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EFFECT OF GRASS MULCH ON SOIL PROPERTIES IN TEA PLANTATION

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Abstract

Some farmers in Shizuoka Prefecture, which locates in middle south part of Japan,have conventionally applied large amount of grass scraps to tea fields. This agricultural method, called “Chagusaba agricultural method”,was designated as Globally Important Agricultural Heritage Systems (GIAHS) in 2013. It is expected that the grass mulch on soil surface prevents soil and nutrient erosion, weed growth and drastic change in soil temperature, but the effect grass mulch on soil properties has not been clarified. The obtained data from the measurements of soil physical properties of a grass mulch and non-mulch field shows that saturated hydraulic conductivity and air permeability of surface soil increased by the grass mulch but the differences of these properties are small. Pruned branchesand leaves of tea tree in the non-mulch field may play a same role with grass mulch in promoting water and air permeability. Readily available moisture for plant growingin grass mulch field is larger than that in non-mulch field especially in surface layer. It is indicated that this increase of available moisture may contribute the high quality of tea in grass mulch field.

Key Words: *soil physical properties, organic matter content, soil compaction*

Introduction

Some farmers in the central area of Shizuoka Prefecture, which locates in middle south part of Japan (**Fig.1**), have conventionally applied large amount of grass scraps to tea fields.These farmers have also managed large fields, which are called “Chagusaba”, to cultivate bamboo grass or reed for the application.And the area of Chagusaba reaches almost 70 % of that of the tea plantation fields (Kakegawa Tourism Association 2014).Some researchers have reported that the rare species lived in Chagusaba and that quality of tea harvested in the grass mulched field tended to be high.This Chagusaba agricultural method is appreciated on codependence between agricultural production and biodiversity in this area and this traditional tea-grass integrated system was designated as Globally Important Agricultural Heritage Systems (GIAHS) in 2013.

Fig.1 Location of Shizuoka Pre. and cities where Chagusaba fields are distributed

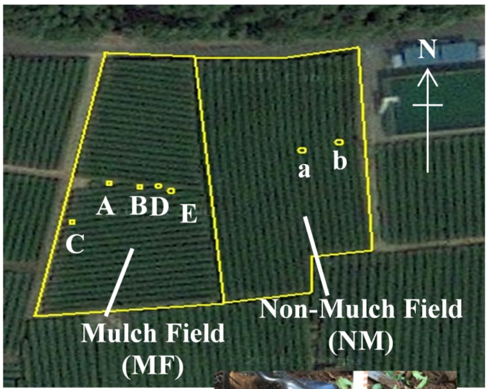
It is reported that the grass mulch on soil surface prevents soil erosion (Adekalu et al.,2007),and decreasesdrastic change in soil temperature and soil water loss by evaporation (Chen et al., 2007; Jun et al., 2014). These changes in soil conditions would bring about increasing in plant growth as Kar and Kumar (2007) but Chen et al. (2007) presented grain yield of winter wheat reduced by straw mulch. A comprehensive understanding of the optimum amount or timing of mulch for plant growth is still lacking.

Mulch grass in the tea fields applied Chagusaba agricultural method is compacted by traveling of a tractor and human walk and surface soil and the grass are mixed after the application of

chemical fertilizer to the soil. These actions could also change physical properties of the surface soil but the effect grass mulch on soil properties has not been clarified.
The objective of this study is to clarify changes in soil physical properties by grass mulch and mixture.

Site and methods

Research was carried out at two contiguous tea fields in Shimada City in Shizuoka Prefecture (Latitude: 34°49/N; Longitude 138°11/E; Altitude 110m above mean sea level). Upland and Average annual air temperature and precipitation in this area are 14.8°C and 2,150 mm, respectively (1981-2010).These fields are located at the edge of Makinoharaupland and soil at the fields is classified red-yellow soil.



Surface soil of one field was mulched by scraps of Phragmites leaf and stark cut into length of 5 - 10 cm (MF in **Fig.2**). The Chagusaba agricultural method (grass mulch practice) has been done for more than 20 years in this field. The scraps were scattered on the soil surface generally in winter (from October to February) in this field and the thickness of the mulch layer is 5 - 10 cm (**Fig. 3**). The farmer of MF applies chemical fertilizer in

Fig.3 Photos of grassmulch in MF (a: just after mulching, b: 10 months after mulching)

early spring and harvests the tea leafs twice, in May and in June. After the second harvest, branches of tea trees are cut for 10 –15 cm to promote the growth of the tree in winter and the pruned branches were scattered. Another tea field (NM) was managed without grass mulch but many large pruned branches whose maximum length was 15 cmwere observed.
Soil samples were obtained from 5 points (point A - E in **Fig. 2**) in MF and 2 points (point a and b) in NM. Sampling depth was 0 - 5, 5 - 10, 10 - 15, 20 - 25, 30 - 35 cm and two undisturbed sampleswith 5.0 cm in diameter and 5.1 cm in height and one disturbed sample were taken at each depth. The field surveys were conducted on 11 October (point A, B and a), the 6th of November (point C, D and b), and the 29th of November (point E).
Ignition loss, which indicated the content of organic matter, was calculated from the difference between the weight of the oven dried sample and that of the sample heated to 800 °C for 3 hours in a muffle furnace. Bulk density of the sample was measured by oven dry (105 °C, 24 hours) with the undisturbed sample. Saturated hydraulic conductivity of the undisturbed sample was determined by falling-head method. Volumetric water content of the undisturbed soil whose matric water potential was adjusted to be 9.8 and 61.8 kPa by the pressure plate method was measured to estimate the soil water characteristic. Readily available moisture for plant (RAM) was calculated by the difference of the water contents of

the soil whose matric water potential is 9.8 kPa and 61.8 kPa.

Results and discussion

Measured ignition loss of disturbed soil was shown in **Fig. 4**. The values of ignition loss in NM were larger than those in MF. This result conflicts with that expected from the general opinion which grass mulch practice enhances the organic material and the carbon stock in soil profile. This discrepancy is due to the effect of the left large pruned branches in NM. Thelength of pruned branches, which is determined by the farmer of the field, in NM is tend to be larger than that in MFandlarge undecomposed fraction was remained in surface soil layer of NM. It is proposed that the organic matter content of surface soil in a tea field was affected not only by the grass mulch but also by the left pruned branches.

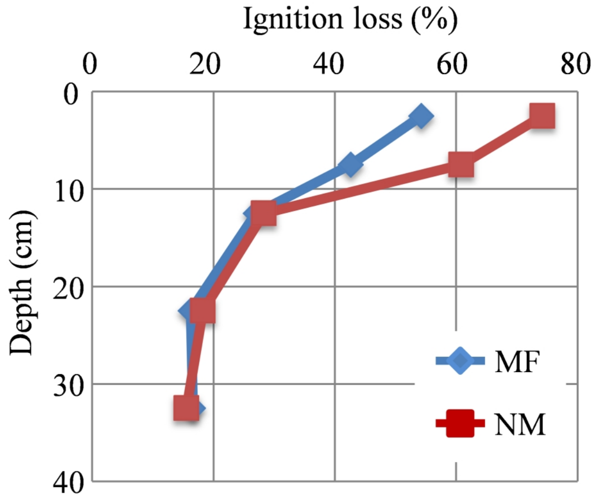


Fig.4 Distribution of ignition loss of soil

Bulk density of the soil in MF is larger than that in NM except at surface layer (**Fig. 5**). It is expected that mulching and mixing of grass husks decreased the density and hardness of soil and this result also conflict with the expected one. The higher soil density in MF than in NM can be explained in term of the difference of the agricultural machineused in each field. Soil in MF is more compressed by treading strass of the larger and heavy machine used for harvest and prune in MF The density of top soil in MF was very small compared with that of

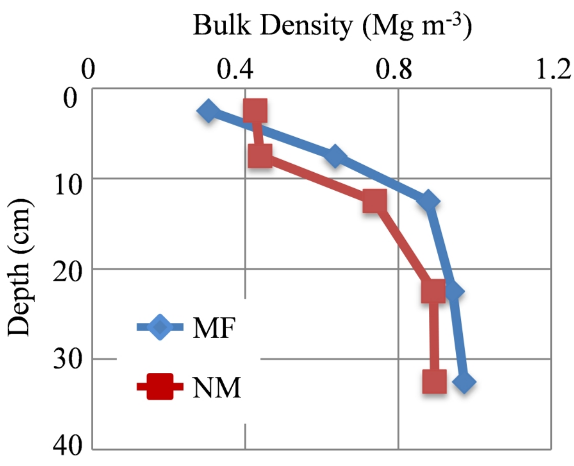


Fig.5 Changes in bulk density of soil with depth

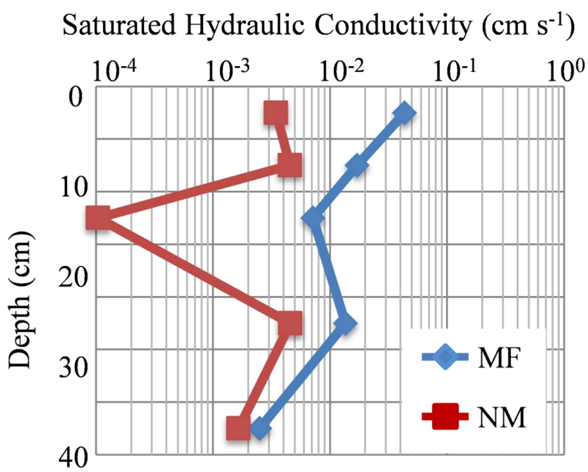


Fig.6 Changes in hydraulic conductivity with depth

other depth and was also smaller than that of top soil in NM. It is suggested that grass mulch in MF controlled the compaction of surface soil. Soil hydraulic conductivity in MF was larger than that in NM (**Fig. 6**). It is expected that high bulk density in MF reduced the hydraulic conductivity of soil because the pore spaces had been compressed during the compaction. The high hydraulic conductivity in MF can be explained by change in the pores size distribution of soil. Many large pores made by mulched and mixed grass kept the hydraulic conductivity high after the compaction although the total amount of pore space was increased.

Volumetric water content of the soil samples whose matric water potential wsa adjusted to 9.8, 61.8 kPa were shown in **Fig.7**. The water content of the soil in MF is smaller than that in NM compared with same drainage condition. It is demonstrated that the surface soil in MF had high drainage property. This high drainage property in MF is consistent with the suggestion that many large pores existed in the soil in MF. Tea trees are easy to take wet injury and prefer high drainage soil. It is considered that large pores made by the grass promote the quality of harvested tea leafs with increasing the hydraulic conductivity and drainage property. From the estimation of RAM, it can be stated that the grass mulch also increased the RAM (**Fig. 8**). The larger pores cannot hold much water after irrigation or rainfall because their retention force of water is small and water in the smaller pores is not available for the plant because their retention force is larger than the water adsorption force by the root. It is proposed that the size of grass husk which affects the pore size distribution of soil may play an important role in the high tea quality in this area.

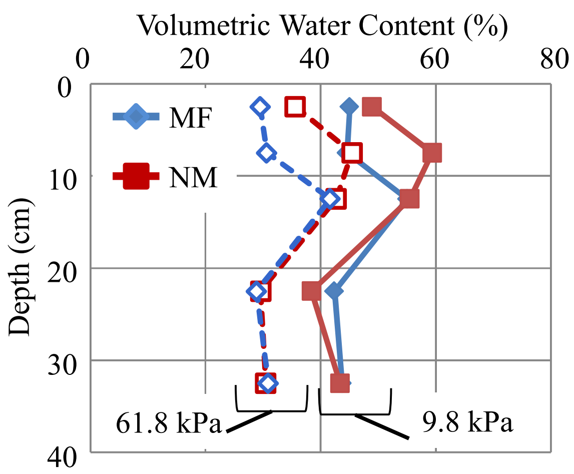


Fig. 7 Volumetric water content of soil drained by pressure plate method

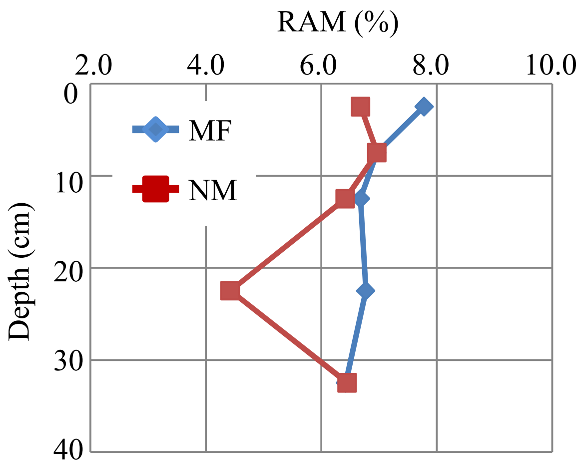


Fig. 8 Distribution of readily available moisture for plant (RAM) of soil

Conclusion

Some farmers in Shizuoka Prefecture, which locates in middle south part of Japan, have conventionally applied large amount of grass scraps to tea fields. To clarify the effects of grass mulch in tea field, the field survey was carried out. The obtained data from the measurements of soil physical properties of grass mulch (MF) and non-mulch (NM) field shows that the values of ignition loss in NM were larger than those in MF. It is proposed that the organic matter content of surface soil in a tea field was affected not only by the grass mulch but also by the left pruned branches. Soil hydraulic conductivity in MF was larger than that in NM although bulk density of the soil in MF is larger than that in NM except at surface layer. This contradiction was interpretedas the large pores made by mulched and mixed grass.These pores were thought to be kept the hydraulic conductivity high after the compaction although the total amount of pore space was increased. The water content of the soil in MF is smaller than that in NM compared with same drainage condition. From the estimation of readily available moisture for plants, it can be suggested that the grass mulch also increased the RAM. It is proposed that the size of grass husk which affects the pore size distribution of soil may play an important role in the high tea quality in this area.

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