*As. J. Food Ag-Ind.* **2009**, *Special Issue*, S197-S204

GO ORGANIC 2009 BANGKOK, THAILAND

*Asian Journal of Food and Agro-Industry*
**ISSN 1906-3040**
Available online at www.ajofai.info

# Fertilizers for organic sesame

**Pornparn Suddhiyam[1]*, Siree Suwannaketnikom[2], Wimolrat Dumkhum[1] and Nongnuch Duandao[1]**

[1]Chiang Mai Field Crops Research Centre, Nong Harn, Sansai, Chiang Mai 50290 Thailand.

[2]Office of Agricultural Research and Development Region 1, P.O.Box 170, Chiang Mai University Post Office, Muang, Chiang Mai 50202 Thailand.

*Author to whom correspondence should be addressed, email: pornparnsudd@yahoo.com

This article was originally presented at the International Symposium "GoOrganic2009", Bangkok, Thailand, August 2009.

---

## Abstract

In order to find out the appropriate organic fertilizers for organic sesame production in paddy and upland areas, two experiments were carried out at two sites in Chiang Mai Field Crops Research Centre in 2006-2008. A split plot design with 2 main plots, 4 subplots each and 4 replications was used. The main plots were 2 production systems, organic and integrated conventional far apart, and subplots were 4 types of organic fertilizer which consisted of 1) green manure (*Sesbania rostrata* at 30 kg/ha seeding rate) 2) EM compost (bogachi) 940 kg/ha 3) cow manure 6.25 tons/ha and 4) no fertilizer (control). Fruit and herbal bio-extracts, at the ratio of water, 1: 200, were sprayed at the same time every 7 days (from 10-70 days after sowing) in organic system. In conventional system, chemical fertilizer 16-16-8 at 156 kg/ha was applied in all treatments except control and insecticides were used if needed for all treatments. The plots were covered with rice straw after planting. The planting date for paddy plot was in February and for upland was in July. The results showed that sesame yields were not significantly different because of the organic fertilizer, production system and their interaction in each of three years for both paddy and upland areas. In other words, green manure (*Sesbania rostrata*), EM compost and cow manure could be used for organic sesame production. They provided average seed yield of 354 (transition period), 84 and 446 kg/ha in paddy area and 894 (transition period), 728 and 988 kg/ha in the upland area 2006, 2007 and 2008, respectively. All three organic fertilizers affected in improved pH (from 5.7 to 6.0-6.5), higher organic matter (from 1.39 to 2.24-2.55%), improved P, K, other minor elements and higher microbial biomass carbon.

**Keywords :** organic sesame; fertilizer; compost; Sesbania

## Introduction

Sesame is one of the most valuable oilseed crops due to the special quality and oil in the seeds for human health. The seed is consumed as a source of calcium and potassium. The oil contains high content of antioxidants, such as sesamin and sesamolin, preventing it going rancid. It also provides mono-unsaturated fatty acid (oleic acid) and polyunsaturated fatty acid (linoleic acid). It is used in pharmaceutical and cosmetic industries, spa and health food. Therefore clean and safe seed from residues is essential for these industries. There has not being any study in organic sesame production.

Sesame is normally grown before rice in the paddy and upland areas in the Central, lower and upper Northern parts of Thailand. Overall sesame production area of the country is about 65,440 ha (Office of Agricultural Economics, 2007). Conventional practices have mostly been practiced. However, sesame plant does not respond much to the high level of chemical fertilizers. The proportion of major nutrients needed is 25-25-12.5 kg/ha of $N$-$P_2O_5$-$K_2O$. There appeared to be some pesticide contamination in the local product and inappropriate post harvest technology in farmer level, causing low seed quality.

Organic farming is an alternative agriculture providing quality and safe products and environment as synthetic chemical fertilizers and pesticides are not allowed. Soil improvement with green manure, compost and animal manure including pest control with natural management, such as bio-extract application, are the main practices needed. According to the standards, the land should be left without any chemical treatment for at least 1 year before producing organically for annual crops (DOA, 2006). This study was conducted to investigate the effects of organic fertilizers in improving the soil and productivity of sesame by comparing organic and integrated conventional systems under two conditions, paddy and upland.

## Materials and Methods

The experimental design was a split plot with 4 replications. The main plot was 2 levels of crop production system, organic and integrated conventional cropping sited far apart. Subplot was 4 levels of organic which were 1) green manure (*Sesbania rostrata* at fertilizer, 30 kg/ha seeding) 2) EM compost (or "bogachi" composed of cow manure, rice husk, rice bran, molass, EM) 940 kg/ha (Pichet, 2004) 3) dry cow manure 6.25 tons/ha and 4) no fertilizer (control). Plot size was 3 x 5 $m^2$, harvested area was 2 x 4 $m^2$ and plant spacing of 50 x 10 cm was applied. Small ridges were made between each treatment. The treatments were ploughed into the soil not less than 15 days before planting. White seeded sesame variety Ubon Ratchathani 2 (90 day maturity) was used. In organic system, fruit (banana + pumpkin + papaya + molass + EM) and herbal (*Azadiracta indica* + eucalyptus + galanga + Tinospora sp. + molass + EM) bio-extracts, at the ratio of water 1:200, (Pichet, 2004) were sprayed at the same time every 7 days starting from 10 to 70 days after planting. In conventional system, chemical fertilizer 16-16-8 at 156 kg/ha was applied in all treatments except control and insecticides were used if needed. The plots were covered with rice straw after planting to control weeds and maintain moisture for both main plots. The experiments were carried out in 2 conditions, paddy (planted in February) and upland areas (planted in July) at Chiang Mai Field Crops Research Centre in 2006-2008 (the first year was transition period for organic system). Seed yield, soil microbial biomass carbon and chemical properties before planting and after harvesting were determined.

## Results and Discussion

*Paddy Condition*

The results showed that sesame seed yield was not significantly different according to the organic fertilizer, production system and there was no interaction between the two factors for all three years. The average yield was 353.8, 83.8 and 446.3 kg/ha in 2006, 2007 and 2008, respectively (Table 1). This indicated that green manure (*Sesbania rostrata*), EM compost and cow manure could be used in organic sesame production. It could also be seen that organic system provided as high yield as integrated conventional or chemical system in the last 2 years. The cause of low yield in 2007 was due to continuously heavy rains during the growing season and the field drained slowly as it is in the paddy condition.

Soil microbial biomass carbon was improved after applying organic fertilizers and decreased after harvest for both systems but overall it increased after the third year (from 180-353 to 584-722 mg C/kg of soil) (Figure 1). Soil chemical properties were improved gradually as seen in the third year (Table 2). Soil pH was higher in the 3$^{rd}$ year (2008) for both organic and conventional systems, from 5.7 to the range of 6.0-6.5 and from 5.4 to the range of 6.1-6.3, respectively. Soil organic matter (%OM) was also higher for all treatments in both systems, from 1.39% to 2.24-2.55% in organic and from 1.39% to 2.41-3.12% in conventional system. Available P (suitable level is 26-42 mg/kg) was higher for all treatments in both systems as well, from 29 to 38-68 mg/kg in organic and from 48 to 51-82 mg/kg in conventional. Extractable K in organic system was higher from 70 to 73-195 mg/kg but in conventional it decreased from 104 to 80-97 mg/kg except for cow manure treatment of which increased to 195 mg/kg for both systems (suitable level is 130 mg/kg). Calcium, magnesium, iron, manganese, zinc, copper and boron tended to be near the adequate level for the crop.

*Upland Condition*

Sesame yield was not significantly different due to the types of organic fertilizer, production system and there was no interaction in all 3 years. Average yield was 893.8, 727.5 and 988.1 kg/ha in 2006, 2007 and 2008, respectively (Table 3). However, the higher yield trend could be seen in the third year especially in organic system. All three organic fertilizers could be used in organic sesame production in the upland area and gave the same results.

As in the paddy condition, soil microbial biomass carbon was improved after applying organic fertilizers and decreased after harvest for both systems but overall after the third year it was somewhat the same as the beginning (224-295 mg C/kg of soil) (Figure 2). Soil chemical properties were slightly improved which could be seen in the third year (Table 4). The possible reason was the slope of the experimental area. Soil pH was a little higher in the 3rd year for both systems, from 5.6 to the range of 5.7-5.9. Soil organic matter (%OM) decreased in all treatments for both systems, from 1.39 to 0.80-1.37% in organic and from 0.98 to 0.50-0.67% in conventional system, except *Sesbania* treatment in organic system which was higher (1.61%). Available P decreased towards the optimum level (26-42 mg/kg) but extractable K decreased markedly after the third year. Calcium, magnesium, manganese, zinc, copper and boron also decreased and were lower than the optimum levels even at the beginning of the experiment. In case of the sloping area, legume green manure should be more introduced in the cropping system and soil erosion protecting grass, such as *Vetiver* sp., should be sown.

**Table 1:** White seeded sesame (cv. Ubon Ratchathani 2) yield after applying with 4 levels of organic fertilizer in organic and integrated conventional systems (paddy, CMFCRC, 2006-2008)

| Treatments | Yield (kg/ha) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2006 | | | 2007 | | | 2008 | | |
| | Org | Chem | aver | Org | Chem | aver | Org | Chem | aver |
| 1. *Sesbania* sp. | 224.4 | 393.8 | 308.8 | 68.8 | 126.9 | 97.5 | 267.5 | 343.1 | 305.6 |
| 2. EM compost | 181.9 | 547.5 | 365.0 | 85.6 | 36.3 | 60.6 | 411.9 | 408.1 | 410.0 |
| 3. Cow manure | 225.6 | 483.1 | 354.4 | 103.8 | 100.6 | 101.9 | 500.0 | 743.8 | 621.9 |
| 4. No fertilizer | 226.9 | 545.0 | 385.6 | 78.8 | 70.6 | 74.4 | 453.1 | 441.3 | 447.5 |
| Aver. | 215.0 | 492.5 | **353.8** | 84.4 | 83.1 | **83.8** | 408.1 | 483.8 | **446.3** |
| CV(a) % | | 90.9 | | | 133.3 | | | 61.7 | |
| CV(b) % | | 68.4 | | | 56.3 | | | 48.8 | |

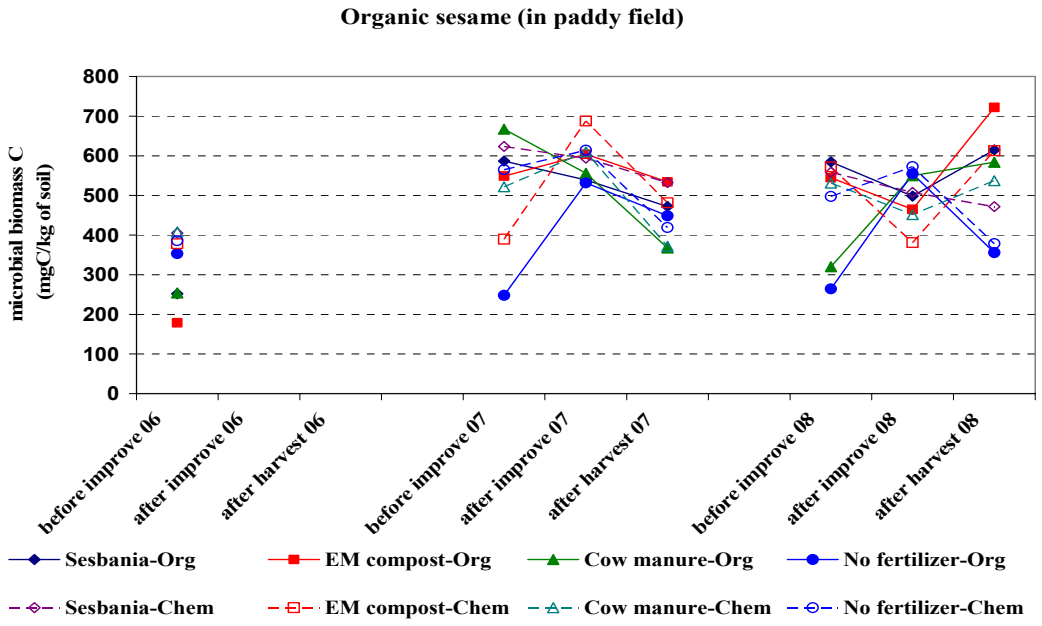


**Figure 1:** Soil microbial biomass carbon after applying with 4 levels of organic fertilizer in organic and integrated conventional systems (paddy, CMFCRC, 2006-2008)

**Table 2:** Change in soil chemical property between the first (2006) and third year (2008) from 4 different treatments in 2 production systems (paddy, CMFCRC).

| | pH | | %OM | | P (mg/kg) | | K (mg/kg) | | Ca (mg/kg) | | Mg (mg/kg) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **2006** | **2008** | **2006** | **2008** | **2006** | **2008** | **2006** | **2008** | **2006** | **2008** | **2006** | **2008** |
| Organic | | | | | | | | | | | | |
| *Sesbania* sp. | 5.7 | 6.0 | 1.39 | 2.34 | 29 | 38 | 70 | 75 | 1,140 | 1,178 | 102 | 94 |
| EM compost | 5.7 | 6.1 | 1.39 | 2.24 | 29 | 48 | 70 | 73 | 1,140 | 1,132 | 102 | 87 |
| cow manure | 5.7 | 6.4 | 1.39 | 2.55 | 29 | 68 | 70 | 195 | 1,140 | 1,221 | 102 | 127 |
| no fertilizer | 5.7 | 6.5 | 1.39 | 2.48 | 29 | 36 | 70 | 74 | 1,140 | 1,183 | 102 | 92 |
| Chemical | | | | | | | | | | | | |
| *Sesbania* sp. | 5.4 | 6.3 | 1.39 | 2.65 | 48 | 51 | 104 | 98 | 984 | 1,123 | 84 | 94 |
| EM compost | 5.4 | 6.1 | 1.39 | 2.55 | 48 | 57 | 104 | 80 | 984 | 1,196 | 84 | 92 |
| cow manure | 5.4 | 6.2 | 1.39 | 3.12 | 48 | 82 | 104 | 195 | 984 | 1,218 | 84 | 146 |
| no fertilizer | 5.4 | 6.1 | 1.39 | 2.41 | 48 | 59 | 104 | 97 | 984 | 1,102 | 84 | 90 |

| | Fe (mg/kg) | | Mn (mg/kg) | | Zn (mg/kg) | | Cu (mg/kg) | | B (mg/kg) | | EC (mS/cm) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **2006** | **2008** | **2006** | **2008** | **2006** | **2008** | **2006** | **2008** | **2006** | **2008** | **2006** | **2008** |
| Organic | | | | | | | | | | | | |
| *Sesbania* sp. | 209 | 113 | 16 | 23 | 0.8 | 0.4 | 2.0 | 1.3 | 0.1 | 0.7 | 0.05 | 0.02 |
| EM compost | 209 | 114 | 16 | 18 | 0.8 | 0.3 | 2.0 | 1.3 | 0.1 | 0.7 | 0.05 | 0.02 |
| cow manure | 209 | 88 | 16 | 18 | 0.8 | 0.5 | 2.0 | 1.1 | 0.1 | 0.4 | 0.05 | 0.05 |
| no fertilizer | 209 | 71 | 16 | 13 | 0.8 | 0.3 | 2.0 | 1.0 | 0.1 | 0.8 | 0.05 | 0.03 |
| Chemical | | | | | | | | | | | | |
| *Sesbania* sp. | 245 | 130 | | 12 | | 0.4 | | 1.5 | | 0 | | 0.02 |
| EM compost | 245 | 164 | | 16 | | 0.5 | | 1.7 | | 0.8 | | 0.03 |
| cow manure | 245 | 90 | | 11 | | 0.7 | | 1.2 | | 0.4 | | 0.06 |
| no fertilizer | 245 | 143 | | 20 | | 0.4 | | 1.4 | | 0.7 | | 0.04 |

**Note:** Optimum level: P – 26-42 mg/kg; K – 130 mg/kg; Ca – 1,040 mg/kg; Mg – 135 mg/kg; Fe – 11-16 mg/kg; Mn – 9-12 mg/kg; Zn – 0.9-1.2 mg/kg; Cu – 0.6-1.2 mg/kg; B – 0.9-3.0 mg/kg

**Table 3:** White seeded sesame (cv. Ubon Ratchathani 2) yield after applying with 4 levels of organic fertilizer in organic and integrated conventional systems (upland, CMFCRC, 2006-2008)

| Treatments | Yield (kg/ha) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2006 | | | 2007 | | | 2008 | | |
| | **Org** | **Chem** | **aver** | **Org** | **Chem** | **aver** | **Org** | **Chem** | **aver** |
| 1. *Sesbania* sp. | 711.3 | 1,015.6 | 863.8 | 726.9 | 735.6 | 731.3 | 1,104.4 | 943.1 | 1,023.8 |
| 2. EM compost | 708.1 | 1,118.1 | 913.1 | 673.8 | 703.8 | 688.8 | 907.5 | 936.9 | 921.9 |
| 3. Cow manure | 766.9 | 1,109.4 | 938.1 | 718.8 | 870.0 | 794.4 | 947.5 | 975.6 | 961.3 |
| 4. No fertilizer | 724.4 | 994.4 | 859.4 | 711.3 | 678.8 | 695.0 | 1,260.0 | 833.1 | 1,046.3 |
| Aver. | 727.5 | 1,059.4 | **893.8** | 707.5 | 746.9 | **727.5** | 1,054.4 | 922.5 | **988.1** |
| CV(a) % | | 46.6 | | | 36.1 | | | 49.8 | |
| CV(b) % | | 17.4 | | | 19.2 | | | 19.8 | |

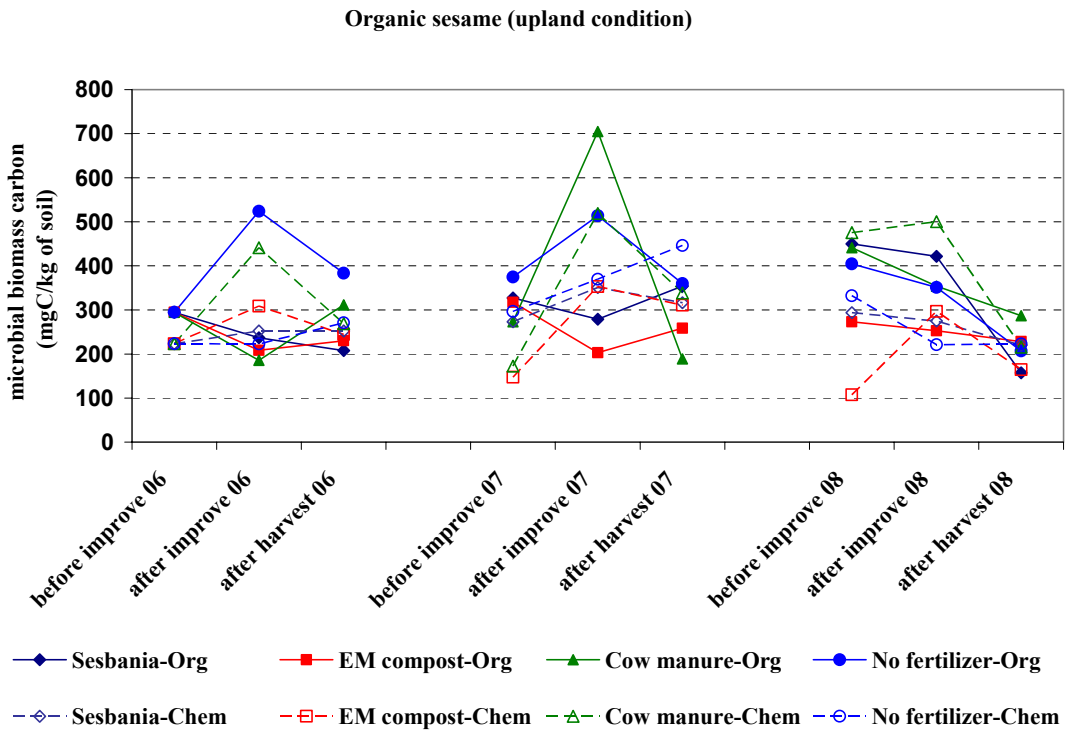


**Figure 2:** Soil microbial biomass carbon after soil improvement with 4 levels of organic fertilizer in organic and integrated conventional systems (upland condition, CMFCRC, 2006-2008)

**Table 4:** Change in soil chemical property between the first (2006) and third year (2008) from 4 different treatments in 2 production systems (upland, CMFCRC).

| | pH | | %OM | | P (mg/kg) | | K (mg/kg) | | Ca (mg/kg) | | Mg (mg/kg) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2006 | 2008 | 2006 | 2008 | 2006 | 2008 | 2006 | 2008 | 2006 | 2008 | 2006 | 2008 |
| **Organic** | | | | | | | | | | | | |
| *Sesbania* sp. | 5.6 | 5.7 | 1.39 | 1.61 | 65 | 41 | 131 | 54 | 585 | 684 | 50.1 | 41.0 |
| EM compost | 5.6 | 5.9 | 1.39 | 0.80 | 65 | 35 | 131 | 61 | 585 | 553 | 50.1 | 36.6 |
| cow manure | 5.6 | 5.8 | 1.39 | 1.07 | 65 | 57 | 131 | 68 | 585 | 453 | 50.1 | 43.9 |
| no fertilizer | 5.6 | 5.8 | 1.39 | 1.37 | 65 | 43 | 131 | 46 | 585 | 562 | 50.1 | 29.1 |
| **Chemical** | | | | | | | | | | | | |
| *Sesbania* sp. | 5.6 | 5.8 | 0.98 | 0.60 | 53 | 45 | 90 | 75 | 384 | 371 | 34.6 | 30.7 |
| EM compost | 5.6 | 5.8 | 0.98 | 0.67 | 53 | 56 | 90 | 55 | 384 | 341 | 34.6 | 28.7 |
| cow manure | 5.6 | 5.8 | 0.98 | 0.50 | 53 | 50 | 90 | 88 | 384 | 242 | 34.6 | 31.1 |
| no fertilizer | 5.6 | 5.7 | 0.98 | 0.57 | 53 | 39 | 90 | 50 | 384 | 304 | 34.6 | 23.3 |

| | Fe (mg/kg) | | Mn mg/kg) | | Zn (mg/kg) | | Cu (mg/kg) | | B (mg/kg) | | EC (mS/cm) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2006 | 2008 | 2006 | 2008 | 2006 | 2008 | 2006 | 2008 | 2006 | 2008 | 2006 | 2008 |
| **Organic** | | | | | | | | | | | | |
| *Sesbania* sp. | 29.5 | 26.1 | 14.9 | 11.1 | 0.63 | 0.36 | 0.28 | 0.32 | 0.04 | 0.77 | 0.035 | 0.015 |
| EM compost | 29.5 | 28.3 | 14.9 | 13.8 | 0.63 | 0.23 | 0.28 | 0.31 | 0.04 | 0 | 0.035 | 0.013 |
| cow manure | 29.5 | 38.7 | 14.9 | 9.76 | 0.63 | 0.58 | 0.28 | 0.32 | 0.04 | 0 | 0.035 | 0.016 |
| no fertilizer | 29.5 | 35.7 | 14.9 | 9.23 | 0.63 | 0.36 | 0.28 | 0.30 | 0.04 | 0.57 | 0.035 | 0.010 |
| **Chemical** | | | | | | | | | | | | |
| *Sesbania* sp. | 29.7 | 39.2 | 22.2 | 23.7 | 0.52 | 0.25 | 0.30 | 0.29 | 0.12 | 0.36 | 0.018 | 0.013 |
| EM compost | 29.7 | 24.3 | 22.2 | 14.3 | 0.52 | 0.27 | 0.30 | 0.22 | 0.12 | 0.37 | 0.018 | 0.014 |
| cow manure | 29.7 | 30.4 | 22.2 | 18.0 | 0.52 | 0.32 | 0.30 | 0.26 | 0.12 | 0.57 | 0.018 | 0.020 |
| no fertilizer | 29.7 | 33.8 | 22.2 | 21.6 | 0.52 | 0.24 | 0.30 | 0.30 | 0.12 | 0 | 0.018 | 0.009 |

**Note:** Optimum level: P – 26-42 mg/kg; K – 130 mg/kg; Ca – 1,040 mg/kg; Mg – 135 mg/kg; Fe – 11-16 mg/kg; Mn – 9-12 mg/kg; Zn – 0.9-1.2 mg/kg; Cu – 0.6-1.2 mg/kg; B – 0.9-3.0 mg/kg

## Conclusions

*Sesbania rostrata* (30 kg seed /ha), EM compost (940 kg/ha) and dry cow manure (6.25 t/ha) could be used effectively in organic sesame production as they provided equally high seed yield as in conventional systems in both paddy and upland conditions. The average yield was 353.8, 83.8 and 446.3 kg/ha for paddy and 893.8, 727.5 and 988.1 kg/ha for upland condition in 2006, 2007 and 2008, respectively. Soil microbial biomass carbon and chemical properties of the experimental plots were improved after 3 years of organic fertilizer application in both paddy and upland conditions.

## References

DOA. (2006). Thai Organic Standard. Department of Agriculture, Ministry of Agriculture and Cooperatives, October 2000. Agricultural Cooperatives Community of Thailand Printing Limited. Bangkok. 30 p. (in Thai)

Office of Agricultural Economics. (2007). Agricultural Statistics of Thailand. Center of Agricultural Information, Office of Agricultural Economics. 169 p. (CD in Thai)

Pichet Visaijorn. (2004). Sufficiency Economic: The Presentation for the Visit of the President of Love Thailand Foundation, Prem Tinsulanon at Ubon Ratchathani Sufficiency Economic Project. People Co. Ltd. 66 p. (in Thai)