Evaluation of agricultural soil properties and organic material management in urban areas, Osaka Prefecture in Japan

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Abstract
Properties of agricultural soils and organic matter management in Osaka Prefecture, urban areas of one of the largest city in Japan, were evaluated, as a monitoring project of MAFF (Ministry of Agriculture, Forestry and Fisheries of Japan). Many nutrient elements were higher than optimum ranges; especially Truog-P for all land use and Ex-Ca in greenhouse and for grapes. For soil C, the values for most soils were within optimum ranges, suggesting that agricultural soils in Osaka would have a capacity for C sequestration. Except in the greenhouse, less than half of farmers applied organic materials for all land uses, indicating that more promotion of organic matter application to increase soil organic matter is needed depending on the land use.

Introduction
Agricultural soils in Japan have been periodically monitored from 1960s to monitor changes in soil properties and agricultural management. From 2008, to fulfill a part of Japanese target for the second commitment period (post 2013), the number of survey points increased. Osaka prefecture, urban areas of one of the largest city in Japan, varied in agricultural land use; paddy, upland, greenhouse and orchard. In this study, the results of this monitoring survey, agricultural soil properties and organic material management in urban areas, Osaka prefecture, Japan were presented.

Materials and methods
Soil investigation
In total, 99 soil samples were collected from agricultural fields in Osaka prefecture, Japan. The number of samples with reference to land use was summarized in Table 1. It should be noted that grapes were cultivated in greenhouses, which it the major method of grape cultivation in Osaka prefecture. Soil samples were classified as Lowland Paddy soils, Gray Lowland soils, Brown Lowland soils, Gray Upland soils, Yellow soils and Brown Forest soils (Cultivated Soil Classification Committee 1995). Soil samples were mostly collected from August 2008 to January 2009 after crops were harvested, although some soil samples were collected when crops were planted. Soil pH, NO_3-N (compact nitrate meter), Truog-P, Ex (exchangeable) -K, Ca, Mg, and total-C were analyzed.

Table 1. Number of soil samples with reference to land use.

Land use	Paddy	Upland	Greenhouse	Orchard	Grape
Number of samples	36	15	26	12	10

Activity data
A questionnaire on agricultural management was conducted with farmers who provided the soil samples. In this study, addition of organic matter to the field (organic amendment and residue management) was summarized in related to land use.

Results and discussion
Figure 1 shows the box plots of soil pH related to land use with optimum range indicated by two (upper and lower) bold lines. For most land uses, pH value were within optimum range, although paddy was higher than optimum range, probably because lime was applied for production of onions, cabbages and some kinds of vegetables after rice harvest in about a half of paddy field. Figure 2 shows the box plots of NO_3-N related to land use. Soils in greenhouse and grape showed higher content than those of other land uses, reflecting less leaching. NO_3-N values were higher than those of Japanese agricultural soils (Sano *et al.* 2004), indicating quite intensive fertilizer use in Osaka prefecture. Figure 3 shows the box plots of Truog-P in related to land use. In all land use, the range of Truog-P was extremely higher than optimum range; 5 to 10 times larger. They were also higher than average value in Japanese agricultural soils (Obara and Nakai 2004). These results suggest that fertilization rate of phosphate should be drastically decreased for efficient use of fertilizer.

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Figure 4 shows the box plots of Ex-K in related to land use. Except paddy soils, the values were slight higher than the optimum range. Unlike Truog-P, the values were lower than those of Japanese agricultural soils (Obara and Nakai 2003). This may be because high contents of other plant nutrient elements lead crops to take up more K than they needs. Figure 5 and Figure 6 show the box plots of Ex-Ca and Mg, respectively. Ex-Ca in greenhouse and for grape was much higher than the optimum range, similar to Truog-P. The values of Ex-Ca were comparable to those of average in Japan (Obara and Nakai 2003). For Ex-Mg, the values for greenhouse soils were slightly higher than the optimum range. The values of Ex-Mg were comparable to average values in Japan (Obara and Nakai 2003). These results suggest that a drastic reduction of phosphate fertilization should be conducted for all land uses, while application of potassium should be decreased slightly. For greenhouse and grape soils, the application rate of Ca and Mg should be also decreased. It is also important that soil test should be conducted to enable the decreased application of fertilizers or liming materials since soil properties varied among the fields.

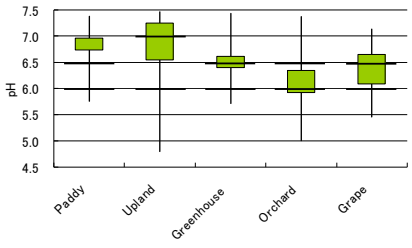

Figure 1. pH.

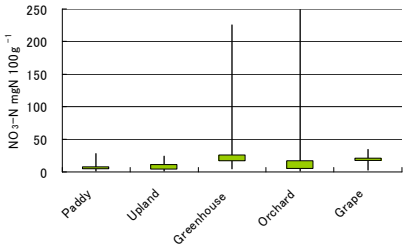

Figure 2. NO_3-N .

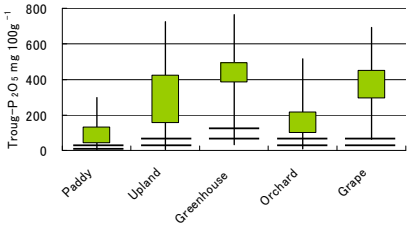

Figure 3. Truog-P.

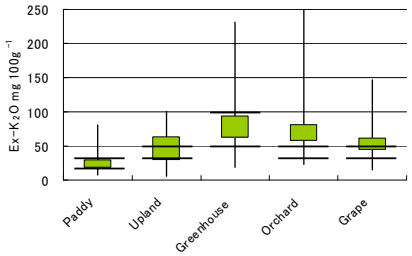

Figure 4. Exchangeable K.

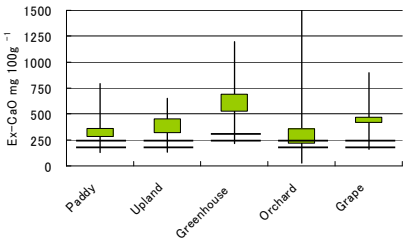

Figure 5. Exchangeable Ca.

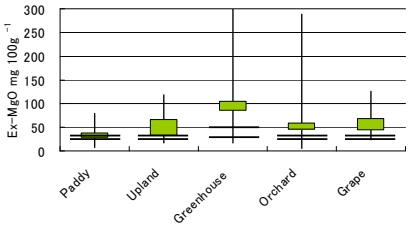

Figure 6. Exchangeable Mg.

Figure 7 shows the box plots of total-C related to land use. The soil C content was comparable among the land uses, except for soils of grape soils and one orchard soil with 20% C content. Most values were lower than that for Japanese agricultural soils (Leon *et al.* 2009), since volcanic ash soils, containing large amount are included of organic matter among Japanese soils (Sano *et al.* 2004, Leon *et al.* 2009). These soils are distributed in limited areas were present in Osaka prefecture; only one Andosol sample in 99 samples used in this study. The values were within optimum ranges, indicating that agricultural soils in Osaka have the capacity of C sequestration.

Table 2 shows the organic materials and crop residue management of farmers in Osaka prefecture, obtained by the questionnaire. For greenhouse soils, most farmers (86%) applied organic materials while for upland soils, only the 14% of farmers applied them, suggesting that, for C sequestration, application of organic matter should be increased for upland soils. In paddy, though most farmers incorporated residues, rice straw or rice hull, only about a half of them applied organic materials, suggesting that, increasing organic matter application in paddy would be effective to sequestrate C in soils. For orchard and grape soils, only a half of farmers applied organic materials, furthermore the residues were removed from fields or burned in most cases. Since most orchard and grape fields are in mountainous areas, it is difficult to apply organic materials, although is management to increase soil organic matter using a grass sward system may be effective.

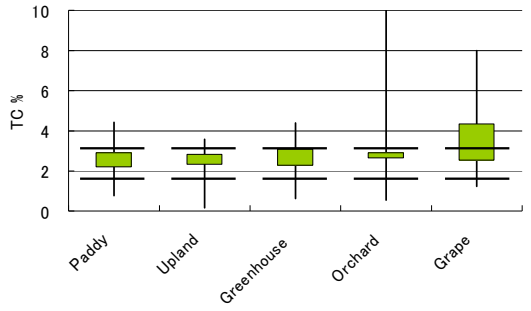

Figure 7. Total-C.

Table 2. Organic material and crop residue management by farmers in Osaka prefecture.

	Number of respondent	Application of organic materials		Incorporation of crop residues	
		Yes	No	Yes	No
Paddy	27	11	16	24	3
Upland	6	1	5	3	3
Greenhouse	23	19	4	5	17
Orchard	12	6	6	2	9
Grape	10	6	4	3	6

Conclusion

Many nutrient elements were higher than optimum ranges; especially Truog-P for all land uses as was Ex-Ca in greenhouse and grape soils. For soil C, the values for most soils were within optimum ranges, suggesting that agricultural soils in Osaka have capacity for C sequestration. Except for greenhouse soils, less than half of farmers applied organic materials for all land uses, indicating that more promotion of organic matter application or management to increase soil organic matter is needed depending on the land use.

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