Journal of Engineering and Applied Sciences 12 (12): 3051-3054, 2017
ISSN: 1816-949X

PGPR by Bacillus in Vetiver Grass's Root Enhance Strength of Soil-Root Matrix System Toward Slope Stabilization in Malaysia

[1, 2]M.N. Noorasyikin and [1]M. Zainab
[1]Faculty of Civil Engineering, Universiti Teknologi Mara, Shah Alam, Malaysia
[2]Faculty Engineering and Build Environment, Segi University, Kota Damansara, Malaysia

Abstract: An inspection have been implemented on root of Vetiver grass in this study. The root samples were collected either from poorly grown or well grown condition with different soil types and were taken to the laboratory for further laboratory work. The root s were investigated to know the bacteria species present in root and determine the root strength toward different soil types and root condition (poorly and well grown). It was found that the presence of microorganism species in root is Bacillus which is primarily known as Plant Growth Promoting Rhizobacteria (PGPR). The Vetiver grass was found able to grow well in Sandy Soil than Clay Soil in both conditions; dry and wet condition. In clay soil, in wet condition especially the Vetiver grass for both condition poorly and well grown acquired high value of tensile strength than dry condition. The results indicated that appearance of Bacillus in the root able to colonize the root and promote plant growth.

Key words: Bacillus, root matrix, tensile strength, pull out resistance, slope stabilization

INTRODUCTION

In primarily, the slope failure is one of the major phenomena frequently occurred in Malaysia (Ali *et al*., 2012; Huat and Kazemian, 2010). This phenomena cause much loss of properties and human. One of the factor was found mainly triggered the slope failure is rainfall. The high intensity of rainfall made the slope easily to slide once the soil become too soft. It is very vital to consider the soil type which is mainly parameter influence the slope stabilization. The geotechnical engineer normally applied bioengineering technique which used grasses rather than mechanical technique because it requires less cost. However, the slope failure is still occur although have been remedial with grasses. This study is going to investigate the suitability of Vetiver grass's growth toward soil type. Besides that, the examination of bacteria species also was carried out to obtain other factor influence the growth of Vetiver grass toward slope stabilization.

Those bacteria who free living in the soil but found near or even the roots of plants are called as Plant Growth Promoting Rhizo Bacteria (PGPR) (Mafian *et al*., 2009). PGPR has an ability to enhance the nutrient content of host plant and stimulate plant growth in several ways: biological nitrogen fixation that is used by plant, increase the nutrients that are used by plant, increase root surface area, stimulate enzymes for plant hormone levels and synthesize other beneficial symbiosis of the host. PGPR also function as biocontrol agent against soil-borne phytopathogens. The bacteria species which belong to this group are Azotobacter, Azosprillium, Bacillus, Pseudomonas, Acetobacter, Burkholdenia and Bacilli.

Previous study; bacillus as Plant Growth Promoting Rhizobacteria (PGPR): The Bacillus able to promote of barley, rice and bean plant. It is indicates that Plant Growth Promoting Rhizobacteria (PGPR) of Bacillus influence plant growth and development by the production of phytohormones such as auxins, gibberellins and cytokinins (Ortiz-Castro *et al*., 2008). Nautiyal *et al*. (2013) found that bacteria Bacillus able to tolerate with salt stress for growth of rice plant in greenhouse experiment. Soil salinity mostly can give negative effect toward growth and productivity of rice and soil inhabiting microbial populations. Huang *et al*. (2015) stated that *Bacilllus* sp. from rainforest able to promote corn and tomato plant under limited nitrogen condition. Besides that, Bacillus is able to improve plant health.

Corresponding Author: M.N. Noorasyikin, Faculty of Civil Engineering, Universiti Teknologi Mara, Shah Alam, Malaysia

MATERIALS AND METHODS

Site characteristics and physical properties: The site inspections were carried out on well grown and poorly grown of Vetiver grass with sandy soil and clay soil at cut slope gradient 45° which is at several site locations area. The soil type identification was conducted by sieve analysis test shown in Fig. 1 which is based on British Standard 1377: Part 2: 1990: Clause 9.2.2. The soil and root samples were collected and taken to laboratory to examine its physical properties. For root properties, the Vernier Caliper was used to measure root length and root diameter. The unit was recorded in mm (millimeter).

Identification of root microorganism: There are many sub-works in this inspection part. First stage, the sterilization work which all of the equipment such as petri dishes, Universal bottles, bijoux bottles, loops and sterile pipettes need to sterilize. The purpose for this research is to ensure there is no contaminants and remove of microbes that may cause disease or undesirable affects. Second stage; prepare a media to the plates. This research involves preparation food for bacteria to grow in plate which use Agar. Third stage, streak plate was carried out. The purpose of Streak Plate is to dilute the small amount of bacterial culture which is to obtain pure culture. Each colony will form a single cell. If the colonies present different cell, so it is consider that the contamination of microorganisms is appear. Last stage, the colonies will be viewed under microscope to identify the characteristics of microorganism in term of shape, size and color. The examination works are shown in Fig. 2.

Root tensile strength test: The Vetiver grass root tensile strength test of poorly and well grown was conducted using Shimadzu Universal Testing Machine as shown in Fig. 3. A root samples were collected in wet and dry condition (poorly and well grown) to know the difference strength between both conditions. In other context, the test was conducted to define the bonding strength between root matrix system of grasses and different soil type. The unit measurement was recorded in MPa (Mega Pascal).

Root pull out test: For this test, equipment was specially designed and fabricated with respective specification as shown in Fig. 4. The equipment was fabricated with manual operated mechanical jack system and steel frame. The data measurement was determined in wet and dry condition (well and poorly grown) toward Vetiver grass.

Fig. 1: Sieve analysis test

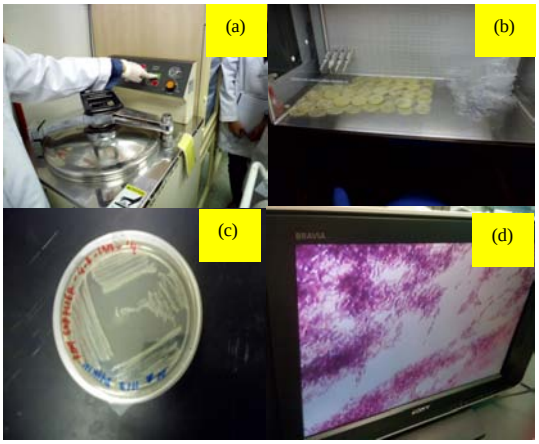

Fig. 2: Stage of microorganism's identification: a) sterilization; b) prepare a media for cultivation of bacteria; c) streak plate and d) view the physical properties of microorganism under microscope

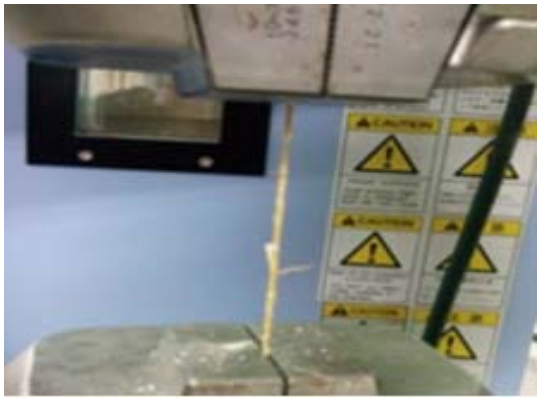

Fig. 3: Photographs of root tensile strength test using Shimadzu Universal Testing Machine (single root of poorly and well grown)

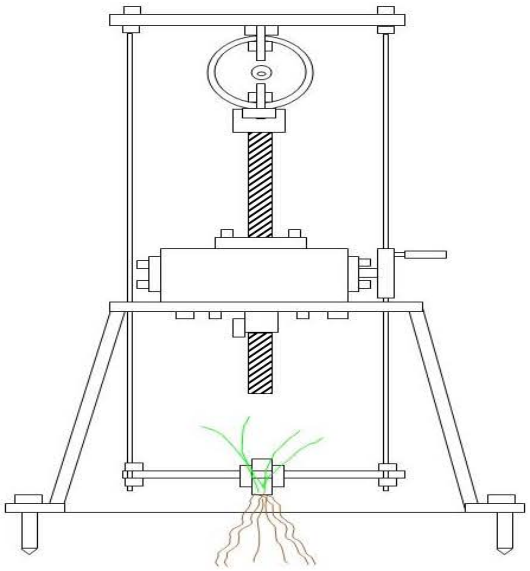

Fig. 4: A new fabricated of root pull-out test

For this test, the green epoxy was put at root to grip shown in Fig. 4. The root then was pulling out until the reading measurement constant.

RESULTS AND DISCUSSION

Identification of bacteria species: Based on root properties view under microscope, it was found that the bacteria present in root of Vetiver grass is Bacillus. Generally, this kind of species is known as Plant Growth Promoting Rhizobacteria (PGPR). Besides that, this bacteria species able act as biofertilizer which can promote plant growth. The shape of Bacillus was found in circular shape.

Root tensile strength of Vetiver grass: The tensile strength test has been implemented on a single root of Vetiver grass for different conditions (poorly and well grown-wet and dry condition) and different soil types shown in Fig. 5 and 6.

It was observed that the Vetiver grass able to grow well in sandy soil than clay soil in both conditions; dry and wet condition with data measurement recorded; wet (poorly grown) and dry (well grown) 0.008-0.20 MPa and dry (poorly grown) and wet (well grown) 0.002-0.05 MPa. However, in clay soil it shows contrarily. In wet condition for poorly and well grown the root acquired high tensile strength value compared to dry condition with data measurement recorded; wet (poorly grown) 0.00015-0.0035 MPa, dry (poorly grown) 0.00029-0.006 MPa, wet (well grown) 0.0084-0.1887 MPa

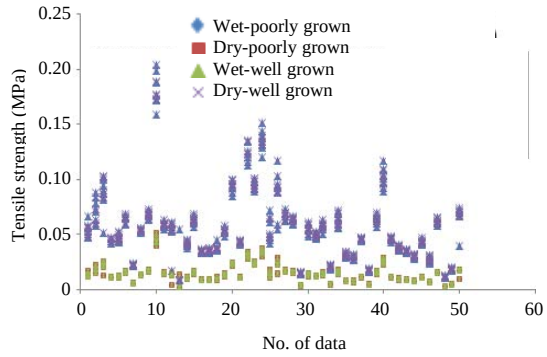

Fig. 5: Profile tensile strength of Vetiver grass (dry and wet conditon) well grown and poorly grown (sandy soil)

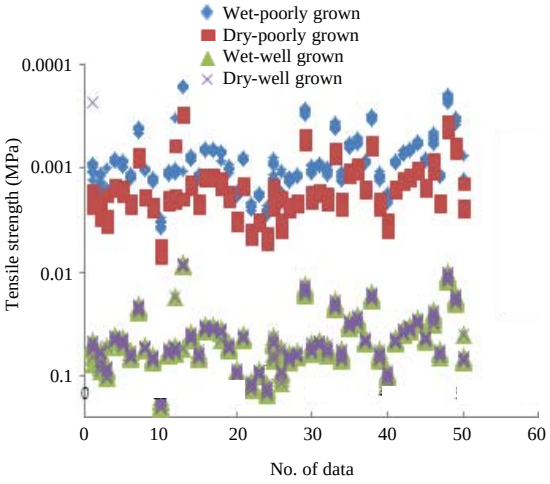

Fig. 6: Profile tensile strength of Vetiver grass (dry and wet condition) well grown and poorly grown (clay soil)

and dry (well grown) 0.0084-0.1718 MPa. These results indicated that appearance of Bacillus in the root able to colonize the root and promote plant growth especially in wet condition.

Root pull out of Vetiver grass: The finding of pull out for Vetiver grass (sandy soil) is shown in Fig. 7. In dry condition, for well grown the root pull out was ranged from 103.5-295.81 N. Meanwhile, for poorly grown in dry condition the root pull out was found decreasingly about 85% which is range from 7.11-67.9 N. In wet condition, for well grown the root pull out was obtained between 105.1 312.25 N. Meanwhile, for poorly grown in wet condition the root pull out was obtained decreasingly about 74% which range from 22.4-97.1 N. The poorly grown of Vetiver grass was found drastically decrease in

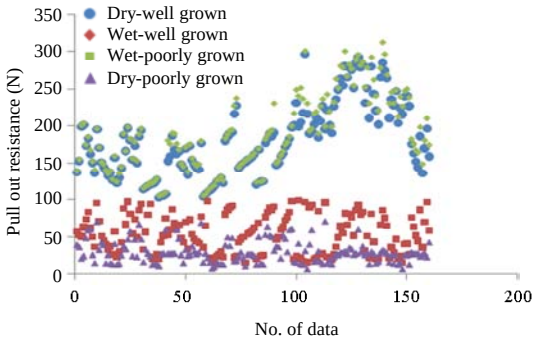

Fig. 7: The profile of Vetiver grass sandy soil (dry and wet condition-well grown and poorly grown)

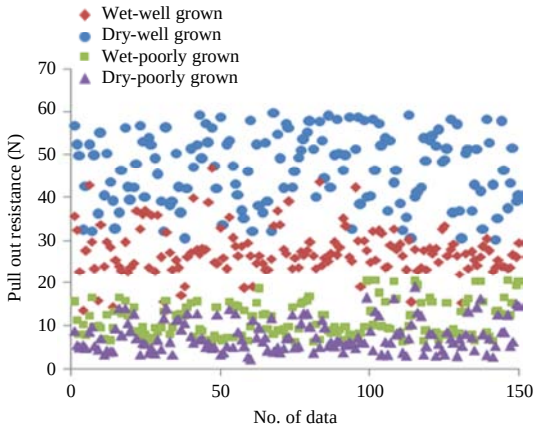

Fig. 8: The profile of Vetiver grass-clay soil (dry and wet condition-well grown and poorly grown)

both condition, dry and wet condition. The finding of pull out for Vetiver grass (clay soil) is shown in Fig. 8. In wet condition for well grown the root pull out was ranged from 20.7-59.7 N. In poorly grow (dry condition), the root pull out shows decreasingly by 66% which is ranged from 7.21-20.37. In dry condition, for well grown the root pull out was obtained ranged from 15.26-46.81 N. Meanwhile, in dry condition for poorly grown the root pull out obtained between 2.11-18.74 N. It shows decreasingly by 73%.

Based on the results obtained, it was found that the Vetiver grass able to grow well with sandy soil compare to clay soil. Although in dry condition, the root was found able to survive. From previous findings by other researcher, Vetiver grass was well known its ability can retain the water content. Bacteria also were known able to survive in wet condition. From these findings, it is possibility that the Bacillus bacteria in root of Vetiver grass promote the growth of Vetiver grass. Similarly, in clay soil the root of Vetiver grass able to grow although in dry condition. But, from the observation the root bonding strength with sandy soil is more strengthen than in clay soil.

The root of Vetiver grass usually grow with huge diameter and able to penetrate into soil about 1 m length. The clay soil usually become crack when it is in dry condition especially for long term drought condition. It is possibility with the huge diameter of root; the root cannot survive well in clay.

CONCLUSION

It is concluded that, the Vetiver grass is more suitable with sandy soil than clay soil in term of strengthen application especially for slope stabilization. The appearance of Bacillus bacteria in root of Vetiver grass is one of the parameter which influences the root growth with soil slope. The specialty of Vetiver grass especially able to retain water content made the Bacillus Bacteria can live in the root.

ACKNOWLEDGEMENTS

Researchers are thankful to University Technology MARA, Shah Alam for providing a place to carried out the experimental work and special thanks to the laboratory staff for their valuable help in handling the laboratory equipment. Thanks also to Segi University for giving endless support during conducting the experiment.

REFERENCES

Ali, N., I. Farshchi, M.A. Muazu and S.W. Rees, 2012. Soil-root interaction and effects on slope stability analysis. Electronic J. Geotechn. Eng., 17: 319-328.

Huang, X.F., D. Zhou, J. Guo, D.K. Manter and K.F. Reardon *et al*., 2015. *Bacillus* sp. from rainforest soil promote plant growth under limited nitrogen conditions. J. Appl. Microbiol., 118: 672-684.

Huat, B.B. and S. Kazemian, 2010. Study of root theories in green tropical slope stability. Electron. J. Geotech. Eng., 15: 1825-1834.

Mafian, S. and B.B.K. Huat and V. Ghiasi, 2009. Evaluation on root theories and root strength properties in slope stability. Eur. J. Scientific Res., 30: 594-607.

Nautiyal, C.S., S. Srivastava, P.S. Chauhan, K. Seem and A. Mishra *et al*., 2013. Plant growth-promoting bacteria Bacillus Amyloliquefaciens NBRISN13 modulates gene expression profile of leaf and Rhizosphere community in rice during salt stress. Plant Physiol. Biochem., 66: 1-9.

Ortiz-Castro, R., E. Valencia-Cantero and J. Lopez-Bucio, 2008. Plant growth promotion by Bacillus Megaterium involves Cytokinin signaling. Plant Signaling Behav., 3: 263-265.