Simple Treatments to Protect Vetiver Against Cold Winter in North Subtropics of China

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Vetiver grass was introduced into China by Mr. Richard Grinshaw through World Banl supported agriculture project in 1988. (Xu L., & Fang C., 2003). It has been developed from soil and water conservation to engineering and infrastructure protection and environmental protection in the recent about 10 Years when Mr. Diti Henchawanich presented his paper titled Vetiver grass for Slope Stabilization and Erosion Control during the International Conference held in Fuzhou China in 1997 (Liyu Xu, 2002). Since 1988 Chinese scientists have done a lot on vetiver and showed that vetiver grass can grow well along the Yangtze River and to the south of the river (Liyu, 2005). However this conclusion was made based on the fact that the grass should be planted in spring or summer. If it was planted in autumn or later, the grass could not spend the cold winter safely. For example, vetiver grass was planted in November and December in 2000 spacing 20cm x _70-80cm_and ordinary management was provide. But most vetiver grass were died after a winter. It indicated that even in southern part of China vetiver could not planted in autumn or winter, otherwise the grass could not stand the following winter cold weather, because the grass could not grow up and 'ripen' in a short time before winter. The suitable planting season should be earlier following increasing latitude. In northern Fujian Province the suitable planting season should be around September.

The earlier study has showed that vetiver could grow well when planted in spring or summer in Jiangsu Province, the north subtropical area. The present research was to understand if vetiver could plant in October in this area with some simple treatment to protect vetiver against cold winter in order that more time can be used for vetiver planting..

1 Material and method

1.1 Background of the planting slope

The fill embankments of Ning-He express way in Nanjing City, the capital of Jiangsu Province, were selected. The embankments belonged to two different kind: north aspect slope and south aspect slope. The two slopes were 196m long respectively with a width of 7.5m. The gradient was around 40°. The total area was 3000m^2 .

The slopes consisted mainly of soil material in addition to some small stones and cement blocks left during the road construction. The south aspect slope had a little more than the north aspect slope.

Due to higher slope gradient rainfall usually caused erosion or even collapse in summer.

1.2 The planting of vetiver grass

Because the embankment was hard and it was difficult to dig, small platforms that were about 30cm wide were prepared before planting. Then narrow ditches were prepared with a depth for 20cm. The planting materials had 20cm stems and 10cm roots. They were planted spacing 15cm x 120cm. Each clump had 4-6 tillers. Watering was provided for continuous 3 days. The total planting spent 10 days in October 2004.

1.3 The winter protection treatments

1.3.1 Three simple treatments were used to protect vetiver grass against cold winter

To study the effectiveness of some simple treatments on vetiver grass survival rate against cold winter four plots were designed on both north aspect slope and south aspect slope respectively. Each plot had an area for 20m x 7.5m = 150 m^2. The four treatments were as follows:

(A) Plastic sheets covered on small arciform skeleton made of bamboo. That was 35-40cm high and 30cm wide. The sheets were fixed with a little of soil.

Fig.1 Plastic sheets covered on small arciform skeleton

Fig.2 Plastic sheets placed directly on vetiver grass

(B) Plastic sheets 50cm wide placed directly on vetiver grass with vetiver stems broken out of the sheets. Again, a little of soil was used to fix the sheets.

(C) Vetiver grass was covered by soil that was 10cm thick.

(D) Control. No any treatments were taken.

1.3.2 Treatment time

All of the treatments were taken when lowest temperature reached 5_ steadily. The treatment (A) and (B) were conducted on 24 November 2004.

Regarding to treatment (C), the first 5cm soil was covered on the same date, 24 November 2004, while the second 5cm was covered on 30 November 2004. Since some soil was washed away by rainfall, the third soil cover was done on 5-6 December 2004.

All of the treatments were stopped on 2 April 2005 when the lowest temperature over 5_ steadily.

1.3.3 Observation of the effectiveness of different treatments

A small *observation plot* that contained 10 clump x 2 rows = 20 clumps was arranged for each plot. Observation was done in the spring of 2005 to check vetiver survival rate of different treatments in order to understand the effect of different treatments on vetiver.

To study ecological condition on different slopes soil temperature was observed at 8:00 am, 2:00 pm, and 5:00 pm every 15 days. Besides, soil moisture at the depth of 0cm, 5cm, and 10cm below land surface was observed.

Besides, soil chemical properties were determined.

2. Results and discussion

2.1 Vetiver survival rate of different treatments

In Nanjing City (N33°), the experimental area, the temperature began to enter zero at the end of December 2004 and ended zero on 14 March 2005. In this period there were over 40 days with the lowest temperature below zero. The absolute lowest temperature was -7_. Under this condition vetiver grass should be effected by low temperature. However, if the grass were planted in spring and it could grow up before winter, the grass could stand low temperature without damage. For example, the grass stood −15.9_ in Jiangxi Province (N28°13') of China when it had been planted few years ago.

The grass turned greening started from mid March and finished in mid April. Then there was no much progress_Table 1_. Vetiver grass on the south aspect slope stared growth much earlier than that of north aspect slope. About 60-70% of the clumps turned into green on 20 March on south aspect slope. On 2 April 2005, when vetiver remained hibernation on north aspect slope, over 90% of vetiver on south aspect slope turned into green.

On south aspect slope, there was very little difference between different treatments. Almost all

of the grass tillers turned into green, possibly because there was plenty of sunshine on the slope and temperature on and in the soil was high. The periodical observation on temperature showed that when the temperature on north aspect slope was 3.0_(at 2 pm), the temperature on the south aspect slope reached as high as 16.5_(Table 2).

Table 1 indicated that the survival rate on north aspect slope was quite low, i.e. 46% for control observed on 22 April. For the treatment (A) and (B) it was much higher, i.e. 94% and 84% respectively. Although the temperature of treatment (A) and (B) on north aspect slope was much lower than the south aspect slope, most vetiver could turn into green after the winter possibly because the plastic sheets were beneficial to soil moisture retention. Table 3 showed that for the control on north aspect slope vetiver survival rate was quite low, 48 clumps, while for treatment (A) and (B) it was 159 and 118 clumps respectively. It means that if without any treatments vetiver could not planted in October on such slope in subtropical area such as Nanjing.

Table 1 Vetiver survival rate observed in 2005 (%, based on clumps)

Location	Treatments	Observation time_2005_				
		2 April	8 April	22 April	29 April	21 May
North aspect slope	(A) Plastic sheets on arciform skeleton	0	49	94	93	95
	(B) Plastic sheets on grass	0	43	84	88	90
	(C) Covered by soil	0	23	60	80	83
	(D) Control	0	14	46	65	70
South aspect slope	(A) Plastic sheets on arciform skeleton	90	*	91	91	90
	(B) Plastic sheets on grass	90	*	94	95	95
	(C) Covered by soil	85	*	93	94*	91*
	(D) Control	89	*	94	94	94

* Stopped by raining

Table 2 Soil temperature difference on north and south slopes (_)

Slopes	Treatments	Depth below land surface_cm_	Observe time		
			8:00am	2:00pm	5:00pm
North aspect	(A)Plastic sheets on skeleton	0	-3.0	0.0	0.0
		5	-3.0	-3.0	-2.0
		10	-1.0	0.0	0.0
	(B) Plastic sheets on grass	0	-4.0	2.0	-3.0
		5	-1.0	-0.5	0.0
		10	0.0	-0.5	-0.5
	(C)Covered by soil	0	-3.0	2.0	-1.0
		5	0.0	1.0	0.5
		10	0.0	1.0	0.0
	(D) Control	0	-3.0	3.0	-0.5
		5	-1.0	0.0	-0.5
		10	0.0	0.0	0.0
South aspect	(A)Plastic sheets on skeleton	0	3.0	22.0	6.0
		5	4.0	10.0	11.0
		10	5.0	11.0	10.0
	(B) Plastic sheets on grass	0	0.0	17.0	3.0
		5	5.0	9.5	9.0
		10	3.0	8.5	9.0
	(C)Covered by soil	0	-1.0	13.0	1.0
		5	1.0	6.0	5.0
		10	3.0	7.0	7.0
	(D) Control	0	-1.0	16.5	4.0
		5	2.0	10.0	8.0
		10	3.0	9.0	8.0

Observed on 15 January 2005

Table 3 Details on vetiver survival in spring 2005

Slopes	Treatments	Clumps turning into green	Clumps not turning into green	Total tillers turning into green	Mean tiller in each clump
North aspect	(A)Plastic sheets on skeleton	75	5	159	2.0
	(B)Plastic sheets on grass	67	13	118	1.5
	(C) Covered by soil	48	32	76	1.0
	(D) Control	37	43	48	0.6
South aspect	(A)Plastic sheets on skeleton	73	7*	238	3.0
	(B)Plastic sheets on grass	75	5	200	2.5
	(C) Covered by soil	74	6	188	2.4
	(D) Control	75	5	257	3.2

Observed on 22 April 2005. Each treatment contained 4 plots and each plot had 20 clumps.

Regarding to the growth of vetiver (Table 4) it was higher (33.5cm-39.6cm) for the grass on south aspect than that on north aspect (17.4cm-30.8cm) at the end of April, mainly caused by higher temperature. But later on 21 May the vetiver on north aspect grew quicker than that on the south possibly caused by higher moisture content, because north aspect received less sunshine and heat that led to less evaporation.

Table 4 Mean height of vetiver in spring 2005(cm)

Slopes	Treatments	Observation time: 29 April	Observation time: 21 May
North aspect	(A)	30.8	57.8
	(B)	25.7	47.5
	(C)	23.9	51.3
	(D)	17.4	47.0
South aspect	(A)	38.1	48.0
	(B)	35.9	49.4
	(C)	39.6	62.7
	(D)	33.5	53.0

(A) Plastic sheets on skeleton
(B) (B) Plastic sheets on grass
(C) Covered by soil
(D) Control

Table 5 Soil moisture on different slopes(%)

Slopes	North aspect		South aspect	
Soil depth_cm	5-10	15-20	5-10	15-20
Treatment (A)	22.47	22.17	17.53	19.80
Treatment (B)	26.45	25.89	18.17	14.35
Treatment (C)	23.96	22.02	19.82	16.23
Treatment (D)	22.87	24.44	16.00	20.75

Observed on 15 December 2004

2.2 The management of survived vetiver

The survived vetiver grass started to grow at the end of March. At the same time weeds started to grow as well. Hence weeding should be provided on time. Soil analysis indicated that N and P contents were not too low (Table 6), therefore a little of nitrogen would be enough for the grass when most of vetiver staring to grow.

3. Conclusion

From the study we can conclude:

(1) At the north subtropical area such as Nanjing of China vetiver grass was effected by low temperature in winter. If planted in autumn the grass could not grow up or 'ripen' before cold winter and therefore could not stand low winter temperature. In next spring vetiver grass might not survive. However the condition differed from different condition such as landform, slope aspect, soil moisture, etc.

(2) On south aspect vetiver survival rate was high in the next spring for all of the treatments even planted in autumn. It indicated that even if without any treatments vetiver could pass cold

Table 6 Soil chemical properties of the embankment

Location	Depth _cm _	O.M. _gkg- ⊤_	Total N _gkg- ⊤_	Total P (gkg-1)	Total K _gkg- ⊤_	Soluble N (mgkg-1)	Soluble P (mgkg-1)	Soluble K _mgkg- ⊢_	pH (water)
North aspect	0-20	15.94	0.826	0.465	17.2	8.35	5.67	143.8	7.84
	20-40	5.81	0.446	0.526	17.8	3.58	3.44	113.8	7.990
	40-60	2.79	0.276	0.411	18.9	3.10	2.25	99.5	8.01
	60-80	3.19	0.315	0.388	18.3	4.17	5.61	111.2	7.94
	80-100	3.51	0.336	0.358	17.2	3.58	8.39	110.4	7.90
South aspect	0-20	19.00	0.883	0.417	17.1	9.66	11.31	140.5	7.94
	20-40	8.59	0.411	0.375	17.4	4.77	2.99	90.6	8.13
	40-60	2.80	0.269	0.415	18.8	4.53	2.39	84.3	8.22
	60-80	2.56	0.207	0.456	18.7	2.98	1.93	87.0	8.23
	80-100	1.46	0.289	0.463	19.3	3.70	2.81	90.1	8.34

winter safely and grow normally. For north aspect, there was great difference for different treatments. The survival rate of treatment (A) and (B) were much high than that of treatment (C) and (D). It means that plastic sheet on both arciform skeleton and directly on grass were useful and effective and also cost very little.

(3)Since south aspect received much sunshine and heat and the evaporation was high, watering should be provided when vetiver turned into green in the next spring.

(4) Further study will be needed to see if vetiver could stand cold winter if planted in winter, November, December or January.

References

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