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Fertility Improvement of Sandy Soil by Vetiver Grass Mulching and Compost

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ABSTRACT

To improve the productivity and fertility of Hupkapong sandy soil, fresh vetiver grass was used in mulching and vetiver grass compost was applied in combination with chemical fertilizer. Soil fertility and productivity were evaluated from the yields of Insee 1 super sweet corn hybrid grown on the soil, and soil moisture determined using a neutron probe. The results indicated that super sweet corn hybrid gave a maximum growth and yield when it was fertilized with 75-75-75 kg N-P_2O_5-K_2O ha^{-1} in combination with soil mulching of 31.25 t ha^{-1} of fresh vetiver grass. Reducing the application of N-chemical fertilizer and vetiver mulching by 50% resulted in a decrease in super sweet corn hybrid yields. This decrease, however, was not statistically significant. Mulching was found to conserve topsoil moisture and increase plant growth and production. Soil incubated with vetiver grass or its compost released approximately the same amount of available-N. However, fresh vetiver grass mineralized higher levels of available-P and extractable-K than vetiver grass compost. One ton of vetiver grass yielded 1.32 kg t^{-1}, 0.24 kg t^{-1} and 6.73 kg t^{-1} of available-N, available-P and extractable-K, respectively.

Key words : vetiver grass, fertility, sandy soil, moisture, mulching, compost

INTRODUCTION

Due to its deep and dense roots, vetiver grass has been widely adopted for soil and water conservation. In addition, vetiver grass is a fast-growing and long living plant. One-year-old vetiver grass planted at 62,500 plants ha^{-1}, produced approximately 45,625 t ha^{-1} yr^{-1} of above ground biomass. This surface biomass is used for animal feeding, mushroom culture, roof thatching and compost making (Office of the Royal Development Projects Board, 1998).

At present, a significant proportion of agricultural land is unproductive because of soil fertility problems caused by inappropriate soil management practices. Consequently, plant nutrients in the form of either chemical or organic fertilizer are necessary to improve agricultural production. Decomposition of fresh vetiver grass which was buried 10 cm below the soil surface released 4.3 kg t^{-1}, 2.2 kg t^{-1} and 20.5 kg t^{-1} of available-N, available-P and extractable-K, respectively. These amounts were equivalent to 20 kg of ammonium sulfate, 11 kg of triple

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superphosphate and 41 kg of potassium chloride (Chairoj and Na Nagara, 1999). Moreover, N content of one ton of vetiver grass compost was as much as 43 kg of ammonium sulfate (Office of the Royal Development Projects Board, 1998). Therefore, vetiver grass has a potential to be used as organic matter to increase soil fertility. The purpose of this research was to investigate the possibility of using vetiver grass as a soil mulch or compost to increase the yield of sweet corn grown in dry, low fertility sandy soil. The amounts of available-N, available-P and extractable-K released from fresh vetiver mulch and vetiver compost incubated with soil for different periods of time were also investigated.

MATERIALS AND METHODS

From March-May 1998 and 1999, Insee 1 super sweet corn hybrid was planted in a completely randomized design (CRD) at Huai Sai Royal Development Study Center, Cha-am District, Phetchaburi Province. The soil is classified as a coarse-loamy, siliceous isohyperthermic, Ustoxic Dystripepts (Hupkaphong series) with 0.8 % organic matter, 0.77, 11.00 and 68.00 mg kg^{-1} available-N (NH_4^+ + NO_3^-), available-P and extractable-K, respectively. Treatments for soil improvement were shown in Table 1. Soil moisture contents at 10, 20, 30, 45, 60 and 90 cm depth levels from surface were measured using a neutron probe at one day before and one after irrigation. Irrigation was applied twice a week with 4 cm per application. Weed control was done by hoeing as necessary. There was no insecticide application since there was no problem with insect pest. Data were also taken on growth and yield of Insee 1 super sweet hybrid corn.

In addition, soil incubation experiments with fresh vetiver grass and vetiver grass compost were conducted, in the laboratory of the Division of Soil Science, Department of Agriculture, Bangkok, to determine nutrient released at 0, 10, 20, 30, 40, 50, 60, 70, 80, and 90 days after incubation. The incubated soil was analyzed for available-N (NH_4^+ + NO_3^-) (Bremner, 1965), available-P (Bray and Kurtz, 1945) and extractable-K (Knudsen *et al*., 1982).

Table 1 Soil improvement treatments for Insee 1 super sweet corn production at Huai Sai Royal Development Study Center, Cha-am District, Phetchaburi in 1998 and 1999.

Treatment (T)	First experiment (1998)	Second experiment (1999)
T1	Control	M
T2	CF (full rate)	$^1/_2$ CF + $^1/_2$ M
T3	CF + CP	$^1/_2$ CF + CP + M
T4	$^1/_2$ CF (half rate) + CP	$^1/_2$ CF + CP + $^1/_2$ M
T5	CF + M	$^1/_2$ CF + M
T6		CF + M

CF = chemical fertilization at 75-75-75 kg N-P_2O_5-K_2O ha^{-1}
$^1/_2$ CF = chemical fertilization at 37.5 -75-75 Kg N-P_2O_5-K_2O ha^{-1}
M = mulching with fresh vetiver grass at 31.25 t ha^{-1}
$^1/_2$ M = mulching with fresh vetiver grass at 15.625 t ha^{-1}
CP = vetiver grass compost incorporation at 37.5 kg N ha^{-1}

RESULTS AND DISCUSSION

Growth and yield of super sweet corn hybrid

The results of the 1998 dry season experiment indicated that using chemical fertilizer at 75-75-75 kg N-P_2O_5-K_2O ha^{-1} in combination with fresh vetiver grass mulching (T5) resulted in significant increase in growth and yield of the super sweet corn hybrid as compared with the control and the other three treatments (Figures 1 and 3). Corn treated with chemical fertilizer in combination with fresh vetiver grass mulching yielded 1312.5 kg ha^{-1} of seed dry weight whilst the other four treatments yielded in the range of 70.0–161.9 kg ha^{-1}

The second experiment in the 1999 dry season indicated that mulching with fresh vetiver grass was not sufficient to improve super sweet corn hybrid production. Fresh vetiver grass mulching in combination with chemical fertilizer application was necessary to promote corn growth and yield. However, yield of corn receiving maximum rate of chemical fertilizer and fresh vetiver grass mulch was not significantly different from that receiving half rate of chemical fertilizer and fresh vetiver grass mulch. Treatment associated with vetiver grass compost application did not show a distinct improvement in growth and yield of corn (Figures 2 and 4).

Soil moisture characteristics

When vetiver grass mulch was applied, soil moisture was high, principally in the top of 0–30 cm. For the T5, chemical fertilizer in combination with fresh vetiver grass mulching treatment (Table 1), moisture contents at 0–10, 10–20 and 20–30 cm were 3.8, 5.4 and 6.4 %, respectively, higher than those for the remaining treatments (Figure 5).

Higher soil moisture at the topsoil and plant nutrient released from fresh vetiver grass mulching

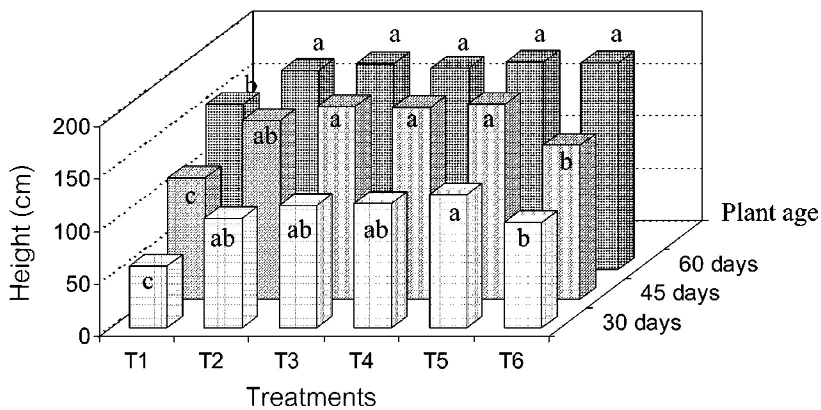

Figure 1 Height (cm) of super sweet corn hybrid under different soil managements in the 1998 dry season.
T1 = Control T2 = CF (full rate) T3 = CF + CP
T4 = 1/2 CF (half rate) + CP T5 = CF+ M
Where: CF = chemical fertilization at 75-75-75 kg N-P_2O_5-K_2O ha^{-1}
1/2 CF = chemical fertilization at 37.5 -75-75 Kg N-P_2O_5-K_2O ha^{-1}
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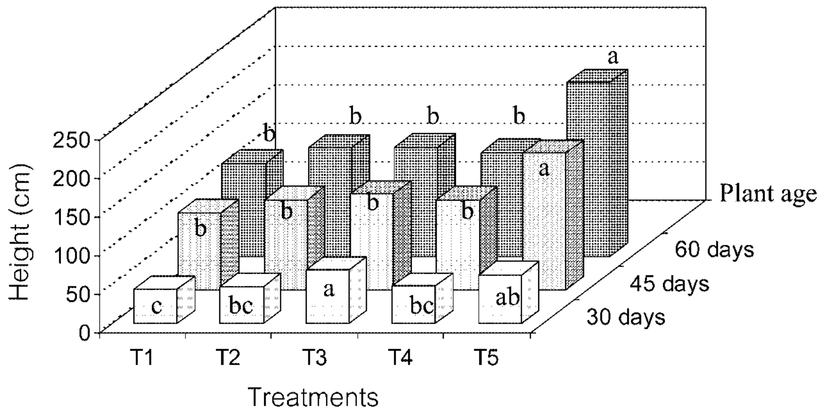

Figure 2 Height (cm) of super sweet corn hybrid under different soil managements in the 1999 dry season.
T1 = M T2 = 1/2 CF + M T3 = 1/2 CF + CP + M
T4 = 1/2 CF + CP + 1/2 M T5 = 1/2 CF+M T6 = CF + M
Where: CF = chemical fertilization at 75-75-75 kg N-P_2O_5-K_2O ha^{-1}
1/2 CF = chemical fertilization at 37.5 -75-75 Kg N-P_2O_5-K_2O ha^{-1}
M = mulching with fresh vetiver grass at 31.25 t ha^{-1}
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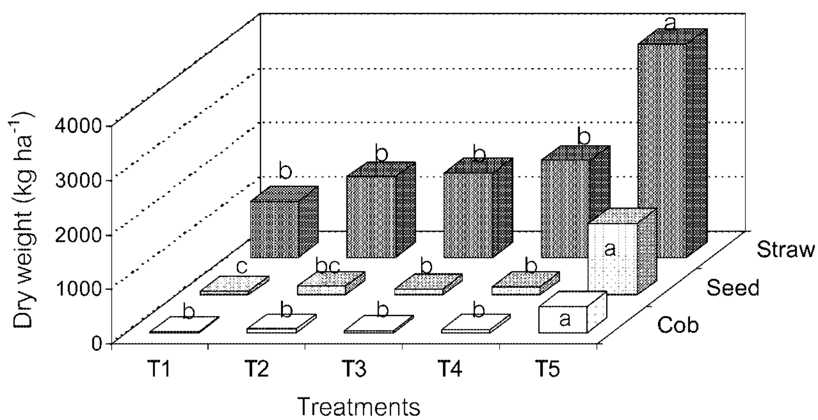

Figure 3 Dry weight of straw, seed and cob of super sweet corn hybrid under different soil managements in the 1998 dry season.
T1 = Control T2 = CF (full rate) T3 = CF + CP
T4 = 1/2 CF (half rate) + CP T5 = CF + M
Where: CF = chemical fertilization at 75-75-75 kg N-P_2O_5-K_2O ha^{-1}
1/2 CF = chemical fertilization at 37.5 -75-75 Kg N-P_2O_5-K_2O ha^{-1}
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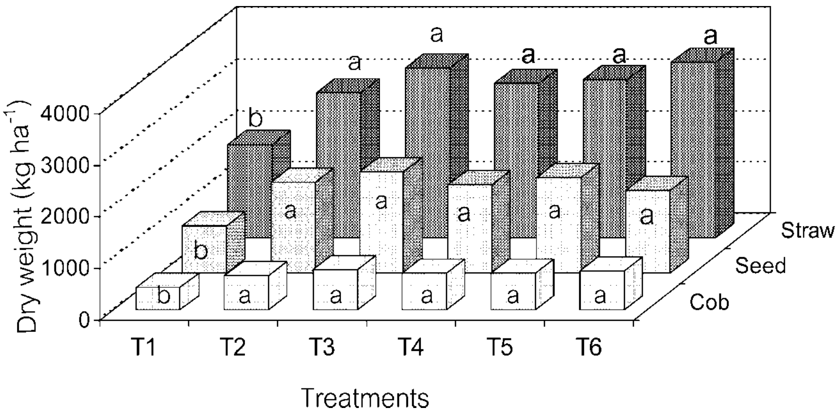

Figure 4 Dry weight of straw, seed and cob of super sweet corn hybrid under different soil managements in the 1999 dry season.

T1 = M | T2 = 1/2 CF + M | T3 = 1/2 CF + CP + M
T4 = 1/2 CF + CP + 1/2 M | T5 = 1/2 CF+M | T6 = CF + M

Where: CF = chemical fertilization at 75-75-75 kg N-P_2O_5-K_2O ha^{-1}
1/2 CF = chemical fertilization at 37.5 -75-75 Kg N-P_2O_5-K_2O ha^{-1}
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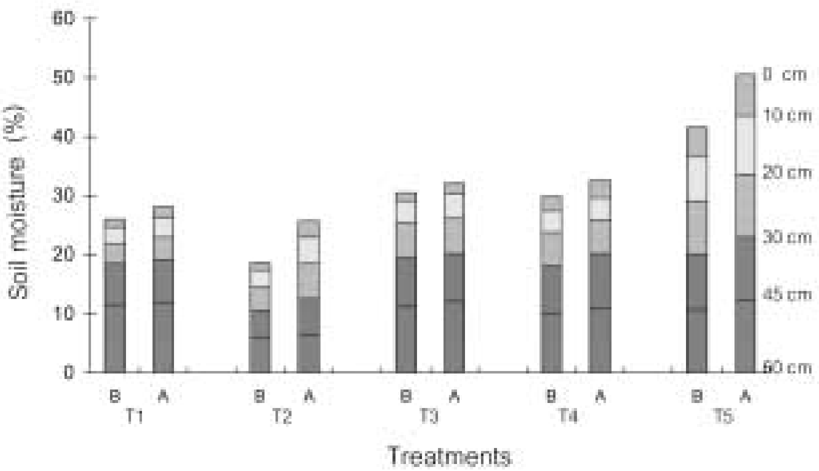

Figure 5 Soil moisture percentage as affected by different soil managements under field condition one day before (B) and one day after (A) irrigation.

T1 = Control | T2 = CF (full rate) | T3 = CF + CP
T4 = 1/2 CF (half rate) + CP | T5 = CF + M

Where: CF = chemical fertilization at 75-75-75 kg N-P_2O_5-K_2O ha^{-1}
1/2 CF = chemical fertilization at 37.5 -75-75 Kg N-P_2O_5-K_2O ha^{-1}
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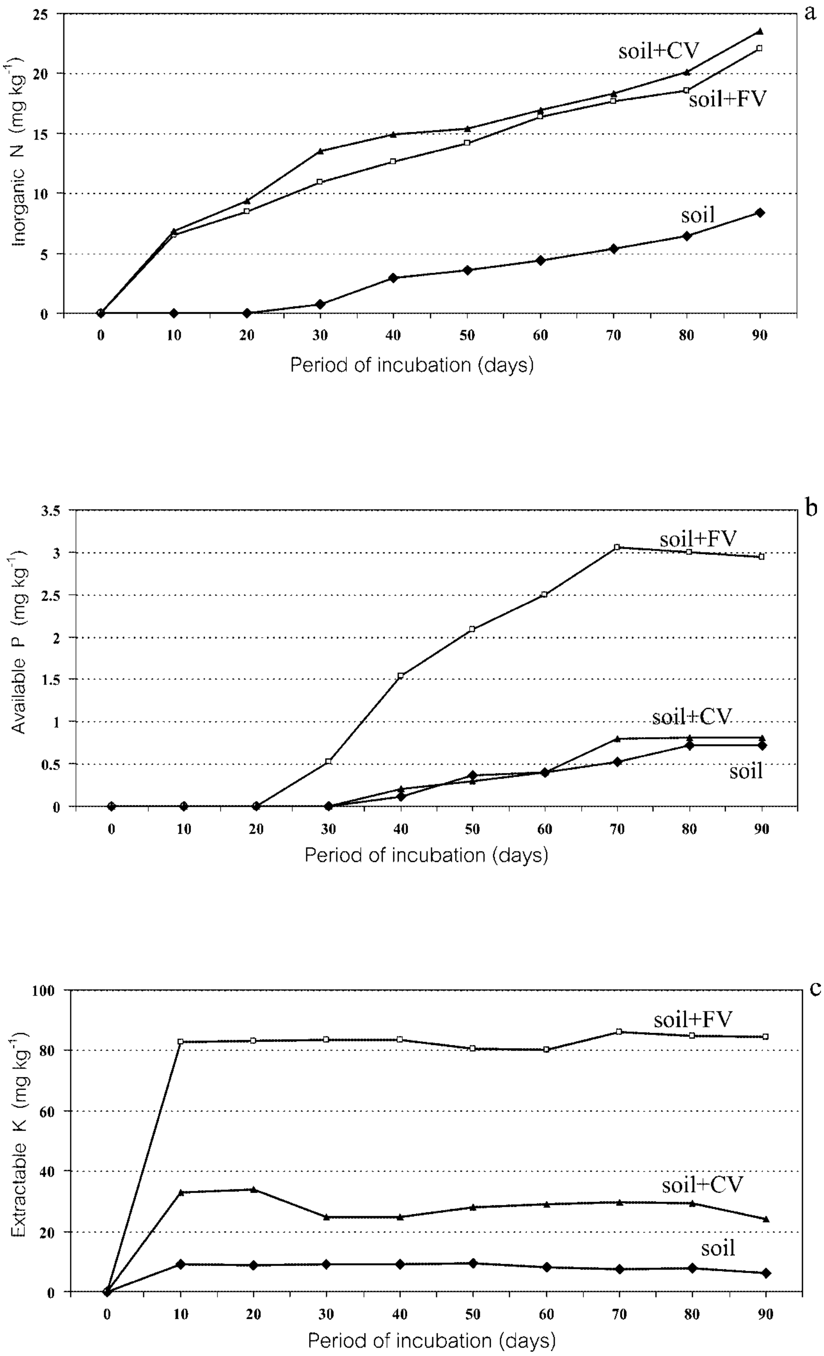

Figure 6 Available-N (a), available-P (b) and extractable-K (c) released at 0, 10, 20, 30, 40, 50, 60, 70, 80, 90 days after incubating soil with fresh vetiver grass leaf (FV), with vetiver compost (CV) and control.

had beneficial effect on super sweet corn growth and yield in the low fertility sandy soil (Figures 1–4). These were achieved by a combination of reduced evaporation and increased surface roughness which created a comparatively stable, humid layer at the soil surface thus restricting evaporation.

Avialable nutrient release from incubated soil

The incubation experiments indicated that soil incubated with fresh vetiver grass and vetiver grass compost released available-N (NH_4^+ + NO_3^-) rapidly at the beginning of the incubation. Their mineralizable-N contents were almost the same and were significantly higher than that of the control for the entire period of the incubation. At 90 days after soil incubation with fresh vetiver grass and vetiver grass compost, the respective treatments had 13.7 and 15.1 mg kg^{-1} more available-N (NH_4^+ + NO_3^-) than the control (Figure 6a). However, soil incubated with fresh vetiver grass gave higher available-P and extractable-K as compared with the vetiver grass compost treatment and the control (Figures 6b and 6c). Available-P rapidly increased after 20 days of incubation whilst extractable-K rapidly increased just after incubation. At 90 days of incubation, available-P and extractable-K were 3 and 83 mg kg^{-1} for soil incubated with fresh vetiver grass and were 0.8 and 28 mg kg^{-1} for soil incubated with vetiver grass compost. Therefore, one ton of fresh vetiver grass gave 1.32, 0.24 and 6.73 kg available-N, available-P and extractable-K, respectively, which were equivalent to 6.3, 1.2 and 13.5 kg of ammonium sulfate, triple superphosphate and potassium chloride, respectively. One ton of vetiver grass compost also released 7.70, 0.14 and 10.20 kg available-N, available-P and extractable-K, respectively, which were equivalent to 36.8, 0.7 and 5.3 kg of ammonium sulfate, triple superphosphate and potassium chloride, respectively.

CONCLUSION

The application of vetiver grass mulching is an effective water conservation measure in the Hupkapong series sandy soil tested. The vetiver grass mulch is also effective in preventing aggregate breakdown by raindrop impacts and subsequent structural seal formation. In addition, vetiver grass mulching increases available-N, available-P and extractable-K, useful for soil fertility improvement and crop productivity. The results of the field experiment indicated a satisfactory improvement in crop production under soil mulching even with low N-fertilizer application.

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