沙漠研究 **19**-1, 309- 312 (2009)
Journal of Arid Land Studies

Study on Stable Mulching as Effective Water Saving Practice

Yuzo KOBAYASHI[1], Shoko YATO[2], Tomonori FUJIKAWA[2], Takahiko NAKAMURA[2], Machito MIHARA[2], Masaharu KOMAMURA[2]

Abstract: Under limited precipitation in Sub Saharan Africa, soil water is the key factor for growing crops. As covering soil surface with organic materials, stable mulching is expected to be beneficial for agriculture in such arid and semi-arid areas. The objective of this study is to evaluate the water saving effect of stable mulching (sorghum stalk residues or lumber chips). Results showed that evaporation in mulched plots were smaller than that in irrigated plots and the soil water content tended to increase slightly with time. The average plant length and fresh weight of these mulching plots were better than those of non-mulched plot.

Keywords: Stable mulching, Sub Saharan Africa, TDR, Water saving

1. Introduction

Sub Saharan Africa (SSA) includes many developing countries and has been marked by rapid population growth and affected by severe desertification[A)]. Regarding agriculture, "water" and "soil fertility" are absolutely insufficient. Mulching of the soil surface controls the evaporation in area having little effective rainfall. Unfortunately at SSA, it is difficult to obtain mulching materials from outside. So, for improving agricultural environment in SSA, this study dealt with the stable mulching, the organic materials obtained from farmlands, as an effective water saving practice. According to former research studies (Silvakumar and Salaam, 1999, Hayashi *et al*., 2008), attention has been paid mostly to the effect of the crop residues on soil fertility improvement. For making clear the water saving effect of stable mulching, cultivation tests were conducted in this study. Furthermore, the effect of stable mulching on plant growth was investigated, as the stable mulching was expected also to supply nutrients to the soil.

2. Materials and Methods

The experiment was carried out at the greenhouse of Tokyo University of Agriculture, Japan, from June to November, 2008. Upland rice was cultivated at each plot of 6.5 m long and 0.8 m wide. Six plots were divided into 2 groups based on the amounts of irrigation; one was irrigated at 3 to 6 mm/day (Standard plot) and the other at 1.5 to 3 mm/day (1/2 water saving plot). Each group was constituted with 3 different treatments, as mulching with sorghum stalk residues (SSR, **Fig. 1**), lumber chips (LC, **Fig. 2**) and non-mulching (NM). The schematic diagram of the cultivation experiments are as follows in **Figure 3.**

After the upland rice germinated, SSR was cut at 20 to 30 cm in length and arranged in the plot (thickness was 3 cm approximately). And LC was also arranged at 3 cm × 3 cm × 0.5 cm (approximately

Fig. 1. SSR mulching.

Fig. 2. LC mulching.

[1] Graduate School of Agriculture, Tokyo University of Agriculture, Japan.
[2] Faculty of Regional Environment Science, Tokyo University of Agriculture, Japan.

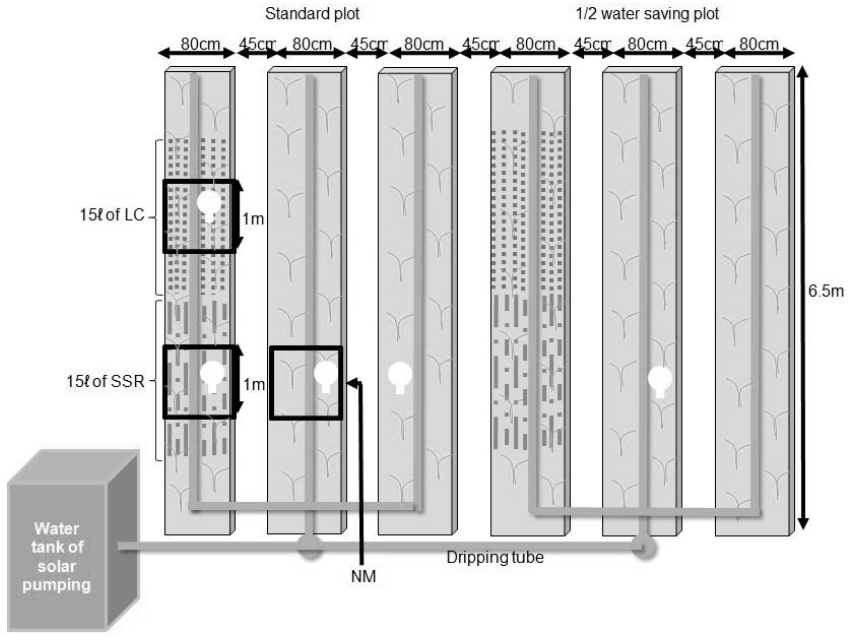

Fig. 3. Schematic diagram of the cultivation experiments.

1-3 cm in thickness). The irrigation amount of standard plot was decided referring to the precipitation of the Atsugi farm, Tokyo University of Agriculture located in Atsugi City near Tokyo. The amount of other water saving plot was referred the precipitation of the rainy season in Niamey, Niger.

Soil moisture was measured at 1 hour interval by SMART- Enviro (Sentek Pty, Ltd. Australia)[B)], that has 5 TDR sensors (5 cm, 15 cm, 25 cm, 35 cm and 45 cm depth) as shown in **Figure 4** (Sentek Pty, Ltd. 2005). The growth of cultivated crops was measured by plant length (43 days after the sowing date), heading rate (at 82 days) and fresh weight of harvesting stage at each plot.

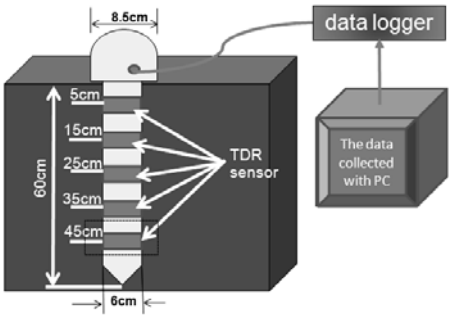

Fig. 4. Outline of the soil moisture measurement system.

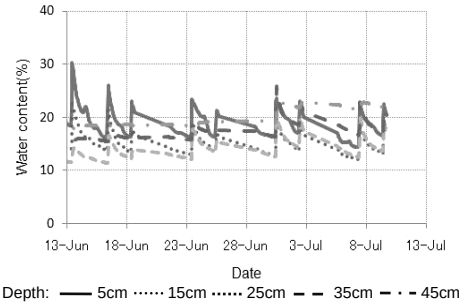

Fig. 5. Water content of NM at standard plot.

3. Results and Discussion

The experimental results of the NM at standard plot showed that water content at 5 to 15 cm deep from soil surface increased sharply, and then gradually decreased with time after the irrigation (**Fig. 5**). It took only 18 hours to return same water content as that before the irrigation. Also more than 10% of volumetric water content decreased in a day.

On the other hand, at deeper layers, changes in the water content were delayed and small. In the NM plot, water contents tended to decrease with time which indicated that evaporation exceeded the amounts of the irrigation. However, the decrease in soil water content in the SSR or LC plots after the irrigation was

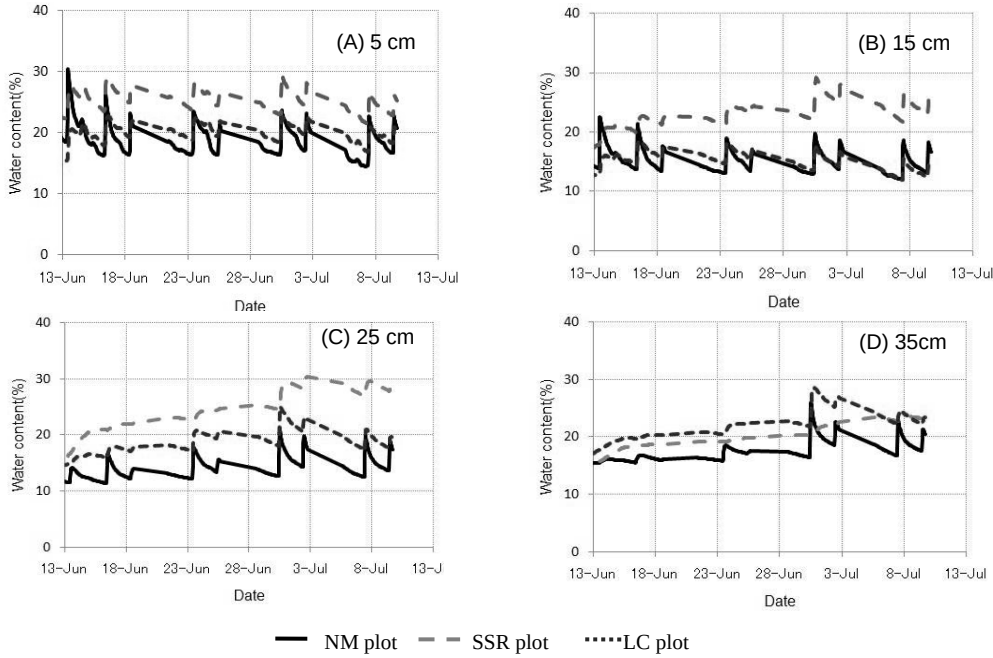

Fig. 6. Water content at different soil depths and treatments.

remarkably slower comparing to NM plot (**Fig. 6**).

This result suggested that the amounts of evaporation became less in the SSR or LC plots, as the water content tended to increase even in the relatively shallow layer (e.g. 15 cm depth at LC plot and 25 cm depth at SSR plot). Especially in the plots applied mulching with SSR, water contents at the depth lower than 25 cm were steady with an increasing tendency. As mulching with SSR or LC worked well for reducing evaporation, it was concluded that stable mulching was effective as a water saving practice.

Regarding the growth of the upland rice on standard plot, the effect of mulching with SSR and/or LC on both early growth and heading promotion was remarkably noticed. After 43 days from sowing, the average plant lengths are significantly different between standard and 1/2 water saving plots also among three treatments: 64.2 cm and 44.2 cm (SSR mulch), 57.1 cm and 45.7 cm (LC mulch) and 56.4 cm 39.5 cm (no mulch), respectively (**Fig. 7**). In standard plot, the heading rates at 82 days after sowing were 66% at SSR and 60% at LC higher than that of NM (45%, **Fig. 8**). However, regarding to the plant length and fresh weight of harvesting time (140 days after sowing) in standard plots, the average plant length and fresh weight at NM plot could be better than those at SSR and LC (**Fig. 9**). It was considered that a small evaporation caused excessive soil moisture in SSR or LC. The effect of the growth promotion due to mulching appeared remarkably in water saving plots (**Fig. 10**). The control of evaporation with mulching worked well for the growth of upland rice with

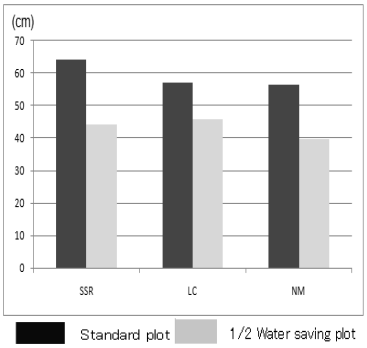

Fig. 7. Average plant lengths (43 days).

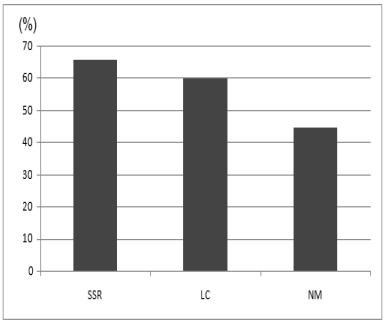

Fig. 8. Heading rate (82 days).
Note: Rice of water saving plot hadn't done heading yet.

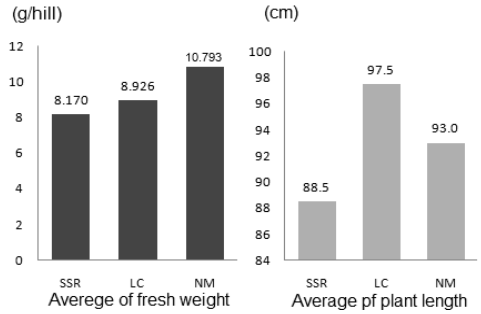

Fig. 9. Result of grown rice at standard plot.

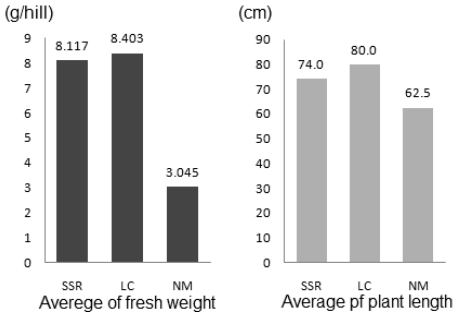

Fig. 10. Result of grown rice at 1/2 water saving plot.

preventing water shortage. According to these results, it was concluded the stable mulching was effective for the plant growth as a water saving practice in SSA.

4. Conclusions

In the plots applied mulching with sorghum stalk residues (SSR) or lumber chips (LC), the amounts of evaporation were smaller than those of the irrigation, and then water content in deeper layers tended to increase slightly with time. Especially in the plots applied mulching with SSR, water content at the depth lower than 25 cm were steady with an increasing tendency. It was concluded that stable mulching was effective as a water saving practice.

However, regarding the growth of the upland rice in standard plots, the average plant length and fresh weight at NM plot were better than that at SSR and LC. It was considered that a small evaporation caused excessive soil moisture in SSR or LC. The effect of the growth promotion due to mulching appeared remarkably in water saving plots. The control of evaporation with mulching worked well for the growth of upland rice with preventing water shortage. According to these results, it was concluded the stable mulching was effective for the plant growth as a water saving practice in SSA.

Annotation

A) FAO Hunger map of 2008, http://www.fao.org/es/ess/faostat/foodsecurity/FSMap/map14.htm, FAOSTAT.
B) SMART-Enviro (Sentek Pty, Ltd. Australia), Japanese edition manual, TWC, Tokyo, January 2005.

References

Hayashi K., Abdoulaye T., Gerard B., Bationo A. (2008): Evaluation of application timing in fertilizer micro-dosing technology on millet production in Niger, West Africa. *Nutr CyLCing Agroecosyst*, **80**: 257-265.

Silvakumar M.V.K., Salaam S.A. (1999): Effect of year and fertilizer on water-use efficiency of pearl millet (*Pennisetum glaucum*) in Niger. *Journal of Agricultural Science*, **132**: 139-148.