSSION

The results of stem dry weights at day 63 after emergence showed that stem dry weights were significantly highest with the SJ5 variety followed by SJ4, KKS 19-0-1 and the lowest was with the TGX 536-O2D (Table 1). The results suggested that SJ5 has its imperative potential for growth in this slightly acid soil type. The effect due to variety x manure was less. The results did not totally agree with the work of Suksri *et al.* (1990) which they suggested the effect of photoperiod was more pronounced and reduced sizes of the plants at this season particularly vegetative growth. Therefore, it is relatively possible to grow soybean crops during the cold or dry seasons of the year provided that nutrients and water are adequately available for the crop plants. The initial values of soil physico-chemical properties were relatively higher than their soil (Suksri *et al.*, 1990) although the soil used belongs to the same series but different location. Rhizobium inoculation also has a large effect on stem growth. The plants received inocultion, in all cases, possessing greater stem dry weights than those without.

Table 1. Stem dry weights per plant (gm) of soybean cultivars as influenced by organic manures and inocculation at days 63 and 77 after emergence.

Varieties	Treatments					
	City garbage compost			Cattle manure		
	0	Uninoc.	Inoc.	Uninoc.	Inoc.	Mean
SJ4	7.43	11.02	10.61	9.47	12.29	10.16
SJ5	9.98	9.05	12.74	11.99	12.42	11.24
KKS 19-0-1	9.16	10.31	9.76	9.39	11.66	10.06
TGX 536-O2D	7.99	7.54	6.57	6.57	7.96	7.73
Mean	8.64	9.48	10.42	9.36	11.08	
LSD(0.05)	Variety = 1.45		Manure = ns		Variety x Manure = ns	
	At day 77 after emergence					
SJ4	4.17	6.37	6.01	7.33	7.27	6.23
SJ5	5.74	5.70	6.71	6.17	8.28	6.52
TGX 536-O2D	3.56	5.26	4.63	4.62	5.07	4.62
Mean	4.72	5.64	6.24	6.06	6.87	
LSD(0.05)	Variety = 0.95		Manure = 1.00		Variety x Manure = ns	

At day 77, the results showed that application of manures has their significant effect on stem growth of soybean cultivars apart from inoculation and varieties used. Therefore, growing soybean crops, manures and inoculation are always required for this soil type. The results also showed that TGX 536-02D gave less amount of stem growth. This perform better at high degree of soil acidity (pH 4.5-5.5).

For leaf dry weights at day 63, the results showed that leaf dry weights were highest with the SJ5 followed by KKS 19-0-1, SJ4 and the lowest was with the TGX 536-02D. City garbage manure treated plants gave higher leaf dry weights than those treated with cattle manure (Table 2). This can be attributed to the higher amount of Ca of city garbage compost than that of the cattle manure, which were 15.46% and 1.84%, respectively. High amount of Ca obviously assists better growth of nodulation. Nevertheless, all plants treated with manures gave significantly greater leaf dry weights than those without. The results agree with the work reported by Lowther and Loneragan (1968) and Suksri (1990). However, with the results at day 77, the same pattern was not found. This can be attributed to the falling off of leaves due to leaf senescence which was more repid with those treated with city garbage compost than cattle manure. The results suggested that cattle manure contented greater amount of N than that of the city garbage compost hence prolonged life of leaves of those treated with cattle manure.

With leaf areas at day 63, the results indicated that leaf areas were highest with the SJ5 followed by SJ4, KKS 19-0-1 and the lowest was with the TGX 536-02D (Table 3). The effect due to inoculation was somewhat inconsistently shown. This can be attributed to the differences in the amount of Ca of the manures discussed earlier. On the contrary, the results of day 77 revealed that leaf areas were greater for those treated with cattle manure than that of the city garbage compost. The reason for this could possibly be due to the differences of N as discussed previously.

Table 2. Leaf dry weights per plant (gm) of soybean cultivars as influenced by organic manures and inoculation at days 63 and 77 after emergence.

Varieties	Treatments					
	City garbage compost			Cattle manure		
	0	Uninoc.	Inoc.	Uninoc.	Inoc.	Mean
SJ4	3.57	4.74	3.80	4.28	5.50	4.38
SJ5	4.46	4.16	5.93	5.35	5.56	5.09
KKS 19-0-1	4.39	4.91	4.58	4.38	5.37	4.73
TGX 536-O2D	3.72	3.58	4.05	3.18	3.91	3.69
Mean	4.04	4.34	4.59	4.30	5.09	
LSD (0.05)	Variety = 0.62		Manure = 0.69		Variety x Manure = ns	
	At day 77 after emergence					
SJ4	1.74	1.75	2.27	2.67	2.32	2.15
SJ5	1.85	1.84	2.64	1.83	2.89	2.21
KKS 19-0-1	2.18	1.96	3.14	5.66	2.69	3.13
TGX 536-O2D	1.10	1.77	1.89	1.55	1.76	1.61
Mean	1.72	1.83	2.49	2.93	2.42	
LSD (0.05)	Variety = 1.00		Manure = ns		Variety x Manure = ns	

Table 3. Leaf areas per plant (cm^2) of soybean cultivated as influenced by organic manure and inoculation at days 63 and 77 after emergence.

Varieties	Treatments					
	City garbage compost			Cattle manure		
	0	Uninoc.	Inoc.	Uninoc.	Inoc.	Mean
SJ4	9,062	12,139	13,139	11,523	14,814	12,232
SJ5	11,537	10,674	15,505	14,291	13,335	13,032
KKS 19-0-1	9,535	11,464	11,849	11,025	12,129	11,200
TGX 536-O2D	9,584	10,079	11,210	8,816	2,367	8,411
Mean	9,884	11,210	12,925	11,413	10,661	
LSD (0.05)	Variety = 1718		Manure = 192		Variety x Manure = 3842	
	At day 77 after emergence					
SJ4	5,058	5,374	5,829	7,341	7,785	6,277
SJ5	4,527	4,964	9,018	5,366	9,417	6,658
KKS 19-0-1	4,839	7,653	10,272	8,470	8,624	7,971
TGX 536-O2D	4,073	5,381	5,679	5,106	6,061	5,260
Mean	4,624	5,843	7,699	6,570	7,971	
LSD (0.05)	Variety = 1,227		Manure = 1,372		Variety x Manure = ns	

For leaf area indices (LAI) at day 63, the results showed that the values of LAI were affected most by variety i.e. the SJ5 gave the highest LAI values followed by SJ4, KKS 19-0-1 and the lowest was with the TGX 536-O2D (Table 4). However, the values of LAI did not exceed 5, therefore, LAI values were not up to maximum for growth and light interception which should be at the level of 6. The results indicated that there were no shaded leaves among the canopies. The results also indicated that leaf growth was maximum only up to day 63 after emergence and later declined with time to seed maturity. If LAI value reaching the value of 6 by adjusting distances used between rows and within the row, for this experiment, the distances used should be 20 x 8 cm. between rows and within the row, respectively and the seed yield should reach the value of 3,553 kg/ha. This LAI value should provide 90-95% light interception among the canopies. However, if the growth is to be carried out in rainy season with cloudy sky most of the time, the distances used should be widen again since less total energy in rainy season is inadequately provided. The suitable value of LAI could obviously provide the tendency to increase the plant population per unit area of land hence increases seed yields of the crop plants (Safo-Kantanka and Lawson, 1980, and Siriprasert, 1981).

Table 4. Leaf area indices (LAI) of soybean cultivars as influenced by organic manure and inoculation at days 63 and 77 after emergence.

Varieties	Treatments					
	City garbage compost			Cattle manure		
	0	Uninoc.	Inoc.	Uninoc.	Inoc.	Mean
SJ4	3.36	4.68	4.87	4.27	5.49	4.53
SJ5	4.21	3.95	5.74	5.29	4.94	4.83
KKS 19-0-1	3.53	4.25	4.39	4.08	4.49	4.15
TGX 536-O2D	3.55	3.73	4.15	3.27	0.88	3.12
Mean	3.66	4.15	4.79	4.23	3.95	
	At day 77 after emergence					
SJ4	1.87	1.99	2.16	2.72	2.88	2.32
SJ5	1.68	1.84	3.34	1.99	3.49	2.47
KKS 19-0-1	1.79	2.83	3.80	3.14	3.19	2.95
TGX 536-O2D	1.51	1.99	2.10	1.89	2.24	1.95
Mean	1.71	2.16	2.85	2.44	2.95	

With pod dry weights and the final seed yields, the results showed that the effect of inoculation was relatively large, inoculated plants gave consistently better pod dry weights than those without (Table 5). The SJ5 gave the highest pod dry weights in both harvests (days 63 and 77) followed by the KKS 19-0-1, SJ4 and the lowest was with the TGX 536-O2D. This pattern of pod dry weights also reflected the amount of final seed yields/ha. i.e. the final seed yield was highest with SJ5 followed by KKS 19-0-1, SJ4 and the least was with the TGX 536-O2D. Seed yields were : 2,631, 2,497, 2,212 and 1,908 kg/ha., respectively. Seed yields were influenced most by inoculation. Cattle manure treated plants gave slightly higher seed yields than those treated with city garbage compost. This can presumable be due to the differences in the amount of nutrients contented in both sources of organic manures which might be greater for the cattle manure than that of the city garbage compost.

Table 5. Pod dry weights per plant (gm) of soybean cultivars at days 63 and 77 after emergence as influenced by organic manures and inoculation.

Varieties	Treatments					
	City garbage compost			Cattle manure		
	0	Uninoc.	Inoc.	Uninoc.	Inoc.	Mean
SJ4	4.89	7.45	8.86	5.97	8.54	7.14
SJ5	6.37	6.04	8.97	7.96	8.75	7.62
KKS 19-0-1	6.92	6.92	7.74	6.43	8.38	7.22
TGX 536-O2D	5.65	5.80	6.81	4.71	6.29	5.85
Mean	5.96	6.55	8.01	6.27	7.99	
LSD (0.05)	Variety = 1.11		Manure = 1.24		Variety x Manure = ns	
	At day 77 after emergence					
SJ4	9.08	12.55	13.21	8.65	15.51	11.80
SJ5	12.37	12.59	14.40	12.20	16.36	13.58
KKS 19-0-1	11.15	10.58	15.45	11.59	13.37	12.43
TGX 536-O2D	8.59	10.17	10.29	10.53	11.47	10.21
Mean	10.29	11.47	13.34	10.74	14.18	
LSD (0.05)	Variety = 1.78		Manure = 1.99		Variety x Manure = ns	
	Final seed yields (kg/ha.)					
SJ4	1,494	1,751	2,968	1,998	2,853	2,212
SJ5	2,271	2,470	3,124	1,974	3,318	2,631
KKS 19-0-1	2,130	2,321	2,634	2,227	3,175	2,497
TGX 536-O2D	1,840	1,652	2,119	1,701	2,228	1,908
Mean	1,934	2,049	2,711	1,975	2,893	
LSD (0.05)	Variety = 238		Manure = 266		Variety x Manure = ns	

ACKNOWLEDGEMENTS

The author wishes to thank Dr. Sanit Luadtong for the KKS 19-0-1 and TGX 536-O2D cultivars and Mr. Komson Leclakakit for statistical calculation carried out.

REFERENCES

Henzell, E.F. (1988). The role of biological nitrogen fixation research in solving problems in tropical agriculture. Plant and Soil. 108:15-21.

Jackson, M.L. (1973). Soil chemical analysis. Prentice Hall of India Private Limited, New Delhi.

Lowther, W.L. and Loneragan, J.F. (1968). Calcium and nodulation in subterranean clover (*Trifolium subtrrancum* L.) Plant Physiol. 43:1362-1366.

Safo-kantanka, O. and Lawson, N.C. (1980). The effect of different row spacings and plant arrangement on soybeans. Can. J. Plant Sci. 60:227-231.

Siriprasert, R. (1981). A study on reproductive growth of soybean (an MS Agri. Thesis) Kasetsart University, Bangkok (in Thai with English abstract).

Sestak, Z., Catsky, J. and Jarvis, P.G. (1971). Plant Photosynthetic Production, Manual of Methods Dr. Junk, N.V. Publ. The Hague.

Suksri, A., Seripong, S. and Terapongtanakorn, S. (1990). Effects of organic manures and inoculation on growth and yield of off season soybean cultivars grown on an acid soil. Thai Agric. Res. J. 8:43-49.

Vangnai, S. and Niamsrichand, P. (1979). Effects of adhesives on nodulation by Rhizobium japonicum. The Kasetsart J. 13(1-2):1-7.

Vangnai, S. (1980). Research on the use of Rhizobium for improving soybean yield in Thailand. The Kasetsart J. 14(1):26-33.