EXPERIMENT OF THE APPLICATION OF VETIVER TO SAND-FIXING IN SUBTROPICAL DESERTS

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Abstract

Desertification, a worldwide problem, is being paid increasing attention by governments and scientists in various countries. There are 1.7 million km^2 of sandy deserts, gobi deserts and desertified lands in China, constituting 17.6% of the country's total land area. In Jiangxi province, satellite observation data shows that in the Poyang Lake Basin, 17 600 hm^2 of land have been desertified in various degrees. In Nanchang City, the capital of Jiangxi province, about 16 268 km^2 of land are desertified, 427 km^2 are covered by semi-fixed sand dunes, 2 555 km^2 by fixed sand dunes and 2 017 km^2 by shift sand dunes.

Shift sand dunes are moving northward from the south with a speed of 5m/a (Zhao et al. 1997). During a period of 30 years, i.e. from 1950 to 1980, eight villages of Guangshang and Fushan townships in Nanchang county and Houtian township in Xinjian county were destroyed and covered by shift sands, causing the loss of 660 hm^2 of farmland and damage to a series of water conservancy facilities due to sedimentation. Hence, desertification is a very urgent hazard to be controlled.

To stabilize the sand dunes, vetiver grass was introduced to Fushan township of Nanchang city in March 1998. It was planted in lines. Although the sands lacked plant nutrients, 91 % of the planted vetiver survived and grew well. Besides, vetiver encouraged weeds to grow. Therefore the sandy dune was fixed. The successful experience is valuable not only to the Poyang Lake area but also to other riverbanks and coastal regions which cover a large area in Southeast China.

Introduction

There are 1 699 000 km^2 of sandy deserts, gobi deserts and desertified lands in China, constituting 17.6 % of the country's total territory. In the past 20 years, desertified lands have increased yearly by 2 460 km^2 on average, resulting in yearly economic losses of Yuan/RMB54 000 million. In Jiangxi province, satellite observation data shows that in the Poyang Lake Basin alone, 17 600 hm^2 of land have been desertified in various degrees. The development of local industry and agriculture and the improvement of local people's lives are limited by fuel shortages and adverse environment conditions caused by desertification. Moreover, the national economy and the sustainable social development are severely affected too. Located in a subtropical humid area, the Nanchang region is subjected to the impact of water and wind erosion, sedimentation and irrational land use, resulting in sand hills, sand dunes and sand beaches of various sizes along the Ganjiang River and around the Poyang Lake. In Nanchang city, 16 268 km^2 of lands are desertified, 427 km^2 of land are covered by semi-fixed sand dunes, 2 555 km^2 of land by fixed sand dunes and 2 017 km^2 by shift sand dunes.

Shift sand dunes are moving northward from the south at a speed of 5 m per annum (Zhao et al. 1997). During a period of 30 years, i.e. from 1950 to 1980, eight villages of Guangshang and Fushan townships in Nanchang county and Houtian township in Xinjian county were destroyed and covered by shift sands, causing the loss of 660 hm^2 of farmland and damage to a series of water conservancy facilities due to sedimentation. Hence, desertification is a hazard that needs to be controlled urgently.

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Several years ago, a subtropical desert experiment station was set up aiming at the research on the control and utilization of subtropical deserts with an EUC5-million grant from the European Union. Although some results have been achieved so far, good solutions to desertification may be found when the integrated balance of the whole ecosystem is reached with help from the whole society.

In China, vetiver was recommended by Mr Richard G. Grimshaw from the World Bank in 1988 for the Red Earth Project in Jiangxi province. It was proved useful for erosion control and helped increase crop production. Now, vetiver grass technology is applied to sand-fixing on sea beaches and riverbanks, for highway embankment protection, edible mushroom culture as well as the control of polluted and eutrophic water discharges in urban areas (Cheng and Libin 1998; Cheng 1998; Cheng et al. 1998). However, the application of vetiver to subtropical desertification control has been very limited. Therefore, an experiment of vetiver application to sand-fixing was initiated at the Nanchang Subtropical Desert Experiment Station with the support of both The Vetiver Network and the China Vetiver Network.

Material and Method

Basic Condition of Experiment Sites

Situated at Fushan township in the Nanchang county (115° 52' 32" E, 28° 32' 30" N), 25 km from downtown Nanchang city, the Nanchang Subtropical Desert Experiment Station was set up in 1993 under the administration of the Nanchang City Commission for Science and Technology and with financial aid from the European Union. Basic conditions at the station are listed in Table 1. It must be pointed out that the groundwater level of the station is quite high, about 40 cm as measured in July 1999.

Table 1. Basic condition for vetiver sand-fixing experiment site

Location	East longitude	North latitude	Max. temp.	Min. temp.	Aver. annual temp.	Aver. annual rainfall
Fushan, Nanchang	115°52' 32"	28°32' 30"	40.1§àC	-10§àC	17.5§àC	1590 mm

Location	Soil texture	pH	OM (%)	N (%)	P (%)	K (%)	Diam. of sand particles
Fushan, Nanchang	Sandy	6.0	0.09	0.004	0.032	0.013	CA 0.01 mm

Experiment Materials and Method

Over 10 000 slips of vetiver, brought on 21 March 1999 from the Jiangxi Red Earth Ecological Extension and Experiment Station situated in the Dongxiang county of Jiangxi province, were planted the next day in contour on about 1/3 hm^2 of selected semi-fixed sand dunes, located at the entrance of the Nanchang Subtropical Desert Experiment Station, with clump spacing of 15 cm and row spacing of 600 cm and planting depth of 15-25 cm. After planting, pig dung manure was applied once (Table 2).

Table 2. Vetiver planting status in sand-fixing experiment

Location	Date of planting	Spacing of clumps	Spacing of rows	Slips in a clump	Depth of planting	Area of protected lands	Tested clumps	Note
Fushan Nanchang	22 March 1998	15 cm	600 mm	1	15-25 cm	1/3 hm^2	30-60 clumps/ time	Observed every 20 days

Experiment Results and Their Analysis

Vetiver Growth Appearance in Sand-fixing Period

Table 3 shows that vetiver grass grew normally on sandy soil in extremely adverse conditions (extreme shortage of N, P and K). They grew up to a height of 1.6 m above ground, tillering well (max. 32 slips/clump), rooting deeply (over 1 m), forming very good ground coverage and hedge. However, they appeared a little poorer in their late growth phase with red tips in their leaves. This might be related to lack of P and Fe elements.

Ecological Effects of Vetiver Hedges

According to field observations on 24 May, 19 June and later, many more species and a number of other plants were found on the ground protected by vetiver hedges, compared with control, i.e. a large quantity of grasses and weeds were found around or within the vetiver hedges, including *Digitaria sanguinalis* (L.) Scop., *Imperata cylindrica* (L.) p. Beauv., *Cynodon dactylon* (L.) Pers., *Colocasia esculenta*, *Cyperus rotundus* Linn., *Eremochloa ophiuroides*. However, no invasion of *Vetia trifolia* var. *simplicifolia*, though suitable for local growth, was found in the experiment ground.

Table 3. Vetiver growth appearance during the sand-fixing period

Date (1998)	Date of turning green	Survival rate	Average tillering number	Average plant height (cm)	Root system distribution	Remarks
22 Mar	Transplanting					
19 Apr	26th day after planting	91%				
10 May			3.18	41.36	Depth 30 cm Width 30 cm	
24 May			3.75	51.5		Vigorous growth even in submerged spots
19 Jun			7.62	80.5		Max. 16 tillers /clump
4 Jul			8.4	117.75		
10 Aug			10.0	135.5		
16 Sep			14.1	139.5		Wilted and red in a few leave tips, maybe lack of P
1 Oct			18.2	140.5	Depth: 85-110 cm, vetiver hedge formed	Max. 32 tillers/clump

Table 4 shows that vetiver planting and growth had positive results in sandy ground treatment. First, sand invasion and shift were successively controlled by vetiver, thanks to its deep and massive root system. Second, an even better ground coverage was formed due to the immigration of more grass or weed species resulting in much better sand-fixing on a large scale.

Table 4. Impact of sand fixing by vetiver on improvement of environment and recovery of vegetation

Treatment	Vegetation coverage (%)	Sand mobility	Organic matter (%)	N (%)	P (%)	K (%)	Vigor of plant
Fixing by vetiver	40-68	Immobile	0.9	0.01	0.016	0.017	6-8 species vigorous
Control	1-8	Mobile	0.095	0.004	0.035	0.015	3-5 species less vigorous

Discussion

Vetiver: A Pioneer Plant

With the establishment of vetiver hedges, the production capability of desertified or degraded land may be recovered or improved gradually. Research elsewhere, for example in India, shows that, with the planting of vetiver on bare land for 12-15 years, the production capacity of the originally degraded grounds was recovered, forming mixed tree and grass fields with a well-improved microclimatic environment (National Research Council 1993). Vetiver grass is a species with extremely strong reverse resistance, including to saline and alkaline conditions, dampness, drought, infertility and heat (Cheng and Libin 1998; Cheng 1998). Our experiment confirmed that vetiver is really a pioneer plant which may grow well in subtropical deserts with very little N, P and K nutrients, standing as high as 160 cm, tillering as many as 32 slips/clump and rooting to a depth of more than 100 cm just in one growing season after planting. There are many more species and plants on subtropical desertified ground planted with vetiver grass than on control bare ground, as ground vegetation coverage was formed after the vetiver establishment, creating a better growing habitat for other grasses and for weeds.

The role of vetiver in water and soil conservation in South China has been confirmed (Xia et al.1996; Xu et al.1997). In their research, Xia et al. (1997) showed that on ground planted with vetiver grasses, runoff and eroded soil masses decreased by 60 and 93 %, respectively, while moisture contents increased by 40 to 42 %. Vetiver grass technology was successively applied for sea beach and riverbank protection (Norton 1992). Effects of vetiver hedges on wind-break and sand-fixing were obvious on Pingtan Island, Fujian province, where there is severe wind erosion; Aeolian sands constitute 90 % of the island's total territory and frequent strong winds are above 7^{th} grade (13.9-17.1 m/sec) (Zhang 1997).

In this studied case, factors limiting vetiver growth might be the lack of nutrients P and Fe, which made the vetiver leave tips withered and red rather than the shortage of moisture because the annual rainfall there was 1590 mm and the groundwater level was about 40 cm. It was concluded that vetiver grasses with their developed root system and vigorous growth could be used to fix the shift and semi-shift sands on subtropical desertified lands by increasing ground vegetative coverage, improving micro-eco-environment and accelerating the growth of other grasses. However, a larger demonstration is needed. The Duchang County Highway Bureau and the Nanchang Water Conservancy and Hydro-Power College of the Ministry of Water Conservancy have signed a contract whereby the grass will be used to fix the sandy highway embankment along the Poyang Lake, starting next spring. Many other projects will also be started shortly as people realize that the grass is very cheap and very effective.

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