VETIVER ROOT AND SOIL MOISTURE CONSERVATION FROM VETIVER GRASS ESTABLISHMENT ON DEGRADED SOILS

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Abstract

Planting of Ratchaburi ecotype vetiver at 25 x 25 cm spacing resulted in high root and leaf biomass equal to 3,960 kg/rai. The results of soil moisture content analysis indicated that there was no significant difference between vetiver grass and other grasses generally, but there could be a significant difference season-wise. Degraded soil can be improved by planting different types of vetiver grass which generates more roots and biomass than natural grass. In the rainy season under vetiver planting soil moisture content is higher than natural grass.

Introduction

Soil organic matter is any material in the soil that was originally produced by living organisms. At any given time, it consists of a range of materials varying from the intact original tissues of plants (mainly) and animals to the substantially decomposed mixture of materials known as humus. The original tissues contain a wide range of organic compounds which typically decompose at different rates.

A study on vetiver root structure and soil moisture conservation after vetiver grass establishment on degraded soils was conducted at the Huai Sai Royal Development Study Centre, Cha-am district, Phetchaburi province, Thailand. The main objective of the study was identify whether the rhizosphere root activity and organic matter of *Vetiveria nemoralis* (Ratchaburi ecotype) or *Vetiveria zizanioides* (Surat Thani ecotype) planted at different spacing was optimal for improving degraded soils (sandy soil).

Vetiver, or *ya faek*, also known in Thailand as heather, has been utilized in rural areas as roofing material for generations. His Majesty the King has been observing its specific features and availability for a long time.

According to results from a systematic plant taxonomy study being conducted on vetiveria in Thailand, the ecotypes which are commonly found are *Vetiveria zizanioides* and *Vetiveria nemoralis*. Both species naturally grow in a wide range of locations from lowlands to highlands, from elevations close to mean sea level to as high as 800 m above mean sea level.

Differences between *Vetiveria zizanioides* and *Vetiveria nemoralis*

Vetiveria zizanioides Nash

Vetiveria zizanioides is a plant that can suitably and rapidly adapt to the environment. Most imported ecotypes include those from India, Sri Lanka and Indonesia. They are selected ecotypes and are planted under controlled conditions that differ from those that are left to grow naturally.

Vetiveria zizanioides at one year of age produces roots that can penetrate to more than 1 m depth. However, this depends on the condition of the soil and the health of the grass. The roots will be longest if the grass is grown in loose clay soil with good water drainage potential.

Keywords: Vetiver grass, ecotypes, organic matter ,degraded soils, sandy soil, soil moisture

***Vetiveria nemoralis* A. Camus**

Vetiveria nemoralis or local vetiveria has a limited scope of distribution. It is found only in Thailand, Laos, Cambodia, Vietnam and Malaysia. Moreover, there are no records of its usages.

Vetiveria nemoralis is commonly found in dry areas or in soil with good water drainage potential in every province of Thailand, especially in dipterocarp forests. However, it is not common in the South. At the same age (one year), the roots of *Vetiveria nemoralis* are comparatively shorter than those of *Vetiveria zizanioides*. Generally, the roots of one-year-old vetiver can be as deep as 80 to 100 cm.

Naming of ecotypes

Vetiver ecotypes have been collected from various sources and are named after the locations in which they were found, i.e. districts and provinces.

Roots

Vetiver roots are more active in the rhizosphere if they are plentiful. The roots are the most important and most useful parts of the plant. Most grasses have fibrous roots which spread out from the subsurface part of the culm and bind the soil in a horizontal pattern. The roots that penetrate vertically into the soil are not deep. In contrast, the root system of vetiver grass does not expand horizontally but penetrates vertically deep into the soil (the main roots, secondary roots or fibrous roots).

Materials and methods

This research was set up at the Huai Sai Royal Development Study Centre, Cha-am district, Phetchaburi province, Thailand. This area has many constraints: no forest, sandy soil, hardpan and rain shadow. Soil Classification is coarse-loamy, mixed, subactive, isohyperthermic Typic Durustept.

Experimental design used a randomized complete block design with three replications and eight treatments:

Treatment 1: Bare land
Treatment 2: Natural grass
Treatment 3: Ratchaburi Vetiver Ecotype, 25 x 25 cm spacing
Treatment 4: Ratchaburi Vetiver Ecotype, 50 x 50 cm spacing
Treatment 5: Ratchaburi Vetiver Ecotype, 100 x 100 cm spacing
Treatment 6: Surat Thani Vetiver Ecotype, 25 x 25 cm spacing
Treatment 7: Surat Thani Vetiver Ecotype, 50 x 50 cm spacing
Treatment 8: Surat Thani Vetiver Ecotype, 100 x 100 cm spacing

Results and discussion

Dry matter leaf weight

The results for dry matter leaf weight are shown in Table 1. Both ecotypes gave more dry weight than natural grass. T3 generated 2,689.44 kg/rai[1] and T4 2,010.00 kg/rai. In contrast, T2 generated only 576.29 kg/rai.

[1] 1 ha = 6.25 rai.

Table 1. Dry leaf average weight

Treatments	Dry weight (kg/rai)	
T1	0	d
T2	576.29	cd
T3	2,689.44	a
T4	2,010	ab
T5	912.15	cd
T6	1,340.69	bc
T7	966.27	cd
T8	1,081.04	bc

Leaf analysis

Leaf organic matter content was higher in all vetiver grass treatments compared to natural grass. The average leaf organic matter content in vetiver grass was 74.21% while in natural grass the average was 68.66% (Table2). However, natural grass had higher macro nutrient content than vetiver grass. Nitrogen, phosphorus and potassium contents were 0.86, 0.11 and 1.38%, respectively while in vetiver grass they were 0.43, 0.09 and 0.64%, respectively.

Table 2. Leaf analysis

Treatments	OM (%)	N (%)	P (%)	K (%)
T1	-	-	-	-
T2	68.66	0.86	0.11	1.38
T3				
T4				
T5	.8			
T6				
T7				
T8	.84			
Average				

Root weight

Vetiver grass had more roots than natural grass. Vetiver grass had better capacity to improve organic matter in the soil than natural grass in sandy soil. *Vetiveria nemoralis* (Ratchaburi ecotype) had more roots than *Vetiveria zizanioides* (Surat Thani ecotype) (Table 3).

Table 3. Root weight

Treatments	Dry weight (kg/rai)
T1	-
T2	49.28
T3	1,271.36
T4	1,167.68
T5	746.88
T6	894.72
T7	941.44
T8	580.16

Root analysis

The average vetiver grass root organic matter content was lower than natural grass roots (68.69 and 78%, respectively) (Table 4). Natural grass roots had nitrogen, phosphorus and potassium contents of 0.69, 0.05 and 0.25%, respectively while vetiver grass root contents were 0.45, 0.05 and 0.76%, respectively. Therefore, natural grass had higher nitrogen content than vetiver grass while vetiver grass had higher potassium content than natural grass.

Table 4. Root analysis

Treatments	OM (%)	N (%)	P (%)	K (%)
T1	-	-	-	-
T2	.00			
T3				
T4		.3		.2
T5	.5			
T6	.8			
T7	.4			
T8	.1			
Average				

Cumulative soil organic matter or organic carbon

At spacing of 25 x 25 cm, Ratchaburi vetiver had higher dry matter in both upper and lower depths than natural grass: 3,960 kg/rai is equal to 2,757 kg/rai organic matter or 1,599 kg/rai organic carbon (58% of organic matter) and equal to 0.06% organic carbon in the 1 m soil depth and 1.63% soil bulk density. Pojanee and Taweesak (2001) found that organic carbon content was 4-8 kg/m^2 (6.4-12.8 t/rai) at 0-100 cm soil depth over 40.25% of Thailand's area.

Natural grass gave 626 kg/rai dry weight due to low fertility soil and lack of water. The total dry weight (626 kg/rai) was equal to 434 kg/rai soil organic matter or 252 kg/rai soil organic carbon. In tropical regions decomposition rates are faster and this leads to lower soil organic matter content.

Therefore, vetiver grass planting at spacing of 25 x 25 cm on degraded soil can improve soil organic matter more than sixfold compared to natural grass. Vetiver grass can also improve soil organic matter in the subsoil which is difficult to do otherwise.

Soil moisture

We collected soil moisture nine times (once a month) at 30 and 60 cm depths. The results indicated that at 30 cm depth average soil moisture content was not significant. However bare land had the highest soil moisture content (30.74%). The Ratchaburi ecotype at 25 x 25 cm spacing had the lowest soil moisture content (23.08%) (Figures 1 and 2.)

At 60 cm soil depth, soil moisture content was not significant. Therefore, the average soil moisture content year round for bare land and natural grass was higher than vetiver grass. However in the rainy season (vetiver planting at 25 x 25 cm spacing) the topsoil had higher soil moisture content than other treatments (Table 5).

Table 5. Total soil moisture by weight(%)

Treatments	Depth		
	0-30 cm	50-60 cm	0-60 cm
T1	30.74	32.02	62.76
T2	30.14	32.92	63.06
T3	23.08	26.50	49.58
T4	27.96	31.57	59.52
T5	29.26	32.08	61.34
T6	27.47	28.95	56.42
T7	27.16	26.79	53.94
T8	25.42	29.54	54.96

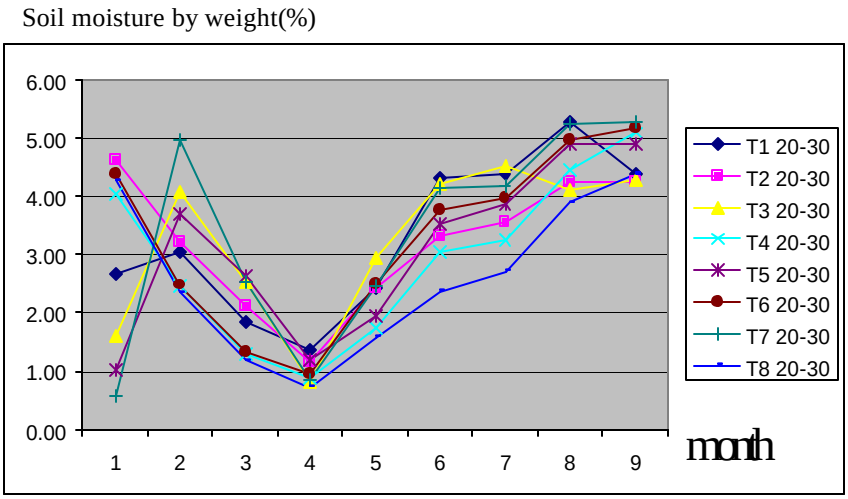

Figure 1. Upper soil moisture content (by weight) of the first sampling from 30 January to 30 September 2002

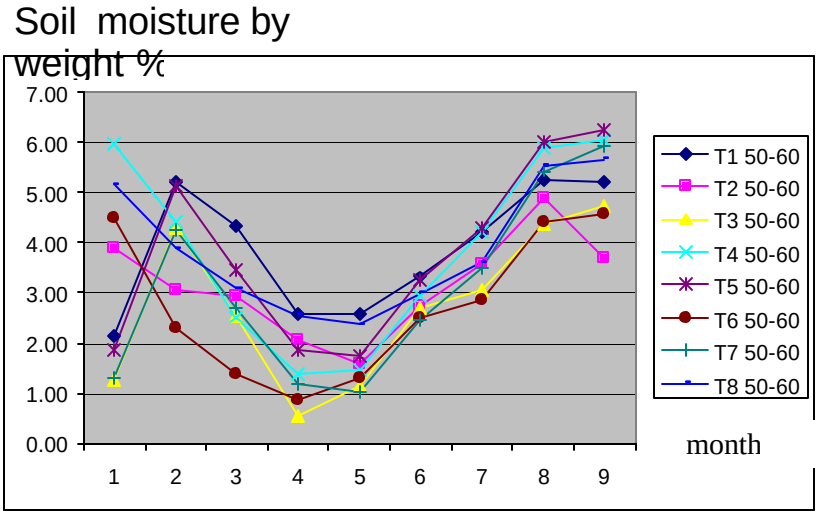

Figure 2. Lower soil moisture content (by weight) of the first sampling from 30 January to 30 September 2002

The results of the soil analysis

Soil samples were taken at 0-5 and 25-30 cm soil depth for soil chemical analysis and the results showed that it was an acid soil with low fertility (Table 6).

Table 6. Soil chemical analysis

Soil depth	S+	20	1	3 PJ NJ	. PJ NJ
-					
-					

The results indicated that:

- Ratchaburi vetiver planting at spacing of 25 x 25 cm had the highest leaf dry weight (2,689 kg/rai) followed by Ratchaburi vetiver planting at spacing of 50 x 50 cm (2,010 kg/rai) and then Surat Thani vetiver (1,341 kg/rai); natural grass gave the lowest dry weight (576 kg/rai). Both Ratchaburi and Surat Thani vetiver ecotypes at spacing of 25 x 25 cm had higher dry weight than other spacings.
- The average leaf organic matter content in vetiver grass was higher than natural grass (74.21% and 68.69%, respectively) while natural grass had higher nitrogen, phosphorus and potassium contents than vetiver grass.
- Ratchaburi vetiver at spacing of 25 x 25 cm had the highest root dry weight (1,271.36 kg/rai) while natural grass had the lowest root dry weight (49.28 kg/rai).
- Average root organic matter in vetiver grass (68.69%) was lower than natural grass (78%) and natural grass had higher nitrogen content than vetiver grass.
- Ratchaburi vetiver at spacing of 25 x 25 cm had 3,960 kg/rai dry weight which is equal to 2,757 kg/rai organic matter or 1,599 kg/rai organic carbon; this was six times higher than natural grass. Natural grass had 626 kg/rai dry weight which is equal to 435 kg/rai organic matter or 252 kg/rai organic carbon.

Conclusion

A randomized complete block design with three replications and eight treatments was used in experiment. The results revealed that:

- Ratchaburi vetiver planting at spacing of 25 x 25 cm provided the highest volume of dry matter (3,960 kg/rai). The results of soil moisture content analysis indicated that there was no significant difference between vetiver grass and other grasses generally, but there could be a significant difference season-wise.

- Degraded soil can be improved by planting different types of vetiver grass which generates more roots and biomass than natural grass. In the rainy season under vetiver plantings soil moisture content is higher than natural grass.

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Appendix 1. Soil profile description

Information on the site

Classification:	Typic Durustept, coarse-loamy, mixed, subactive, isohyperthermic
Location:	Khao Kapuk Huai Sai Royal Development Study Center Tambon Sam Phraya Amphoe Cha-am Changwat Phetchaburi
Elevation:	Approximately 45 m (MSL)
Map sheet number:	4934 II; coordinates: 47 59 86^{E}, 14 03 82^{N}
Landform	
1. Physiographic position:	Erosional footslope
2. Surrounding land form:	Gently undulating
3. Slope of profile site:	2%
Land use:	Experimental area
Annual rainfall:	Approximately 965.7 mm
Mean temperature:	Approximately 27.6^{o}C
Climate:	Tropical savanna
Others:	*Cassia siamea* Lamk., *Capsicum frutescens* Linn. *Musa sapientum* Linn.

General information on the soil

- Parent material: Local washover residuum derived from granite
- Drainage: Well-drained
- Permeability: Moderate
- Runoff: Moderate
- Depth of groundwater: Deeper than 2 m at time of sampling

Profile description

Horizon	Depth (cm)	Description
Ap	0-15	Brown (10YR 4/3); loamy sand; weak medium and coarse subangular blocky structure; soft dry, very friable moist, nonsticky and nonplastic; common traces of dead roots; few variegated sands; many fine and fine vesicular pores; commo n very fine, few medium and coarse roots; slightly acid (field pH 6.5); clear, smooth boundary to BC1.
BC1	15-38	Yellowish brown (10YR 5/4); loamy sand; weak medium and coarse subangular blocky structure partially to single grained; soft dry, loose moist, nonsticky and nonplastic; few traces of dead roots; common variegated sands; few very fine, fine and medium and coarse roots; neutral (field pH 7.0); clear, smooth boundary to BC2.
BC2	38-63	Light yellowish brown (10YR 6/4); loamy sand; weak medium and coarse subangular blocky structure partially to single grained; soft dry, loose moist, nonsticky and nonplastic; few traces of dead roots; common variegated sands; common very fine, fine and few medium vesicular pores; few very fine, fine, medium and coarse roots; slightly acid (field pH 6.5); clear, smooth boundary to BC3.
BC3	63-90	Pale brown (10YR 6/3; loamy sand; mostly single grained with some weak fine and medium subangular blocky structure; loose dry, loose moist, nonsticky and nonplastic; few traces of dead roots; common variegated sands; few very fine, common fine and medium vesicular pores; few very fine, fine, medium and coarse roots; slightly acid (field pH 6.5); abrupt, smooth boundary to 2Bqm1.

Horizon	Depth (cm)	Description
2Bqm1	90-128	Mixed brown (10YR 5/3) 80% and light grey (10YR 7/2) 20%; common fine prominent olive yellow (2.5Y 6/6) mottles; massive, practically cemented by silica and clay; very hard dry, extremely firm moist; practically no roots; moderately alkaline (field pH 8.0); abrupt, smooth boundary to 2Bqm2.
2Bqm2	128-148	Light grey (10YR 5/1); massive, practically cemented by silica and clay; very hard dry, extremely firm moist; practically no roots; moderately alkaline (field pH 8.0); abrupt, smooth boundary to 2BC.
2BC	148-170+	Light grey (10YR 7/2); sandy loam; moderate fine and medium subangular blocky structure; hard dry, firm moist, slightly sticky and slightly plastic; few clay coats on ped faces and common clay bridges on ped faces and between sand grains; few variegated sands; common silan; very few very fine, fine and medium vesicular pores; practically no roots; neutral (field pH 7.0).

Plate 1. Vetiver roots in 1 m^2 of T1, T2, T3, T4, T5, T6, T7 and T8