Kasetsart J. (Nat. Sci.) 38 : 31 - 37 (2004)

# Effects of Organic Manures on Production of Lettuce (*Lactuca sativa* L.) in Reference to Chemical Fertilizer

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## ABSTRACT

The effect of three types of organic manures, its combination within and with chemical fertilizer was studied under the nylon net house. A lettuce cultivar of 'Green Fancy' was grown during December, 2002, February and April 2003. The same amount of nitrogen from organic manures and chemical fertilizers was applied to the experimental plots for each crop. Cow dung (CD), chicken manure (CM) and duck manure (DM) were applied 4.5, 4.7 and 5.8 t/ha, respectively, contributing 81 kg nitrogen each. In the case of combination treatments each combination contributed 1:1 ratio of nitrogen. A treatment with recommended dose of chemical fertilizer (CF) providing 81 kg nitrogen was also included. The crop grown with 4.7 t/ha of CM alone and its combination with CF (2.35 ton CM plus 156 kg complete fertilizer i.e., 15-15-15 together with 82 kg/ha of ammonium sulfate) gave a significantly higher yield throughout the crop season. Combination treatments within organic manures did not establish any statistical significance. In spite of the differences in total yield, fiber content and dry matter percentage showed not significant results irrespective of treatments and crop seasons.


**Key words :** organic manures, chemical fertilizers, lettuce

## INTRODUCTION

From ancient times until the present, the effective utilization of manure has been an important part of agriculture. Today, the use of organic manure is considered an important strategy in the effort to preserve the global environment (Nishimune, 1993). Organic manure contains nutrient elements that can support crop production and enhance the chemical and physical properties of soil. In addition to the major nutrient elements, manure contains several trace elements required by the crop and a large amount of organic matter needed for soil improvement (Manitoba Agriculture and Food, 2001). Soil organic matter improves the tilth and structure of soil. It improves the ability of soil to hold water and plant nutrients. Furthermore, it improves the buffering capacity of the soil i.e., keeps soil from over-reacting. Organic matter supports the soil's microbial activity, which contributes both major and minor nutrients and helps to release nutrients slowly (Stephens, 2002).

Many studies concerning proper combinations of organic and chemical fertilizer have been reported (Lui and Lin, 1982; Mamaril and Villapando, 1984; Lui and Chin, 1991). In most of these cases, higher nitrogen recovery and fertilizer efficiency, as well as higher yields, were


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Received date : 03/02/04 Accepted date : 30/03/04

reported when a combination of chemical and organic fertilizer was applied, compared with the use of chemical fertilizer alone. But increased cost and uncertain availability and reliability of chemical fertilizer made the growers look towards renewable and organic sources of nutrients for their crops (Roe, 1998). Regular and unbalanced use of chemical fertilizers in the long run leads to decreasing base saturation and acidification of soil (Ridder and Keulen, 1990). To increase soil life, improvement of its physical and chemical properties, the use of organic manure is indispensable. It helps to reduce dependency on chemical fertilizers and ultimately leads to the creation and production of a safe environment and food.

A number of studies showed that organic produce contains more vitamins, nutrients and cancer-fighting antioxidant than non-organic food (Earthbound Farm, 2002). A high level of chemical fertilizer can reduce the level of vitamin content in leafy salad vegetables (Leclerc *et al*., 1990). For thousands of years, farmers have used agricultural residues as a major source for maintaining and improving soil fertility, but there is still limited information about their effectiveness and behaviors in the soil (Cordovil and Dachler, 2001). Research using different types of organic manures in different levels has been made available. In contrast to chemical fertilizer, studies using different types of organic manure alone, combinations with and within chemical fertilizer are few particularly in regard to salad vegetables.

The main objective of this research was to evaluate the effects of three different types of organic manure, its combination with and within chemical fertilizer on production of lettuce.

## MATERIALS AND METHODS

The field experiment was conducted on Kamphaeng Saen soil series (fine-silty, mixed Typic Haplustalfo) at Tropical Vegetable Research Center, Nakhon Pathom. The soil test values before planting were as follows: pH 7.44, EC 1.91dS/m, OM 1.79 %, available P 127.25 mg/kg, exch. K 404.74 mg/kg, Ca 3772.7mg/kg, and extr. Fe, Mn, Cu, and Zn 8.99, 6.35, 0.87 and 1.52 mg/kg, respectively. Leaf lettuce 'Green Fancy' was grown in the same experimental plot for three different growing periods i.e., December, 2002, February and April, 2003. The same amount of nitrogen was applied for each crop. Three types of organic manures, namely cow dung (CD), chicken manure (CM), and duck manure (DM) were used at the rate of 4.5, 4.7, and 5.8 t/ha respectively. The chemical analysis of these manures is shown in Table 1. Combination treatments were made such that each contributed 1:1 ratio of nitrogen. In the case of chemical fertilizer (CF), 312 kg/ha of complete fertilizer (15-15-15) as a basal dose and 164 kg/ha of ammonium sulfate (21% N) as a top dressing was applied. First and second top dressings were made 15 and 22 days after sowing each providing a further 34.4 kg nitrogen/ha. The amount of manure and fertilizer was adjusted to the recommended dose of nitrogen from chemical fertilizer i.e., 81 kg N/ha. Organic manure was applied to the experimental plot two weeks before the sowing of lettuce seed.

The experimental design was a randomized complete block with 11 treatments. Each treatment was replicated four times. Plot size was considered 8 $m^2$. Plant to plant and row-to-row distance was maintained at 10 cm apart. Among the 11 treatments, 3 were solely organic i.e., CD, CM and DM; 3 were a combination with chemical fertilizer i.e., CD + CF, CM + CF and DM + CF; 3 were combination within organic manures i.e., CD + CM, CD + DM and CM + DM; one treatment was with the recommended dose of CF and the other was the control (without manures and chemical fertilizers). Organic manures and chemical fertilizers used in all treatments contained 81 kg nitrogen. In the case of combination treatments each contributed 40.5 kg N/ha.

**Table 1** Chemical properties of organic manures.

| Nutrient content | Cow dung* | Chicken manure* | Duck manure* |
|---|---|---|---|
| EC 1:5 (dS/m) | 2.49 | 7.02 | 2.78 |
| Total N (%) | 1.79 | 1.72 | 1.39 |
| Total P (%) | 2.05 | 1.11 | 1.36 |
| Total K (%) | 0.75 | 1.51 | 0.65 |
| Total Ca (%) | 0.93 | 1.09 | 0.72 |
| Total Mg (%) | 0.45 | 0.49 | 0.34 |
| Total Na (%) | 0.06 | 0.28 | 0.07 |
| Total Fe (%) | 0.34 | 0.29 | 0.34 |
| Total Cu (ppm) | 19.09 | 141.89 | 7.67 |
| Total Mn (ppm) | 384.95 | 416.02 | 476.25 |
| Total Zn (ppm) | 72.39 | 48.05 | 14.82 |

* Samples were analyzed at central soil laboratory and greenhouse complex, KU, Kamphaeng Saen Campus, Nakhon Pathom.

Ten plant samples were randomly selected from each treatment. The roots were removed, the fresh weight measured, the number of leaves counted and the leaf area measured by Li-cor, model 3100 Area Meter. The samples were sun dried for one day and kept in the oven at 80°C for 24 hours to measure the dry weight. For fiber analysis, 5 plants were randomly selected from each treatment and 50 g sample was boiled with 100 ml of water for 10 minutes. After 10 minutes, 12.5 ml of 50 % NaOH was added and the samples boiled further 5 minutes. The fiber was cleaned over a 20-25 µm mesh with clean water, oven dried at 100°C for 2 hours and the weight of fiber measured. The total yield was estimated by selecting 1 $m^2$ area from the same crop stand in each treatment. All plants were harvested and the weight recorded.

Data analysis was performed using combined analysis of variance (MSTATC statistical software version 4.0). Significant differences were further examined with Duncan's multiple range test (DMRT) at 5 percent level.

## RESULTS AND DISCUSSIONS

The effect of organic manures and chemical fertilizers on production of lettuce is shown in Figure 1, Table 2 and 3. The crop grown during February resulted in a significantly higher leaf area (2553.66 $cm^2$) as well as total yield (18.4t/ha). Moreover, the fresh weight was not significantly different for the crops grown in December and February. The crop grown in December showed significantly higher dry weight than the crops grown in other two months. As regards the fiber content and dry matter percentage, no detectable difference was observed (Table 2).

While evaluating the crop yield supplemented with different types of organic manures and chemical fertilizers, lettuce grown with chicken manure (4.7 t/ha) and its combination with chemical fertilizer (2.35 ton chicken manure plus 156 kg complete fertilizer i.e., 15-15-15 together with 82 kg/ha of ammonium sulfate) resulted in significantly higher fresh weight, dry weight and total yield as that of recommended dose of chemical fertilizer (Figure 1, Table 3). Moreover, significantly higher leaf area was

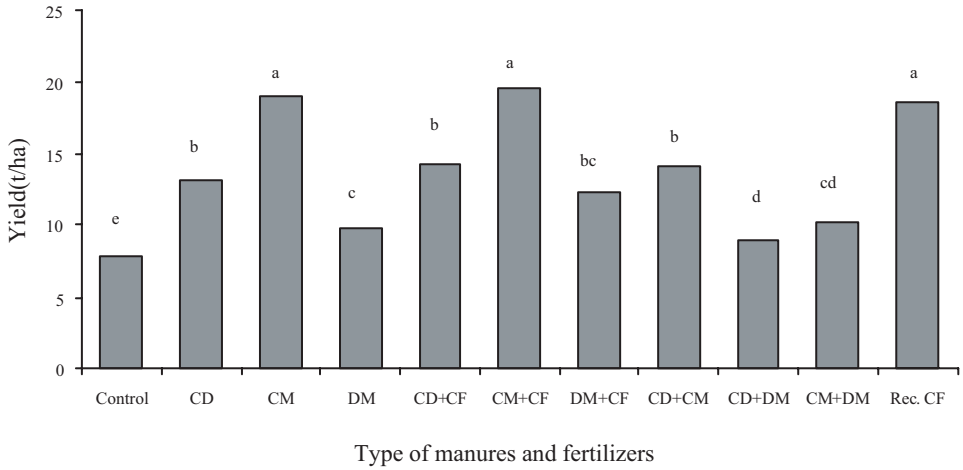


**Figure 1** Yield performance of lettuce grown with different types of manures and fertilizers.

**Table 2** Overall effect on crop yield during different months.

| Parameters | December | February | April | Pr>F |
|---|---|---|---|---|
| Fresh weight (g)[1] | 242.86a | 238.47ab | 206.90c | ** |
| Dry weight (g)[1] | 16.13a | 14.82b | 12.79c | ** |
| Leaf area (sq.cm)[1] | 1752.56b | 2553.65a | 2007.58b | ** |
| Fiber (%) 0.59 | 0.48 | 0.57 | ns | |
| Dry matter (%) | 6.65 | 6.41 | 6.28 | ns |
| Total yield (t/ha) | 11.91b | 18.38a | 9.81c | ** |

[1] the average of ten plants; Means in each row followed by the same letters are not significantly different by DMRT;
** Significant at probability level of 0.01; ns = not significant.

observed from the crop treated with the recommended dose of chemical fertilizer. The crop grown with chicken manure and its combination with chemical fertilizer noticed statistically identical leaf area. However, the percentage of fiber and dry matter was not significant irrespective of season and treatments (Table 2 and 3).

Out of three sole organic treatments, fresh weight, dry weight, leaf area, and total yield were found to be significantly higher in lettuce grown with chicken manure. The yield was significantly different when compared with the crops grown with cow dung and duck manure. Duck manure amended crop gave the lowest yield. Chicken manure has been shown to give significantly higher yield, as similar results were also reported by Flynn *et al*. (1995), El-shinawy *et al*. (2002), Ekbladh *et al*. (1993), and Obi and Ebo (1994) in vegetable and maize crops. Because of the shortage and high cost of chemical fertilizers, chicken manure has become a popular alternative, attracting high prices. Consequently, poultry keepers make additional profits through more frequent removal and sale of the chicken manure (Carol *et al*., 1996).

Among three combinations of organic manures with chemical fertilizer, chicken manure plus chemical fertilizer showed significantly higher

**Table 3** Effect of organic manures and chemical fertilizers on production of lettuce.

| Manures and fertilizers | Fresh weight (g) | Dry weight (g) | Leaf area (sq.cm.) | Fiber (%) | Dry matter (%) |
|---|---|---|---|---|---|
| Control | 109.8g | 7.25f | 1242i | 0.491 | 6.639 |
| CD | 177.10ef | 11.63de | 1987ef | 0.523 | 6.649 |
| CM | 338.3a | 20.96a | 2682b | 0.532 | 6.221 |
| DM | 151.5f | 9.89e | 1690gh | 0.525 | 6.579 |
| CD+CF | 257.00b | 17.03b | 2288cd | 0.578 | 6.656 |
| CM+CF | 331.70a | 20.87a | 2511bc | 0.610 | 6.314 |
| DM+CF | 213.60cd | 13.52cd | 2017def | 0.552 | 6.360 |
| CD+CM | 246.00bc | 15.59bc | 2253cde | 0.566 | 6.351 |
| CD+DM | 163.00ef | 10.02e | 1571h | 0.551 | 6.267 |
| CM+DM | 195.70de | 12.49d | 1902fg | 0.528 | 6.463 |
| Rec.dose of CF | 340.00a | 21.31a | 3009a | 0.602 | 6.462 |
| F-Test | * * | * * | * * | ns | ns |
| C.V. % | 17.97 | 18.77 | 15.15 | 18.28 | 14.80 |

Means in each column followed by the same letters are not significantly different by DMRT.
** Significant at probability level of 0.01; ns = not significant.

yield (19.50 t/ha) throughout the experiment. (Figure 1) The yield was significantly different from the other two combinations. The mean yield of the crop grown with cow dung plus chemical fertilizer was identical to that of duck manure plus chemical fertilizer. These results are in close agreement with the findings of Lian (1993). Yeh (1976) reported that organic manure combined with chemical fertilizer increases soil organic matter content and level of phosphorus. Both organic manure and chemical fertilizer have a complementary role and their simultaneous use will allow better crop yields (Bationo and Mokwunye, 1991).

Combination within organic manures has different yield response. The crop grown with a combination of cow dung plus chicken manure showed a greater yield compared with the other two combinations although statistical significance was not clearly established. Lower yield was observed from a manure combination of cow dung plus duck manure and chicken manure plus duck manure. This may be slow release of nutrients from these manures.

From the result it was indicated that fiber content and dry matter yield of lettuce was not significantly different (Table 3). This result is in complete agreement with the finding of Premuzic *et al.* (2002) with lettuce. The crop grown during April showed lower yield performance compared with the crops grown during December and February. This may be due to the higher temperature effect on the crop.

## CONCLUSION

Since well-decomposed chicken manure at a rate of 4.7 t/ha produces a significantly higher crop yield throughout the cropping seasons, it may be a complete substitute of chemical fertilizer.

Consequently, chicken manure could be the best alternative for organic growers for a higher and sustainable production of lettuce. A combination treatment of chicken manure plus chemical fertilizer (2.35 t/ha chicken manure + 156 kg 15-15-15 and 82 kg/ha ammonium sulfate) also showed a higher yield performance, as did that of chicken manure. For the farmers who wish to use both organic and chemical fertilizers, the above combination may lead to higher yields. The combination treatments within organic manures did not show any significant increment on production of lettuce. Although the same amount of nitrogen was applied from different sources of manures and fertilizers, chicken manure alone and its combination with chemical fertilizer resulted in a higher crop.

## ACKNOWLEDGEMENTS

We wish to thank Mr. Supachai Amkha, and Mr. Wittaya Sadwittaya for their constant help in the field experiment. All the staff of the Tropical Vegetable Research Center are also greatfully acknowledged for providing all facilities used in this study. Our thanks also to Mr. Efren Altoveros for his support in statistical analysis and reviewing this manuscript.

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