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SUMMARY OF DOCTORAL THESIS

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Title: Effect of continuous compost application on qualitative and quantitative changes of organic matter in particle size fractions of soils – in the case of a field subjected to mainly double cropping

長期間の堆肥連用が土壌（主として二毛作田）粒径画分の有機物の質的および量的変化に及ぼす影響

SUMMARY

Soil organic matter (SOM) is a physically and chemically heterogeneous mixture of organic compounds of plant, animal and microbial origin and has components at different stages of decomposition. Humic substances, carbohydrates and organic nitrogen-containing compounds (organic N) are three principal components of the SOM. Many authors have studied the effects of different types and levels of organic fertilizer on soil fertility and found that organic amendment increases the level of the SOM and nitrogen fertility, improves the physical and chemical properties of soil. However, the role of the amendments in the soils of double cropped fields has received little attention. Thus, Shindo *et al.* began to investigate the effect of continuous compost application on various properties of soils in a field subjected to long-term double cropping (paddy rice and barley). The objective of present study is to gain the information about the effects of long-term compost application on the SOM (humus, organic N and sugar) of whole soils and their particle size fractions in the field subjected mainly to double cropping, using soil samples which were taken from three plots from field experiment described below.

The field experiments with different types of management were established in 1975 at Yamaguchi Prefecture Agricultural Experimental Station, Yamaguchi, Japan. The soil at this site was classified as Gray Lowland soil (FAO-UNESCO: Eutric Fluvisol). Soil samples were collected from three plots of different types of management: (a) F, only chemical fertilizers containing N, P and K were applied; (b) F+LC, both chemical fertilizers and a low level of compost (5 Mg ha^{-1}) were applied; (c) F+HC, both chemical fertilizers and a high level of compost (15 Mg ha^{-1}) were applied. The same plots were used as paddy fields for rice in summer and as upland fields for barley in winter until June 2001. The application rate of N, P_2O_5 and K_2O for each crop was 100 kg ha^{-1}. After harvest (June and November), rice straw-cow dung compost was applied as described above. However, since June 2001, these plots were used only as paddy fields and the amounts of fertilizer and compost applied were reduced by half.

In April 2007 and October 2008, to obtain an average soil sample in each plot, soils were taken from the plow layer (0-15 cm) of five sites across each of the three plots and

mixed well. The soils were air-dried, gently crushed and then passed through a 2-mm mesh sieve. Each soil sample was divided into CSA, MSA, FSA, SIA and CLA fractions by wet-sieving and sedimentation. In addition, the CSA and MSA fractions were subdivided into MP and DP by a density fractionation.

Quantitative and qualitative changes of humic substances of whole soils and their particle size fractions was investigated and presented in chapter 2. Humus composition was influenced depending upon the level of compost applied. The application induced an increase in the amounts of TH, HA and FA in the whole soil and many size fractions, particularly, SIA fraction. The increase was remarkable in the F+HC plot. In the CSA and MSA fractions, the amounts of TH, HA and FA were much larger in the CSA-DP and MSA-DP fractions than in the CSA-MP and MSA-MP fractions. The amounts of TH, HA and FA in the SIA fraction were larger than those in the CLA fraction for the F+HC and F+LC plots, and the reverse was true for the F plot. On the other hand, the degrees of humification of humic acids in whole soils and many size fractions, particularly SIA fraction, decreased by compost application. The decrease was markedly in the F+HC plot.

Effects of different levels of compost application on the amounts and percentage distribution of organic N forms in whole soils and particle size fractions were investigated (chapter 3). The amounts of total N and different organic N forms in the whole soils as well as size fractions generally increased with increasing the amount of compost. In the whole soils, percentage distribution of NHN and ASN increased by compost application while the distribution values of the HAN and HUN decreased. The application did not affect the distribution degree of AAN. In the size fractions, the distribution values of most organic N forms increased in the CSA-DP, MSA-DP and FSA-DP fractions by compost application. In the CLA fractions, the amounts and percentage distribution of organic N forms were the highest, although the application caused decreases in their distribution values.

Effects of different levels of compost application on the amounts and percentage distribution of sugar components (including hexose, pentose and uronic acid) in whole soils and particle size fractions were assessed (chapter 4). In the whole soils, the amounts of hexose, pentose and uronic acid increased with increasing the level of compost application, while the percentage distribution was not affected. In many size fractions, the amounts of sugar components increased by compost application, particularly in the plot received the high level of compost. However, no relationship was found between different levels of compost application and percentage distribution of hexose, pentose and uronic acid in the CSA, MSA, FSA (including MP and DP) fractions and SIA fraction. In the CLA fraction, although the amounts of sugar components increased, their distribution values declined. In all the plots generally, both amounts and percentage distribution of hexose and pentose were the highest in the SIA fractions, followed by CLA fractions. The reverse was true for uronic acid.

More than 50% of total contents of the TH, HA, FA, most of organic N forms and sugar components were concentrated in the SIA and CLA fractions. The amounts of all organic N forms and uronic acid were higher in the CLA fraction than in the SIA fraction. The reverse was true for humic substances as well as hexose and pentose. The findings obtained in this study indicate that the SIA and CLA fractions merit close attention as important reservoirs of SOM, which is importance depends on the kind of organic components.