

# Short-term effect of organic materials application on properties of agricultural soils in urban areas, Osaka Prefecture in Japan

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## Abstract

Short-term effect of organic materials on soil properties of agricultural lands (paddy and greenhouse) in Osaka Prefecture, around one of the largest cities in Japan, was investigated. In both sites, only a few years application of cow manure compost increased total-C and other plant nutrients, especially Total-N, suggesting that short term application of organic matter to agricultural fields was significant for C sequestration and soil nutrient accumulation. Effect of organic materials on organic fractions in greenhouse soils is also discussed.

## Introduction

It is indispensable to apply organic materials in agricultural practice for sustaining soil quality. To assess the effect of organic materials on soil quality, soil properties under long-term experiments were investigated extensively (Karbozova-Saljniov *et al.* 2004, Triol-Padre *et al.* 2005, Yan *et al.* 2007). Short term effect of organic materials on soil quality should also be investigated, because most organic materials contains considerable amount of plant nutrient elements, which often lead to high accumulations of nutrients in agricultural soils, and some studies (Tatsumi *et al.* 1985, Biederbeck *et al.* 1998) demonstrated that soil properties on organic fractions were changed in only a few years. The objective of this study is, therefore, to investigate short-term (a few years) effect of organic materials on soil properties in agricultural lands (paddy and greenhouse) in Osaka Prefecture, Japan.

## Materials and methods

### *Climate*

The climate of Osaka Prefecture is humid temperate. Mean annual temperature is 16.6 degrees centigrade, and mean annual precipitation is 1194 mm (Sakai city, near the both experiment site 2008). The temperature in summer is very hot; it sometimes exceeds 35 degrees centigrade, probably due to relatively low precipitation in summer and radiation of heat from the city area (heat island).

### *Paddy*

The experiment was conducted in the experiment paddy field of Research Institute of Environment, Agriculture, and Fisheries, Osaka Prefectural Government, Habikino-City, Osaka, Japan. The experiment was carried out since 2005. Soil was classified as Typic Epiaquepts (Soil Survey Staff 1999). Design of the experiment is shown in Table 1. The characteristic of this experiment was that frequencies of application of cow compost manure (CM) are different in each plot (Table 1). Soil samples were collected in March 2009, and soil physico-chemical properties were analyzed. The grain yield and protein content of rice is also investigated in October 2008.

**Table 1. Experimental design of paddy field.**

Name	Treatment	Frequency of CM application
CF	Chemical fertilizer	None
M1	Chemical fertilizer and CM	Every year
M2	Chemical fertilizer and CM	Every 2 years
M3	Chemical fertilizer and CM	Every 3 years
M5	Chemical fertilizer and CM	Every 6 years

Application rate of CM was 15t/ha.

### *Greenhouse*

The greenhouse site was located in Senshu region (Kumatori town), where the agricultural production was largest in Osaka Prefecture. Soil was classified as Typic Epiaquepts (Soil Survey Staff 1999). From 2003 spring, 3 treatments were used; (1) no organic material (C), (2) rice straw (RS), and (3) cow manure compost

(**CM**)). Main crop was crown daisy (*coronarium*. Syn, *Leucanthemum coronarium*) planted 4-5 times by year, and taro (*Colocasia esculenta* Schott) planted every 2 years. Soil samples were collected in February 2009 before taro was planted. Soil physico-chemical properties and contents of labile organic matter (determined by sequential extraction with 0.5M K<sub>2</sub>SO<sub>4</sub> (**SE**), phosphate-buffer (**PB**) and hot-water (**HE**) (Sano *et al.* 2009) and light fraction organic matter (**LF**)) were also analyzed.

## Results and discussion

### Paddy

Soil data are indicated in Table 2. Due to the CM application, many properties increased, except for pH and exchangeable Mg. Total-C was highest in M1 treatment, lowest in CF. Soil C content in the M1, M2, M3, and M5 treatments increased 68.0%, 38.5%, 24.6%, and 4.9% compared to the control, respectively, suggested that a few years of organic matter application is effective in sequestering C to soil. Every 2 or 3 years application of CM (M2 and M3) also had positive effect of C sequestration, though the amounts of additional C (difference from CF plot) were lower than that of M1. Truog-P, exchangeable K and exchangeable Ca also increased by CM application. Especially, Truog-P in soils of M1, M2, M3 plot were considerably higher than that in CF plot. Since the price of P fertilizer has risen, effective use of soil P would be effective in cutting the cost of fertilizer. The rice grain yield and protein content in the experimental plot are also shown in Table 2. CM application affected grain yield as well as protein content, probably due to an accumulation of soil labile N.

**Table 2. Physico-chemical properties of soils and rice properties in experiment field (paddy).**

	pH 1:5	Total-C %	Total-N %	Truog-P P <sub>2</sub> O <sub>5</sub> mg/kg	Ex-K <sub>2</sub> O mg/100g	Ex-CaO mg/100g	Ex-MgO mg/100g	Grain yield t/ha	Protein %
CF	6.86	1.22	0.123	29.6	9.5	261	34.4	3.24	5.1
M1	6.72	2.05	0.193	67.7	23.5	313	37.3	3.76	5.6
M2	6.92	1.69	0.173	63.5	17.6	287	36.5	3.73	5.7
M3	6.76	1.52	0.145	51.6	22.4	272	42.3	3.40	5.3
M5	6.77	1.28	0.126	27.2	15.2	223	34.4	2.99	4.9

Ex- K<sub>2</sub>O, CaO and MgO mean exchangeable K<sub>2</sub>O, CaO and MgO, respectively.

Grain yield was determined using unpolished rice.

Protein content was determined using polished rice.

### Greenhouse

The content of total-C, Truog-P, and exchangeable K in soils are shown in Figures 1, 2, and 3, respectively. Total-C content considerably increased in CM relative to the control and slightly increased in RS. CM application also increased the content of phosphorus and potassium content, indicating that reduction of fertilizer use is needed in an agricultural field where CM was applied. Labile C content (PB, HE and LF) are shown in Figures 4, 5, and 6, respectively. CM application slightly increased PB-C and HE-C and considerably increased LF-C. These results suggest that light fraction organic matter contributed to high content of total-C in CM. Management and measurement of light fraction organic matter may be essential to achieve C sequestration in the short-term.

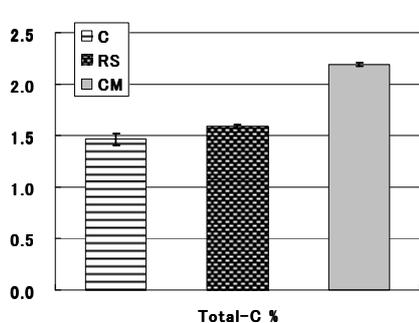


Figure 1. Total-C content.

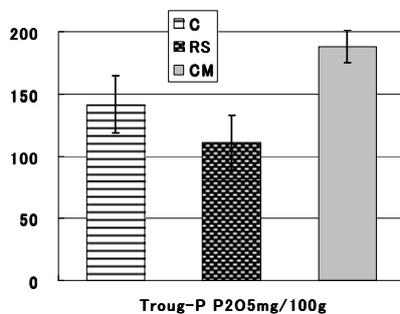


Figure 2. Truog-P content

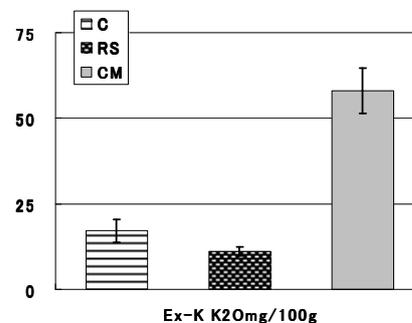


Figure 3. Exchangeable K content.

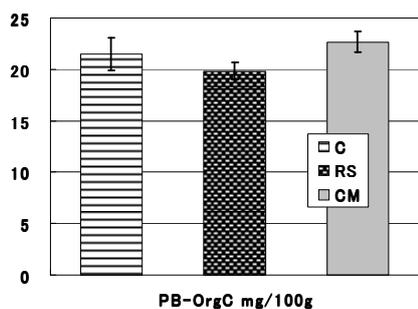


Figure 4. PB-C content.

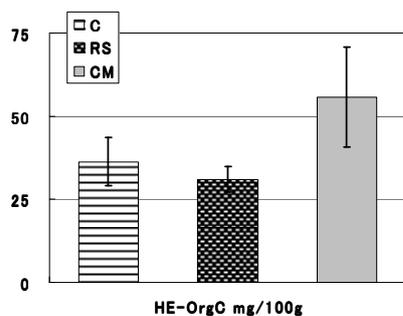


Figure 5. HE-C content.

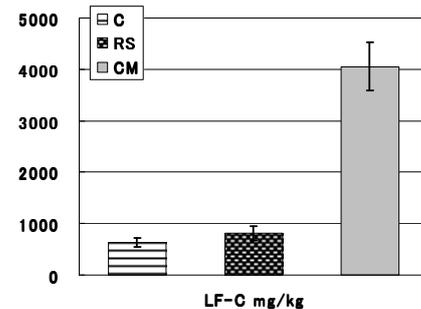


Figure 6. LF-C content.

## Conclusion

The short term effect of organic material on agricultural soils (paddy and greenhouse) was examined in Osaka Prefecture, Japan, where temperature sometimes exceeds 30 degrees centigrade in summer. Short term application of organic matter to agricultural fields was significant for C sequestration and other nutrient elements also accumulated; especially, phosphorous which was increased by cow manure application at both sites.

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