



National Institute of Development Administration (NIDA)

NIDA International Conference for Case Studies on Development Administration 2013 (NIDA-ICCS)

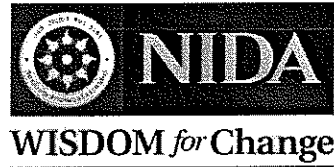


September 5-6, 2013

At Chira Boonmak Hall, 3rd floor, Sayamboromrajakumari Building,
National Institute of Development Administration (NIDA),
Serithai Road, Bangkok, THAILAND

Organized by

National Institute of Development Administration (NIDA)
Bangkok, THAILAND



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on Development Administration 2013
(NIDA-ICCS)**

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**At Chira Boonmak Hall, 3rd floor Sayamboromrajakumari Building
National Institute of Development Administration (NIDA),
Serithai Road, Bangkok, THAILAND**

Editors

Associate Professor Dr. Wisakha Phoochinda

Organized by

**National Institute of Development Administration
Bangkok, THAILAND**

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Preface

The third NIDA International Conference for Case Studies (NIDA-ICCS) will be held in Bangkok Thailand, during September 5-6, 2013, at NIDA's Bangkok campus. The conference brings together scholars and experts from a wide range of development administration fields to discuss practical and research issues related to teaching case studies.

NIDA proudly invites scholars and experts to send their case study in various fields of development administration relating to the conference theme and sub-themes.

Conference Theme and Sub-Themes

Main Theme: *Case Studies on Development Administration*

Sub-themes in various fields of development administration including:

Public Administration
Economics
Business Administration
Social Development
Environmental Management
Law, Legal Studies
Human Resource Development
Language and Communication
Applied Statistics
Decision Technology
Actuarial Science and Risk Management
Population and Development,
Information System Management and Computer Science
Tourism Management
Sustainability
Corporate Social Responsibility and Ethics
Communication Arts and Innovation

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National Institute of Development Administration (NIDA), is established in 1966, is a unique higher education institute in Thailand that offer exclusively graduate degree programs. NIDA was originally established to support national development in Thailand; this objective has now been expanded to encompass regional development in countries outside of Thailand, with the aim of producing advanced degree graduates who can serve in the public, business, and nonprofit sectors. NIDA holds its academic conferences and publish at least two journals regularly—NIDA Development Journal (in both English and Thai) quarterly, and NIDA Case Research Journal (in English) semi-yearly. For more information please visit our website: <http://www.nida.ac.th>.

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Comparative Study on Growth and Efficiency of Vetiver Grass Strips in Preventing Soil Loss

Piyada Wachirawongsakorn¹, Boonseub Thongkam,
Nuttawut Kongkum and Pravit Hoonthong

Abstract

Efficiency of Vetiver grass in preventing soil loss for agriculture farm, Ban Kok Phag Wan, Chat Trakan district, Phitsanulok province was investigated using 3 vetiver grass ecotypes (Monto, Roi-Et and Kamphaengpetch) with 3 experimental designs under different replications of rainfall simulation. The plots was on 9 percent of slope consists of ten 1.5x3 m plots with a plot of bare soil (control) and 9 plot replications of 2, 3 and 6 strips of vetiver grass vertical interval base on 3 vetiver grass ecotypes. Each strip of vetiver grass was planted in single row with 10 centimeter spacing, the height of vetiver grass was monthly measured. The amount of soil loss and run off was collected and compared under 15 minutes of rainfall simulation. At 4 months old, it was found that the Roi-Et ecotype showed the highest average, 155.8 cm, followed by Monto and Kamphaengpetch ecotypes were 105.4 and 103.2 cm, respectively. The maximum soil loss and runoff was occurred on bare soil plot. The minimum soil loss and runoff was in 6 strips plot of Roi-Et ecotype, which had 1.05 ton/rai and 18.50 litters with the same maximum efficiency, 94.3 and 49.3 percent, respectively.

Keywords: Vetiver grass, land degradation, soil erosion, runoff, rainfall simulator

¹ This case study was written by Dr. Piyada Wachirawongsakorn of Department of Environmental Science, Faculty of Science and Technology, Pibulsongkarm Rajabhat University (Thailand) and is based mainly on archival research. NIDA cases are developed solely as the basis for class discussion, and are not intended to serve as endorsements, sources of primary data, or illustrations of effective or ineffective administrative or managerial practice.

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Introduction

Soil is one of the earth's most important natural resources, which an important part of the landscape and contributes to determine the way in which natural vegetation, crops and human settlements. However, the destruction degree of soil quality is far great than maintenance by human beings under rapid population growth and industrialization. Soil erosion is one form of soil degradation that may be a slow process that continues relatively unnoticed. Erosion from land area is generally related to accelerated erosion, where the natural rate has been significantly increased mostly by human activity. It affects all natural and human-managed ecosystems, including agriculture and forestry. When agricultural land is eroded, the soil loss may be reflected in lower surface water quality, damaged drainage networks and reduced crop production potential. To compensate for the loss, forests are cleared to provide needed agricultural land. Indeed, erosion is the major cause of the deforestation now taking place throughout the world (David and Nadia, 1998 : 416).

Soil erosion by water is a widespread problem throughout many slope areas in Thailand. Ban Kok Phag Wan, Chat Trakan district, Phitsanulok is one of agricultural community located on the slopes farmland. The majority population in community is poor rural people include women and men who are heads of households, small-scale farmers, landless farmers, small merchants, agricultural workers and laborers for rural service operators. With the limited farmland area, farmers are more likely try to use steeper slope hillsides to grow crops for agricultural products increases. Normally, their production is too low to enable them to maintain their families. A large number of small-scale subsistence farmers and their families have to seek off-farm employment or another income-generating activity to supplement household incomes. Therefore, finding the basic and easy way to keep the soil's natural productivity is managed in a sustainable way should be emphasized on this investigation. The cultivation of vetiver is simplicity technology, easy maintenance, and inexpensive, that farmers can handle themselves. His Majesty has continuously expressed ideas of using vetiver grass for soil and water conservation measurement. The first Royal Initiative given on 22 June 1991, a part of which is "... study and trial on vetiver planting to prevent soil erosion at the specific sites of various Royal Development Study Centers, particularly at Huai Sai and Khaohinsorn, as well as other appropriate locations should be conducted to a wide extent ..." (Suda et. Al, 2006 : 3) Vetiver grass has strong fibrous root system which rapidly penetrates deep into soil and develops into horizontally with a tightly knitted net. It can hold the soil together and serves as an underground wall which not only retards waterflow but also allows it to seep into the soil. The hedgerows will stop erosion caused by lower level contour and also capable to absorb plant nutrients and chemical substances. This method can improve their land and help soil and water conservation which the farmers will benefit.

The study aims to evaluate growth rate and determine the efficiency of Vetiver grass strips of difference Vetiver grass ecotypes and strips performance as barriers against runoff and soil loss on slope farm. These results could help the farmers of this community to avoid soil erosion which reduce the impacts of agriculture and the loss of valuable land.

Material and Method

The 10 sample plots were established on farm land with 8.76% of slope in Ban Kok Phag Wan, Chat Trakan district, Phitsanulok. Each plot was 1.5x3 m³ with 15 cm of two months vetiver grass sprout, planted 10 cm apart between each sprout. Every plots were installed the collector for eroded sediment and runoff collection. Three difference vetiver grass ecotypes such as Monto, Kampeangpech and Roi-Et were used. There were three strip performances; 1) two strips which planted 1.5 m apart along a contour 2) three strips which planted 1 m apart along a contour and 3) six strips which planted 0.5 apart along a contour to create barrier of stiff grass that acts as a buffer and spreader of down slope water flow, and a filter to sediment (Fig.1, 2 and 3). The vetiver grass growth and based leave lengths in all treatments during four months field study were measured every month in cm, with each vetiver grass sprout trimmed down to 15 cm for starting. The survival rates were investigated every week during experiment and took a place of new vetiver grass sprout for the death one.

For the efficient soil erosion and sedimentation protection, the experiment carried out after four months of vetiver grass growth by using rainfall simulator. The three plane-jet nozzles used on this simulator is Cyto 318-BB-SS27 and a water pump of Hino 30 AC with 17 Bar. The nozzle lined 2 m above the floor (Fig.4). Diameter of the rainfall simulator was established fit to the plot, allowing rainfall to cover treatment area. The sediments loss and runoffs were measured in each treatment plot for 5, 10 and 15 minutes of simulated rainfall event (58.1, 117.2 and 174.1 L of rainfall) with 3 replications for each period under dry run. The plot runoff in millimeters was calculated. After thoroughly stirring the content of the runoff collectors, the sediment losses were filtrated and weighted, while runoff volumes were measured. The collected sediment samples were sun dried at experimental site and taken to Pibulsongkarm Rajabhat University for oven dry weights and for calculating the total dry soil loss. The runoff collecting cans were emptied and cleaned after each measurement to make them ready for the next rainfall event. Then, the most appropriate ecotype of vetiver grass and pattern to protect soil erosion in this area base on the results comparisons was selected.

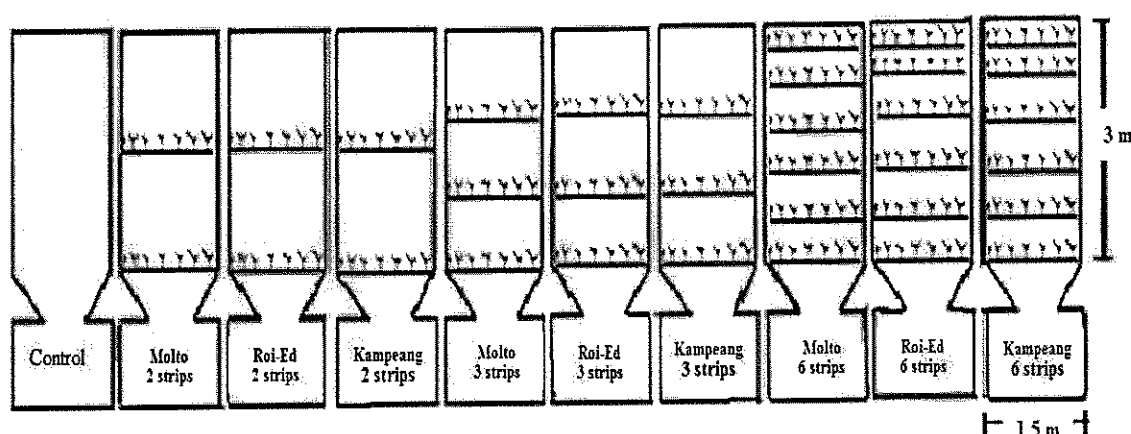


Figure 1: Ten plots were established on farm land with 8.76% of slope

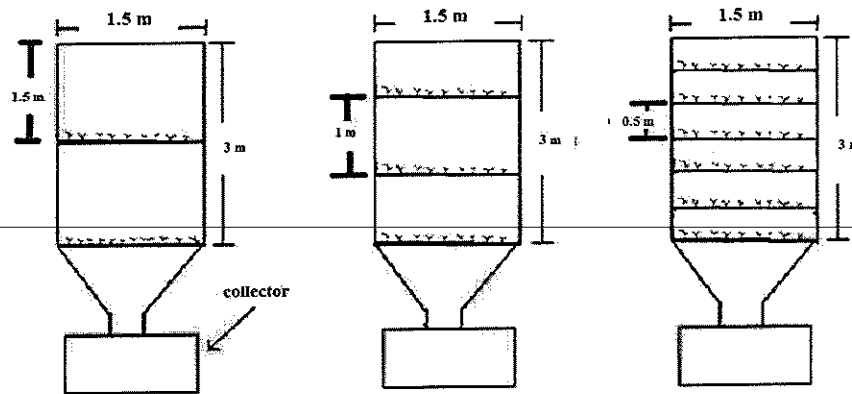


Figure 2: The vetiver grass strip performances; 2, 3 and 6 strips along the contour



Figure 3: The experiment was established on the farm land

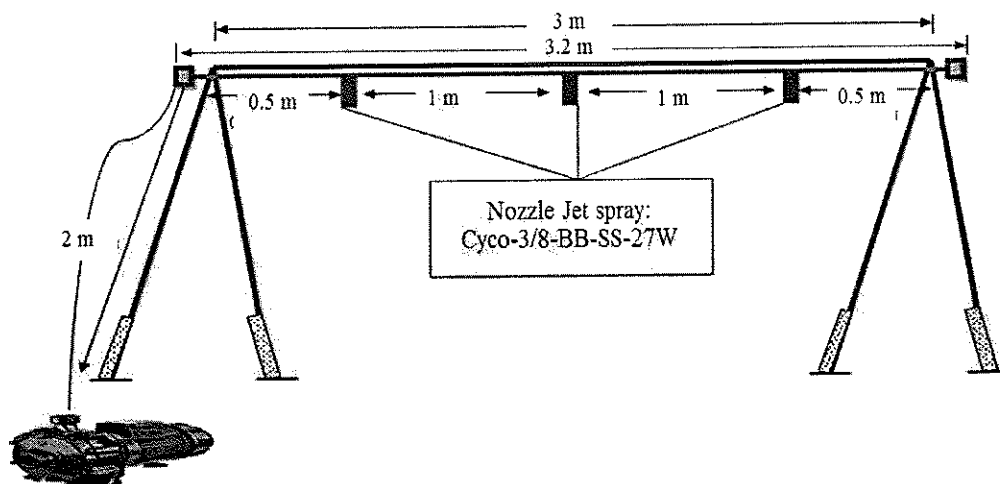


Figure 4: The rainfall simulator

Results

Evaluation of Vetiver Grass Growth

Vetiver grass growth recorded during four months showed that Roi-Et ecotype was the fastest growing on loamy sand soil. At the fourth month, Roi-Et ecotype growing was up to 155.79 cm high, which was significantly higher than Monto and Kampeangpech ecotypes, respectively (Figure 5 and Table 1). According to Nualchavee (2007: 12-23) suggested that Roi-Et was suitably grow in sandy soil.

Survival rate of Roi-Ed, Monto and Kampeangpech were 97.40, 91.55 and 77.92%, respectively (Figure 6).

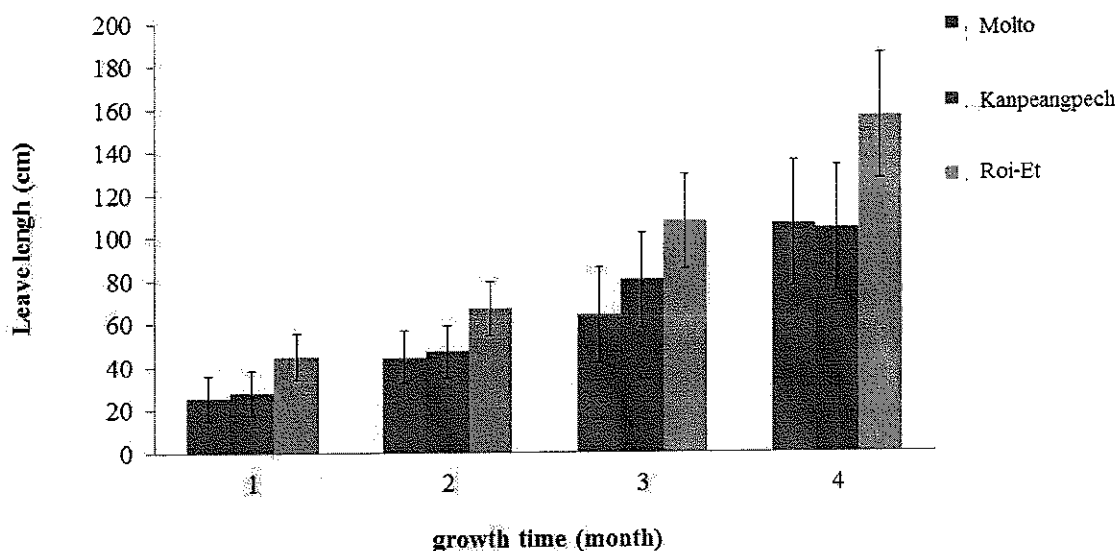


Figure 5: The leaf lengths of three vetiver grass for four months

Table 1: Growth comparisons of vetiver grass for four months field study measurement.

Vetiver grass Ecotype	Height (cm)			
	1 st month	2 nd month	3 rd month	4 th month
Monto	25.42 ± 0.26 ^a	44.44 ± 0.59 ^a	63.68 ± 0.19 ^a	106.28 ± 0.20 ^a
Kampeangpech	27.84 ± 0.55 ^b	46.98 ± 0.60 ^b	79.94 ± 0.67 ^b	103.95 ± 0.29 ^b
Roi-Et	44.79 ± 0.70 ^c	66.84 ± 0.21 ^c	107.27 ± 0.3 ^c	155.79 ± 2.00 ^c

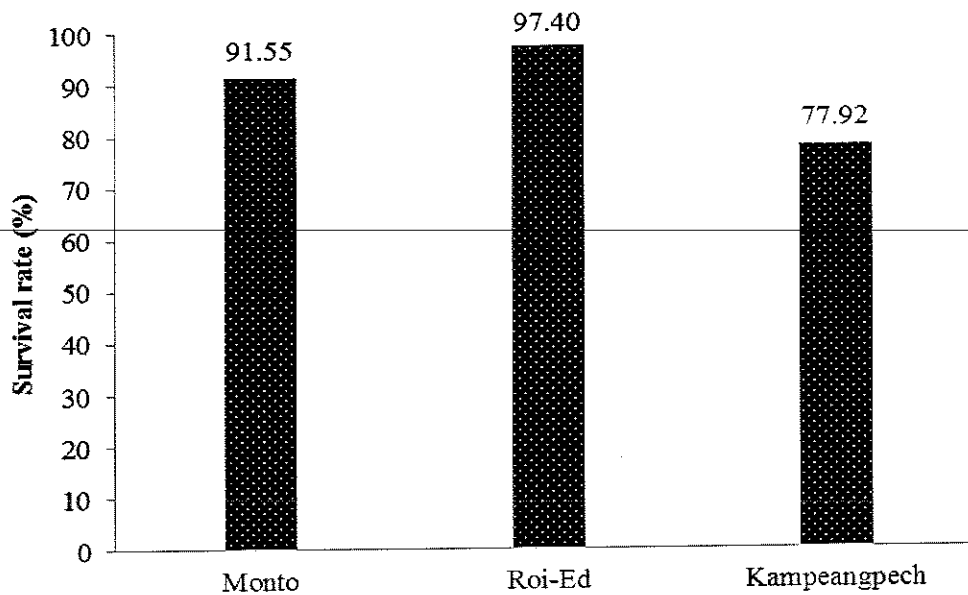


Figure 6: The survival rate of vetiver grass planted on loamy sand soil in study area

Evaluation of runoff and sediment losses

Runoff reduction

Average runoff values are presented in Table 2. Large rainfall simulation events affected the volume of runoff increasing. The volume of runoffs were decreased when had more vetiver grass strips in a plot. All period of experiments shows that 2, 3 and 6 strips of Kampeangpech treatments had the highest average volume of runoff, 7,745.33, 13,694.33 and 30,159.67 ml under 5, 10 and 15 minutes of rainfall simulation event, respectively. Roi-Et was the best vetiver grass ecotype to decrease the volume of runoff, especially on the plot of 6 strips of vetiver grass hedgerows, only 4,571.00, 9,553.00 and 18,501.00 ml under 5, 10 and 15 minutes of rainfall simulation event, respectively. Table 4 shows that efficient of runoff protection of Roi-Ed treatment by 49.30% was significant higher than other treatments ($p < 0.05$). Kasozi (1997: 255-257) referred that establishing vetiver on contour lines, the embankment of both cut and fill sloped soil can be effectively stabilized. The deep-root system stabilizes the slope, while the hedges reduce runoff, increase infiltration and trap sediment. This provides a very favorable environment for planting crops on the slopes.

Sediment loss reduction

The soil loss results after carried out under different rainfall simulation events are presented in Table 2 and Table 4, respectively. The sediment losses from the nine vetiver grass treatments were significantly lower than that the control treatment. The lowest sediment loss was recorded from 6 strips of Roi-Et. This was because of several factors such as vetiver grass reduced velocity of runoff due to a relative roughness protected to the flow by its stems and leaves. This can increase rate of infiltration into the soil. Moreover, the vetiver grass limited the capacity of runoff to detach and transport soil particles, these effect on runoff volume and velocity, and the physical protection of the soil from the runoff. The organic matter that gain from decayed leaves, stems and roots of the vetiver grasses by microbial

activity increased stability of soil aggregate which increase a soil permeability and infiltration. This can reduce runoff and soil loss because the stability of the soil aggregates affected their detachability by rain drop impact and their detachability and transportability by runoff (Styczen and Morgan, 1995: 496-509). Foster (1982) stated that sediment transport through grass strips diminishes exponentially with increasing grass width (Humberto et. Al, 2004: 1670-1678). The percentage reduction soil loss when compared with control treatment, Roi-et reduced sediment losses in all performance and rainfall simulation events (Table 4). However, all vetiver grass strips treatment could significant help to protect sediment losses more than 70% when compared with control plot. Chengchun et al. (2003: 349-357) staged that a good hedge will reduce rainfall runoff by as much as 70% and sediment by as much as 90%.

Table 2: Runoff of each plot under different rainfall simulation event

Vetiver grass ecotype and performance	Average runoff ^{1/} (ml.)		
	5 mins	10 mins	15 mins
Control plot	9,259.67 ± 2.60 ^a	18,250.00 ± 8.66 ^a	36,494.33 ± 2.96 ^a
Monto (2 strips)	7,301.00 ± 4.39 ^b	14,961.67 ± 9.62 ^b	29,938.00 ± 3.51 ^b
Roi-Et (2 strips)	7,069.33 ± 17.62 ^b	13,694.33 ± 3.76 ^b	27,374.67 ± 6.77 ^b
Kampeangpech (2 strips)	7,745.33 ± 2.60 ^b	15,090.67 ± 5.21 ^b	30,159.67 ± 2.60 ^b
Monto (3 strips)	6,105.33 ± 7.54 ^c	11,204.00 ± 8.72 ^b	23,403.00 ± 4.36 ^c
Roi-Et (3 strips)	6,033.00 ± 6.36 ^c	10,054.00 ± 6.66 ^b	21,092.33 ± 2.85 ^c
Kampeangpech (3 strips)	6,430.33 ± 1.45 ^c	12,863.33 ± 6.01 ^b	25,722.67 ± 1.45 ^c
Monto (6 strips)	4,981.67 ± 2.40 ^d	9,762.67 ± 4.37 ^c	19,930.33 ± 0.88 ^d
Roi-Et (6 strips)	4,571.00 ± 7.55 ^d	9,553.00 ± 4.36 ^c	18,501.00 ± 5.57 ^d
Kampeangpech (6 strips)	5,128.00 ± 1.53 ^d	9,962.67 ± 4.37 ^c	20,522.67 ± 1.45 ^d

Note: ^{1/} Means within column followed by different letters are significantly different from each other (P<0.05).

Table 3: Sediment loss of each plot under different rainfall simulation event

Vetiver grass ecotype and performance	Average sediment loss ^{1/} (ton/rai)		
	5 mins	10 mins	15 mins
Control plot	2.08 ± 0.001 ^a	6.55 ± 0.004 ^a	18.35 ± 0.002 ^a
Monto (2 strips)	0.49 ± 0.001 ^b	1.84 ± 0.002 ^b	3.67 ± 0.001 ^b
Roi-Et (2 strips)	0.41 ± 0.002 ^b	1.58 ± 0.001 ^b	2.78 ± 0.002 ^c
Kampeangpech (2 strips)	0.62 ± 0.001 ^c	2.80 ± 0.001 ^c	4.63 ± 0.003 ^d
Monto (3 strips)	0.33 ± 0.002 ^b	1.21 ± 0.001 ^b	3.00 ± 0.001 ^b
Roi-Et (3 strips)	0.30 ± 0.001 ^b	1.05 ± 0.002 ^b	1.74 ± 0.001 ^c
Kampeangpech (3 strips)	0.41 ± 0.002 ^b	1.49 ± 0.001 ^b	3.72 ± 0.002 ^b
Monto (6 strips)	0.23 ± 0.001 ^d	0.49 ± 0.001 ^d	1.29 ± 0.002 ^e
Roi-Et (6 strips)	0.20 ± 0.002 ^d	0.47 ± 0.001 ^d	1.05 ± 0.001 ^e
Kampeangpech (6 strips)	0.28 ± 0.003 ^d	0.59 ± 0.001 ^d	1.58 ± 0.001 ^e

Note: ^{1/} Means within column followed by different letters are significantly different from each other (P<0.05).

The Roi-Et distinctively showed highest reduction in runoff and soil loss of all performances and rainfall simulation events (Table 4). This was attributed to the fact that more leaves and stems growing retarded more runoff flow and filtered more sediment. Moreover, growth rate in width and height of Roi-Et vetiver grass was faster than that of the other two ecotypes, enabling it to develop a more effective barrier against runoff and soil loss (Sultan et al., 2006: 549 – 558).

Table 4: Efficient of vetiver grass strips for sediment and runoff protection

Vetiver grass ecotype	Efficient of sediment loss protection (%)			Efficient of runoff protection (%)		
	2 strips	3 strips	6 strips	2 strips	3 strips	6 strips
Monto	79.98±0.01 ^c	83.67±0.01 ^d	92.67±0.01 ^b	17.97±0.02 ^e	35.87±0.01 ^c	45.39±0.01 ^b
Roi-Et	84.85±0.01 ^d	90.53±0.01 ^c	94.26±0.01 ^a	24.99±0.01 ^f	42.20±0.01 ^b	49.30±0.01 ^a
Kampeangpech	74.77±0.02 ^f	79.70±0.01 ^e	91.40±0.01 ^b	17.36±0.01 ^s	29.52±0.01 ^d	43.76±0.01 ^b

Note: different letters are significantly different from each other (P<0.05).

Conclusion

The vetiver grass strips treatments were effective for controlling runoff and soil loss under rainfall on gentle land slope (8.76%) of loamy sand soil on where the experimental plots were established. The 6 strips of Roi-Et treatment was the best practice to protect sediment loss and runoff because of the fastest growing and tight clump of Roi-Ed ecotype and more vetiver grass strips has a superior capability to reduce soil erosion. However, all vetiver grass ecotypes and performances could be used as barrier against runoff and soil loss. Eventhough, we recommended that they should be rates as: Roi-Et>Monto>Kampeangpech and 6 strips>3 strips>2 strips in accordance with their effectiveness. Although many grasses, shrubs, trees and mechanical techniques have been used to prevent soil erosion over the years but the vetiver grass has stood the test of time. With its wide ranging tolerance of adverse climatic conditions, vetiver offers a simple low-cost technique that can help farmers solve their biggest problem, soil erosion. Therefore we highly recommend planting vetiver grass not only in this study area, but also worldwide. Let us join hands to support the vetiver grass and its users.

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