The root extension rate of vetiver under different temperature treatments

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Abstract:
The root system of vetiver is account for the main source of its soil erosion control ability and yet the rate of the root growth has only been documented briefly. This research was to evaluate the rate of root growth under different temperature conditions. Three genotypes of vetiver: Taiwan, Ohito and a selected plant of PI196257 were evaluated under 35, 30, 25, 20 and 15°C chambers in the phytotrone of National Taiwan University. One-meter long acrylic tubes with 10 cm in diameter filled with sand containing 10% of peat moss were used to grow the vetiver slips in the phytotrone. The experiment was stopped when the root of one of the plants reaches 95 cm in 24 days. The plant was removed from the tube and the growth media was carefully separated from the roots. The length of roots was then measured. The data shown the average daily root extension rate of vetiver was 3.06, 2.86, 2.87, 2.00, and 0.52 cm for the temperature treatment of 35, 30, 25, 20, and 15 °C respectively. The highest growth rate of 3.96 cm per day was recorded in the Ohito vetiver under 25°C. The trend of the growth curve corresponds to the temperature showed that the rate of root extension reaches a plateau at 25°C, although 35°C treatment shown highest extension rate on average.

Introduction

Vetiver grass has been used intensively and successfully as hedgerow for erosion control in the tropical and sub-tropical regions of the world. The extensive and intermingled underground network formed by the roots is accounted as the main source for its erosion control ability. The depth and the mass of the underground network the vetiver root normally produced is comparable or better than most tree species. Although the vetiver root can reach 60 cm in depth in three weeks in Malaysia (National Research Council, 1993), the data was not published and the conditions of the observation need to be more specific.

The growth of plant root is affected by the physical properties of soil such as temperature, texture, and moisture, as well as the chemical properties of soil including pH, salinity and heavy metals contents. Although the vetiver grass has shown its wide adaptability to various soil conditions (Truong and Baker, 1998), the rate of the root growth under these conditions yet need to be studied in order to provide information for both the scientific arguments and practical applications. The study was a preliminary experiment of the rate of root extension of vetiver grass under various temperature conditions with the intention to serve as information for reference for the future study.

Materials and methods

Three vetiver grass collections were used in this study: Ohito, which is believed to be collected in Ohito farm, Japan; Taiwan, which is a local collection in Taiwan preserved in the nursery of Taiwan Agriculture Research Institute for over 20 years; and VVZ008-18, a selected plant from PI196257. The widely distributed genotype “Sunshine” was not included in this study due to the ongoing quarantine process. The initiation of root from a slip can be a variable for different genotypes of vetiver grass. Thus each of the tested plant was grown from a slip in a 4-inch plastic pot for over 2 months with well-established and vigorous growth of root system to eliminate the factor.

Transparent acrylic tubes were used as the containers to hold the growth medium in

order to observe the growth of the root during the experiment. It was covered with aluminum foil to block the light during the experiment to provide an adequate environment for the root. In order to reduce the stress that soil texture can imposed on the root, the growth medium was composed of 90% of sand and 10% of peat moss to provide a least stressful environment for the extension of the root. The pH of the medium is 7.1. The one-meter long acrylic tube with inner diameter of 10 cm was filled with the medium and fully watered and drained to settle the growth medium until it reached 90 cm in depth before the vetiver grass was planted on top of the tube.
Three replications of each vetiver genotype were kept in the glass chambers without supplemental illumination in the phytotrone of National Taiwan University. There is a five-degree difference of temperature in the chamber between day and night, which is set to be 12 hours for both periods of the day. There are five temperature treatments: 35/30, 30/25, 25/20, 20/15, and 15/13 degree of centigrade in this study to cover the regular growth conditions of the tropical and sub-tropical climate.
The plant was watered when the surface of the soil was dry. The growth of the root was examined daily. The experiment was stopped when the root of one of the plants reached the bottom of the tube. The plant was removed from the tube and the medium was carefully separated from the root. The length of the root was then measured. The analysis of variance was applied to the data using statistics computer package SAS. Duncan's multiple range tests was used to discriminate the difference of each factors.

Results and Discussions

The color of the leaves of all the three genotypes of Vetiver grass under the low temperature treatments, including 15/13 and 20/15°C, turned red in less than a week after the beginning of the experiment. The appearance of the red color was started from the tip of the leave and spread to the rest of the plants, which is typical to the C-4 plants survived in the low temperature environment. The rate of the appearance of the red color is negatively correlated with the temperature. In the 15/13°C treatment, all the three genotype did not show significant above ground growth even until the end of experiment. While in the rest of the temperature treatments, significant shoot extension was observed within 2 days of the beginning of the experiment.
The vetiver grass is categorized as warm season grass by the Kranz anatomy in the leave, which is a characteristic of typical C-4 plant structure. Because of the absence of the detectable photorespiration of C-4 plants, even above 30°C, the efficiency of photosynthesis of C-3 plants become lower than C-4 plants when the temperature rise above 30°C. Generally, 35°C is considered to be the optimum temperature for C-4 plants, while 25°C for C-3 (Björkman, 1981) plants. Under the optimum temperature, the maximum growth of the plants is expected.
The data of the root growth under the five temperature treatments of the three genotypes was presented in table 1. The longest root was recorded in the 25/20°C treatment by the Ohito vetiver while the shortest one was found in the 15/13°C treatment by the VVZ008-18. The root extension rate was calculated by dividing the length of root by the number of day during the experiment. The result showed the fastest rate of root extension was 4 cm per day under 25°C of soil temperature. Optimistically, in approximately 75 days, the root of vetiver can reach 3 meter in the best environment.
The analysis of variance of the data revealed that the temperature and genotypes were significantly (both p=0.0001) affecting the root extension. Also, there was no interaction between the temperature and genotype effects (p=0.2317). Thus the

Duncan's multiple range tests was applied to the data of the average root length over the three genotypes. The analysis showed that the root length of the three high temperature treatments, including 35/30, 30/25, and 25/20°C, averaging 70.4 cm was significantly longer than the 48 cm of the one of the 20/15°C treatment. The 15/13°C temperature treatment showed the slowest root extension with only 12.6 cm over the 24 days of experiment.

The VVZ008-18 was a selected plant from PI 196257, which is a North Indian weedy type of vetiver. The other two vetiver grasses are cultivated type with average 61.5 cm of root length in 24 days. The analysis of variance indicated that root length of the cultivated vetiver was significantly longer than the 40 cm of the one of the weedy type.

The graph of the root length showed a plateau after the temperature reached 25/20°C as indicated in figure 1. Although there was an upright trend in the 35/30°C treatment, the difference was not statistically significant. As the Kranz anatomy expected, the vetiver grass showed the average highest growth rate (3.06 cm per day) at 35/30°C treatment. But the plateau of the rate was reached in the 25/20°C treatment. This result suggested that the vetiver grass should have optimum performance when the soil temperature reached 25°C.

The 15/13°C treatment did not show effective above ground growth (0.08 gm dry weight in 24 days), but the root still extended for 12.6 cm, which indicated that vetiver grass was not dormant under this temperature. The vetiver might just be in the state of hardening to adjust to the low temperature during the experiment. It might be an issue for future study.

Conclusions

The growth of vetiver root corresponding to the temperature was studied in this research. Approximately three centimeters per day of root extension was observed when the soil temperature reached 25°C. The maximum growth of vetiver was achieved when the temperature rise up to 25°C. Even the root extension rate was higher in 35°C, the difference was not significant statistically. The vetiver still had detectable underground growth in the 15/13°C temperature treatment in this study, which suggested the vetiver is not dormant at this temperature. It is still possible to establish vetiver hedgerow under this temperature, although the time will be longer.

Reference

Björkman, O. 1981 Responses to different quantum flux densities. Page 57-107 in O. L. Lange, P.S. Nobel, C.B. Osmand, and H. Ziegler (eds.), Encyclopedia of Plant Physiology, New Series, Vol. 12A, Physiological Plant Ecology I. Springer-Verlag, Berlin.

National Science Council, 1993. Vetiver grass: a thin line against erosion. National Academy Press, Washington, D.C.

Truong, P.N. and Baker, D. 1998. Vetiver grass system for environmental protection. Technical Bulletin No. 1. Pacific Rim Vetiver Network, Bangkok, Thailand.

Table 1. The root length (cm) of three vetiver genotypes under five temperature treatments

Vetiver genotypes	Temperature treatments				
	15/13°C	20/15°C	25/20°C	30/25°C	35/30°C
Ohito	10.6±7.5	54.7±4.4	79.4±20.9	73.3±1.5	81.7±15.0
Taiwan	16.0±5.5	51.2±16.5	80.3±10.9	82.3±7.5	86.0±9.6
VVZ008-18	11.2±1.5	38.4±1.9	47.0±7.9	50.2±8.4	53.0±23.1

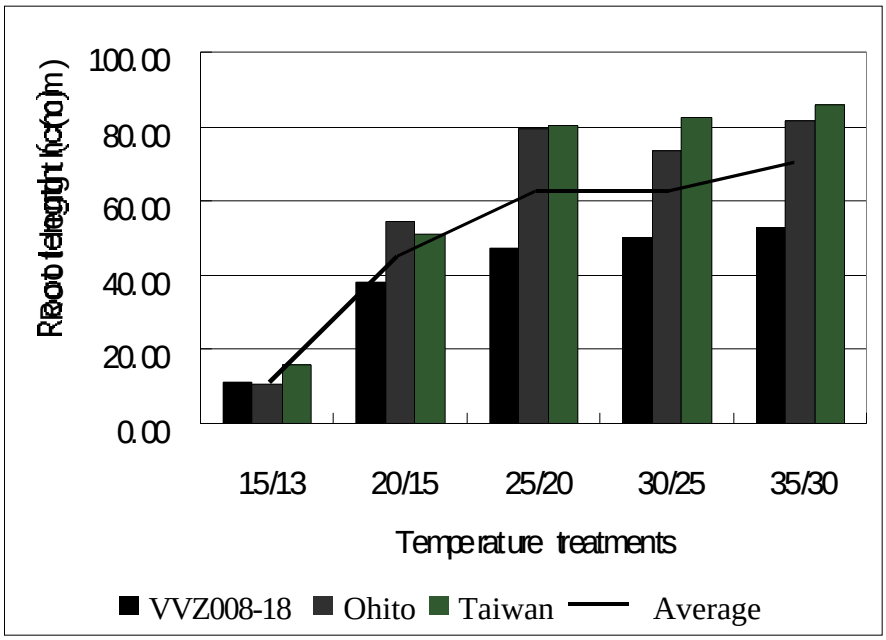

Fig. 1. The effect of temperature on the root length of vetiver.
Three genotypes of vetiver: VVZ008-18, Ohito, and Taiwan were included in this study. Five temperature treatments: 15/13, 20/15, 25/20, 30/25, and 35/30°C were applied to the three genotypes. The vertical bars represented the length of each genotype at each temperature treatment. The line indicated the average length of the three genotypes.