Studies on Development of Vetiver Root System in the Rejuvenation Period After Transplanting: A Fertilizer Experiment

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Abstract: The soil pot experiment of vetiver was carried out. The results indicated that application of fertilizer had a distinct effect on the growth of vetiver root systems in the infertile soils during rejuvenation period, but the developmental emphasis of the vetiver root system is different. Applying chicken manure not only had a positive effect on the rejuvenation of vetiver but also supplies the diversity of nutrients needed in shallow soil, makes vetiver grow a large number of new roots and branch roots in the shallow soil, and increases the surface area of the root system. So applying chicken manure is better than applying other fertilizers to vetiver, and produces a better effect on water and soil conservation.

Key words: *Vetiveria zizanioides*, root, rejuvenation period, fertilizer experiment

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1 INTRODUCTION

Vetiver grass (*Vetiveria zizanioides*) is a perennial grass of Gramineae, which originated from Southeast Asia, India and tropical Africa. At present, there are more than 100 countries or areas cultivating and using vetiver. Cultivated vetiver hedge is seen as an effective measure for water and soil conservation in provinces of Southern China since 1988 (Chen, 1998; Xia *et al.*, 1996). There is a positive future in using bio-measures. But vetiver has a long rejuvenation period and the growth of the vetiver root system is slow. Especially in the infertile soils on the sloping fields, the effect of the water and soil conservation during the vetiver field planting period was destroyed. If there are rainstorms in the construction and shallow soils eroded, the construction of vetiver hedge would fail. In order to search for the measures that accelerate the growth of vetiver root systems in shallow soil, the comparative experiments of different fertilizers were carried out. The fertilizer that can better improve the root system of vetiver and strengthen eco-engineering of vetiver during the rejuvenation period is considered a worthwhile endeavour.

2_ MATERIALS AND METHODS

2.1 Soil Materials

In the experiment, infertile red soil originated from granite was provided. The basic, physical and chemical properties of the experiment soil can be found in Table 1.

2.2 Methods

These experiments were conducted using soil pots. . Four types of fertilizer were collected for the experiment. They are respectively organic fertilizer (chicken manure, from market), compound fertilizer (BB fertilizer, 25.7-7.8-20, from Nongzi Company of Guangdong), organic and inorganic compound fertilizer (KangBao fertilizer, 10-2.5-6 from LiangTian compound fertilizer factory in Guangzhou), NaCl (containing iodic salt, from market). Five treatments were chosen in the experiment. Each treatment and the quantity of fertilizer was as follows: T1: CK (no fertilizer), T2: chicken manure (15 g/kg soil), T3: BB

fertilizer (0.3 g/kg soil), T4: KangBao fertilizer (0.6 g/kg soil), T5: chicken manure (15 g/kg soil) + BB fertilizer (0.3 g/kg soil) + Nacl (0.5 g/pot, hole fertilization). Each treatment was the mean of three replicates.

Table 1 Physical and chemical properties of the experiment soil

Analytical item	Determination method	Value	Classification
pH	Electro-potential method	6.05	-
O.M. (%)	$K_2Cr_2O_7$ volumetric procedure out-heating method	0.10	Very low
Available N (mg/kg)	Alkali-solute diffusion method	30.75	Very low
Available P (mg/kg)	0.05N HCl-0.025N H_2SO_4infusion, molybdate antimony colorimetry	2.14	Very low
Available K (mg/kg)	1N NH_4OAC infusion, flame photometry	64.57	Very low
Total N (%)	$HClO_4$-H_2SO_4 boiling, diffusion method	Vestige	Very low
Total P (%)	$HClO_4$-H_2SO_4 boiling, molybdate antimony colorimetry	0.03	Very low
Total K (mg/kg)	NaOH fusion, flame photometry	0.73	Very low

10 kg clay pots were chosen in the experiment. Soil and fertilizer were mixed and filled into the pots. Each vetiver with three tillers was planted and NaCl was fertilized besides vetiver in T5. Before transplanting, shoot parts (stem and leaf) of vetiver were cut 15 cm high and root parts of vetiver were cut 10 cm long. During plant growth, each pot was irrigated. After 2 months planting, the experiments were terminated and the vetiver was harvested. The traits such as plant height, tillers, the number of new roots, root depth, shoot and root biomass were measured. Then special photo-analysis software (WinRHizo, Canada, Regent Instruments company) was used to quantitatively measure total length, total surfaces area, average diameter and total volume of each treatment.

2.3 Data Analysis and Statistic Analysis

All analysis was performed using software Microsoft Excel and SAS, including variance analysis and multiple comparisons.

3 RESULTS AND ANALYSIS

3.1 Shoot Growth of Vetiver in Different Treatments During Rejuvenation

The results of the experiment indicated that fertilization had a distinct effect on the shoot growth of vetiver and the effects were different with different fertilizers. The results of variance analysis showed there were significant differences within the traits, such as the tiller height and shoot biomass, in different treatments. The effect of chicken manure was better than others. Take plant height as example, the effects of T2 and T5 were better than T1 and T4. Vetiver tillers with chicken manure were approximately seven after two months, more than others. The shoot biomass of vetiver was best with the treatment of chicken manure which can be seen in Table 2.

3.2 Root Growth of Vetiver in Different Treatments During Rejuvenation

The experiment results in Table 3 shows that fertilization during rejuvenation not only increased the number of new roots and facilitated the anchoring of new roots but also helped to enhance the amount of root biomass and increase the survival rate of transplanting. There were not significant differences in new root biomass among different treatments. The total number of vetiver new roots treated by chicken manure was highest in all treatments. On the other hand, KangBao fertilizer use resulted in the longest root growth.

Table 2 Shoot growth of vetiver in different treatments

N	Treatment	Plant height (m)	Tillers	Shoot biomass (g)
T	CK	0.79c	3.1c	4.45c
T	Chicken manure	1.55a	6.7a	13.76a
T	BB fertilizer	1.34ab	4.3b	10.75ab
T	Kangbao fertilizer	1.17b	4.7b	7.55b
T	Chicken manure+ BB + NaCl	1.27ab	5.3b	9.98ab

Each datum is the mean of three replicates. Values with the same letter in each column are not significantly different at $P<0.05$

Table 3 Root growth of vetiver in different treatments

No.	Treatment	Root depth (cm)	No. of new roots	Root biomass (g)
T1	CK	50.00c	10.0c	0.82b
T2	Chicken manure	66.67b	26.3a	1.76a
T3	BB fertilizer	75.33ab	14.3b	1.33a
T4	Kangbao fertilizer	81.33a	15.0b	1.70a
T5	Chicken manure+BB+NaCl	70.00ab	18.0b	1.19a

Each datum is the mean of three replicates. Values with the same letter in each column are not significantly different at $P<0.05$

3.3 Some Root Morphology Traits of Vetiver in Different Treatments During Rejuvenation

According to some root morphological traits of vetiver, fertilization had a distinct effect on the growth. All fertilizers showed positive effects on the root morphological traits of vetiver, such as new root total length, total surface area, average diameter and total volume. The number of new roots significantly increased in the chicken manure treatment in contrast to others.

It can be seen from four root morphology traits that new root total surface area is greater in T2 treatment than in T5, whereas new root average diameter of T2 treatment is greater than T3. It is obvious that the amount and diameter of new root increased by fertilizing with chicken manure, but there aren't any significant differences in the other two traits.

Table 4 Some root morphological traits of vetiver in different treatments

No.	Treatment	Total length (cm)	Total surface area (cm^2)	Average diameter (mm)	Total volume (cm^3)
T1	CK	3138.42b	333.72c	0.69c	7.23b
T2	Chicken manure	4889.16a	1152.18a	2.41a	22.78a
T3	BB fertilizer	4006.43a	999.86ab	1.77b	21.22a
T4	Kangbao fertilizer	4882.55a	990.12ab	1.91ab	16.36a
T5	Chicken manure + BB + NaCl	4048.67a	846.99b	1.95ab	14.50a

Each datum is the mean of three replicates. Values with the same letter in each column are not significantly different at $P<0.05$

4_ RESULTS AND DISCUSSION

Vetiver is used to plant in reclaimed bare sloping fields, two sides of mountainous roads and dykes as it is a very desirable plant hedge for water and soil conservation. The main soil characteristic in these areas is low fertility. poor soil quality, sand content and in-differentiation parent rock problems. There is no natural plant growth and the raw soil is deep and collected from bare sloping fields in this study. The content of total N even is at the level of vestigial character and contains much parent rock. So fertilization produces good effect on the growth of plants.

Chicken manure contains various organic nutrients with appropriate proportions and continually provides nutrition during the rejuvenation. Moreover, the chicken manure already is fully pythogenic and soft. The chicken manure mixed with the soil improves soil structure and enriches the poor soil. When vetiver was fertilized with chicken manure the growth of root and root biomasses had better development than with BB fertilizer. Though KangBAo is a mixture of organic and inorganic fertilizer, the content of N, P, & K is low. Low P significantly affects the growth of vetiver, so KangBAo fertilizer is not likely to play a role including the organic part.

According to experimental data the number of roots treated by chicken manure was highest in all treatments with the roots tending to widely distribute in shallow soil with the root diameter appearing remarkably big and robust. But the traits which reflect the speed of root growth, such as new root biomass, total length, total surface area and total volume of vetiver, were not significantly different in contrast to other treatments.

This phenomenon would benefit water and soil conservation after vetiver field planting. The reason for this is may be the penetration of chicken manure is small and again depth of penetration is shallow after decomposition. Inorganic fertilizer is prone to mobility and penetrates deeply. Because the growth of plant roots is fertilizer tropism, which is shallow when using chicken manure and grows down with inorganic fertilizer. The effect of water and soil conservation in early vetiver eco-construction can be enhanced when chicken manure is used.

The literature indicated that NaCl could help weak vetiver rejuvenation (Hu and Chen, 1999) In this study, T5 improved the growth of vetiver by using NaCl and chicken manure and BB fertilizer. To sum up, the results of this experiment indicate that treatments T2 and T5 were better than T1, but in contrast, treatments not using chicken manure, the effect isn't desirable.

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A Brief Introduction to the First Author

Ms Xiurong Wang is the lecturer and researcher in plant nutrition and fertilizer.