THE USE OF VETIVER GRASS IN THE RECLAMATION AND IMPROVEMENT OF ACID SULPHATE SOILS IN THAILAND: A PRE-EXPERIMENT STUDY

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Introduction

Acid sulphate soils are soils which occur in low-lying coastal areas with brackish sediments. Their natural drainage is poor or very poor, and if they have not been artificially drained, the water table lies close to or at the surface, at times or throughout the year.

They occur when pyrite is oxidized upon drainage to form sulphuric acid. Acid sulphate soils normally give no yield or very low yields. Acid sulphate soils in Thailand cover about 1.5 million ha and are scattered in the southern part of the Central Plain as well as in coastal areas of the East and South. The total area of acid sulphate soils in the Central Plain is about 0.88 million ha. They are classified into sulphaquents (potential acid sulphate soils), sulphaquepts (young acid sulphate soils), and sulphic tropaquepts (mature acid sulphate soils). Young acid sulphate soils are found in the coastal areas of eastern and southern Thailand. In general, these soils have a low potential for agricultural production and require heavy investment in lime and fertilizer to be brought under production.

The mature and young acid sulphate soils (sulphic tropaquepts and typic sulphaquepts) have jarosite in the profile. Generally, the soils are very low in pH. The low pH is caused by the oxidation of sulphides (mainly pyrite) into sulphuric acid and complex iron/aluminum sulphates. They are poorly drained, clayey textured soils; the subsoil is very loose when dry and very easy to be eroded. Jarosite mottles, found as yellow mottles, mark the end of the oxidation reaction. However, at a later stage, hydrolysis of the jarosite takes place, releasing more sulphuric acid. The degree of acidity in the root zone of the topsoil is generally related to the amount and depth of jarosite. Most of the soils are used for paddy cultivation with very low yields.

The Soil Survey Division of the Land Development Department uses the depth of jarosite horizon as a major diagnostic criterion in classifying the suitability of acid sulphate soils for rice. Three classes are recognized, namely, (1) P-II, pH 4.4-4.9 and the jarosite horizon is deeper than 100 cm from the soil surface; (2) P-III , pH 4.0-4.4, and the jarosite horizon is between 50-100 cm from the soil surface; and (3) P-Ia, pH is lower than 4.0 and the jarosite horizon is within 50 cm from the soil surface. Class P-Ia is a non-acid sulphate.

The problems arising from adverse effects of acid sulphate soils are acidity, aluminium and iron toxicity, phosphorus deficiency, and low base status; salinity and hydrogen sulphide toxicity have also been found.

The main limitations of these soils for agricultural production are soil acidity, phosphorus deficiency and toxicity of Fe and Mn. Flooding often occurs in the depression areas. In addition, the drainage condition of the areas is limited, preventing crop diversification. Liming and phosphorus application are generally recommended for improvement. All acid sulphate soils tend to be low in nitrogen and available phosphorus. Where the acidity is high, added phosphate tends to be quickly fixed. The benefits from fertilizer are therefore greatest where the acidity has been reduced by liming or other means. Liming alone has minor benefits in increasing available calcium and, at least initially, aiding the mineralization of nitrogen, but in general can only usefully be used in conjunction with adequate fertilizer. All these soils need fertilizer. The greater the initial acidity level, the more benefit is likely from a liming program.

Regarding how to improve these soils for agriculture, it is held in some quarters that liming is justified on all acid sulphate soils. Varying rates are recommended. Assuming that marl is the liming agent used, then 3.125 t/ha on P-IIa soils has been quoted, 3.125 to 6.25 t/ha on P-IIIa soils, and 6.25 to 12.5 t/ha on P-IVa soils. The residual effects of liming are expected to last for about five years in each case, after which liming should be repeated. The effects are expected to last for six to seven years.

To use acid sulphate soils requires large capital investment and high technology (Panichpong 1982). These two requirements do not normally exist in developing countries such as Thailand. The high rate of population increase creates great pressure on using land for different purposes, especially for producing food and fibre vital for human beings.

Given the vast area of acid sulphate soils in Thailand and the increasing need for more land for food production, their importance cannot be understated (Vasuvat 1996). Therefore, great effort has been put into research work for reclamation and improvement of the acid sulphate soils by using vetiver grass.

His Majesty King Bhumibol Adulyadej of Thailand fully realizes that soil erosion and problem soils are a major national and international problem which needs to be managed properly (Tantivejkul 1996). He has urged all concerned agencies to seek effective management and long-term conservation and management measures. His Majesty has recognized the potential of vetiver grass as a practical and inexpensive yet effective tool to address the soil erosion problem. He has, therefore, promoted the experimental use of vetiver grass in Thailand.

Realizing the need for the reclamation of acid sulphate soils for agriculture and to prevent good soils from becoming problematic ones, this study was conducted to investigate ways to conquer the problem of acid sulphate soils.

Objectives

The main objectives of this study were to: (i) select the ideal vetiver grass ecotypes for the improvement of acid sulphate soils; (ii) study the proper management supporting vetiver grass hedgerow establishment efficiency; and (iii) study the bioengineering function of vetiver grass.

Methodology

The study plan was divided into three stages as follows:

- *Stage 1:* Pre-experimental study of options of ecotypes and management for promising measures under controlled factors by pot experiments
- *Stage 2:* Field experiments to obtain the best opportunity measure of outstanding performance
- *Stage 3:* Evolution study to set pilot projects to define the problems encountered

A three-year work plan was initiated in October 1997. Pot and field experiments were conducted. The project was supervised by Mr. Sima Morakul and Mr. Chaiyasit Anecksumpunt. The studies and experimental sites are as follows:

Study on Acid Sulphate Soils at the Office of Land Development Region 2

In the first year, the experiment was conducted in greenhouses. Height and tiller number were investigated and analysed for statistical comparison. The best ecotype that can survive with very low pH should obtain a tendency of highest biomass production to be used for mulching purposes, having the greatest tendency to stop the export of topsoil. The highest tiller number per hill revealed an ability to obstruct eroded soil and control runoff and loss of applied fertilizers. The fastest growing hedgerows obtained from a high rate of tillering would contain runoff and stop erosion; therefore costly mechanical contouring of slopes would not be required. This measure could also be practical for embankments and soil stabilization. The root distribution was investigated. The highest root distribution ecotype should have the highest tendency to retain sufficient soil moisture by water harvest action, moisture conservation and decontamination of agronomical residues, thus cleaning water in the streams and rivers and ensuring watercourse stabilization, slope stabilization and environmental protection.

Experimental Methodology

At the initial stage, experiment on the use of vetiver grass for development and rehabilitation of acid sulphate soils on the Bang Nam Prieo soil series (P-IIa, typic tropaquepts) was conducted under greenhouse conditions in Chon Buri province. The experimental design was 4 x 4 factorial in CRD.

Factor 1 was four ecotypes of vetiver, namely, India (Khao Kho), Phra Ratchathan, Sri Lanka and Loei. Factor 2 was four rates of 15-15-15 fertilizers, namely, 0, 2.5, 5.0 and 7.5 g/hill. Every pot was treated with hydrated lime at the rate of 3.125 t/ha.

Results and Discussion

Results showed that the Sri Lanka ecotype obtained the highest plant height (76.67 cm) when 15-15-15 fertilizer was applied at the rate of 5.0 g/hill. There was no statistical difference among the three ecotypes of vetiver, namely, Phra Ratchathan, Sri Lanka and Loei, but all were different from the India (Khao Kho) ecotype. There was no statistical difference on plant height from using every rate of 15-15-15 fertilizer as shown in Table 1 and Fig. 1.

The results indicated that the Sri Lanka ecotype gave the highest number of tiller/hill (11.5). There was no statistical difference among the rates of fertilizer on the number of tiller/ as shown in Table 2 and Fig. 2. There was no statistical difference among the rates of 15-15-15 on vetiver grass ecotypes.

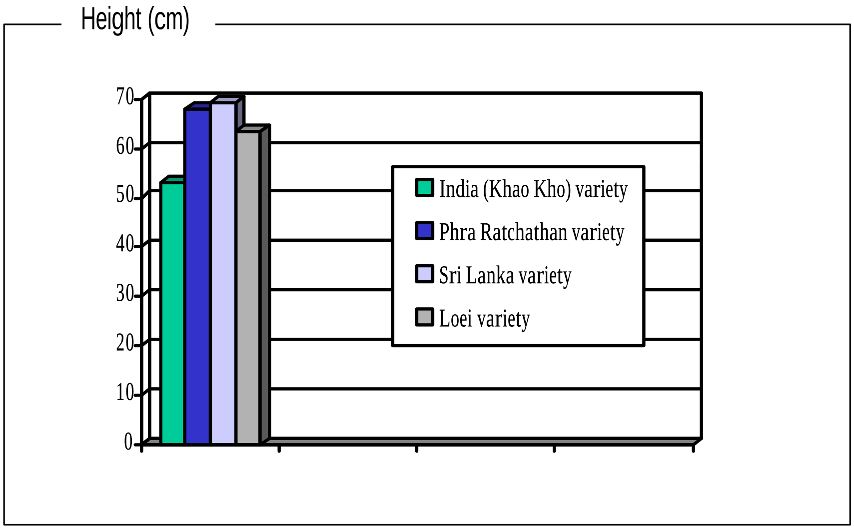

Fig. 1. Effect of vetiver grass ecotypes on plant height (cm) of vetiver grass

Table 1. Effect of vetiver grass ecotypes and rates of 15-15-15 fertilizer on plant height of vetiver grass (cm)

	V 1	V 2	V 3	V 4	Average
F 1	163	225	185	156	60.75
F 2	165	195	200	200	63.33
F 3	160	210	230	195	66.25
F 4	148	185	217	215	63.75
Average	53.00A	67.92BC	69.33BCD	63.52B	63.52

NB: V1 = India (Khao Kho) ecotype F1 = 15-15-15 fertilizer, 0 g/hill
V2 = Phra Ratchathan ecotype F2 = 15-15-15 fertilizer, 2.5 g/hill
V3 = Sri Lanka ecotype F3 = 15-15-15 fertilizer, 5.0 g/hill
V4 = Loei ecotype F4 = 15-15-15 fertilizer, 7.5 g/hill

In each column, means followed by a common letter are not significantly different at the 1% level by DMRT

Table 2. Effect of vetiver grass ecotypes and rates of 15-15-15 fertilizer on tiller/hill

	V 1	V 2	V 3	V 4	Average
F 1	25	30	26	21	8.5
F 2	17	30	39	25	9.25

F 3	21	31	31	31	9.50
F 4	20	29	42	30	10.08
Average	6.92A	10.00BC	11.50CD	8.92AB	9.33

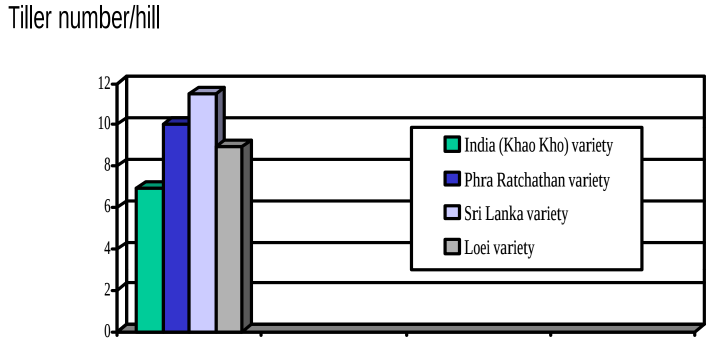

Fig. 2. Effect of vetiver grass ecotypes on tiller number per hill of vetiver grass

Conclusion

From the experiment on the use of vetiver grass for development and rehabilitation of acid sulphate soils on the Bang Nam Prieo soil series (P-IIa, Typic Tropaquepts) under greenhouse conditions, it can be concluded that the Sri Lanka ecotype obtained the highest plant height and had the highest number of tillers per hill. There is no statistical difference among rates of 15-15-15 on vetiver grass ecotypes.

To date, the focus on increasing food production throughout the world has been predicated on a world population increase of about 1.7 % annually. It is obvious that much of the additional food production needed in future years must come from poor soils such as acid sulphate soils. Vetiver hedges used to stabilize the bank of a farm pond protecting it from flooding are a cheap and effective methodology.

The vetiver system has reclaimed the land to full production by retaining the runoff as a means of moisture conservation, retaining 60 % of the rainfall. This is the best way of refilling groundwater.

The results of this experiment will enhance the moisture content of acid sulphate soils by improving the water-holding capacity of soil and by decreasing soil salinity and toxic substances, providing anchorage and stabilizing the soil at road shoulders. According to His Majesty's initiative to use vetiver grass as a practical and inexpensive effective management and conservation tool to address problem soils and the soil erosion problem, these experimental results show how to solve those problems to preserve natural resources and carry out sustainable agriculture. Vetiver can benefit farmers by producing better crop yields, obtaining fuel for energy while stopping land degradation and export of topsoil, decreasing fertility loss, improving underground water reserves and doing without mechanical engineering systems which decrease the farm areas.

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