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Bio-Electricity Generation by *Cynodon dactylon* from Bio-Photovoltaic Device Technology

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ABSTRACT
In the present situation for green electricity generation with living plants as low level of carbon sequestration, eco-friendly, sustainable and directs harvesting electricity without any damage to living plants as well as environment. Bio-Photovoltaic device (BPV) is prepared for the electricity generation by organic frameworks which includes of living plants and electrogenic bacteria from plant-roots which are used to transform solar energy into renewable electricity. In this experiment, Cynodon dactylon is used as a Bermuda grass seeds were procured from Farm seed™ and directed planted in the BPV device pots, the zinc electrode were inserted at the bottom rhizospheres which form the anode. While others set of the copper electrode submersed on the soil-surface asides that form cathode. A copper and zinc plates were used as an electrode which was connected with the copper wire as a current collector, thus on completing the circuit it is generates green electricity. The potential difference was estimated and the total voltage achieved in each of BPVs device voltage was 0.60 ±0.02V with grass and 0.34 ±0.02V seedling free as control in 10th days of incubation. Further, again 12 BPVs device pots were used for the production of green electricity which formulated into a grass e-table device for maximum generation of electricity and a total voltage of grass e-table device was achieved 4.23 ±0.02V at 30th days of incubation. The main purpose for the development of eco-friendly biological device is to reduced electricity uses in remote areas small land and might be used in the generation of electricity in an electrical lamp for education tools purpose. This device installed with a 9 Volt battery for storage of energy from the device due to produce energy for long time. The Bio-Photovoltaic device for eco-friendly technology development has a good chance to protect the energy crisis.
Keywords: *Bio-Photovoltaic Device, Cynodon dactylon, Grass e-table, Sustainable Energy, Electricity Generation*

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INTRODUCTION

Now a day's world is facing severe energy crisis and energy demand continues to upward push indefensible rate. Many of unsustainable electricity generation were used for the manufacturing of energy consisting of coal, gas and wood etc, which is increasing the hazardous outcomes of carbon emission leading to global warming. Bio-Photovoltaic device is capable of using plants as substrates which uses chemical energy to make over electrical energy, through the bio-electrochemical system. It means that chemical energy is converted into electrical energy by biological materials. This is simplified technology to promote pollution free energy sources, showing that 60% of unsustainable energy sources replaced with wind and solar being the most sensible energy age in up-coming years. This technology conserves and preserves biodiversity for the generation of electricity. India is the seventh largest country which is utilizing electricity consistent with capita 1010kWh. Simultaneously, 4.7% of the geographical landmass in India is wetland which is still not utilized [1]. Bio-Photovoltaic device (BPVs) is consists of several biological materials, conductive electrode and based on the process of photosynthesis. Photosynthesis is a process which is living plants and microbes are used to carbon dioxide from the environment into the organic matter with the source of energy from sun-light. The living plants release source of these organic compounds like carbohydrates, proteins and lipids to nearby rhizospheric soil. The soil with this biosystem also contains natural microbes like decomposing bacteria for recycling the waste material thus generates electrons during catabolism. Therefore, discharging of an electron traps from the conductive electrodes by biodevice creates renewable electricity without any damaged to the living plants [2]. This is a better application for renewable energy generation with BPVs device as depicted in Figure 1 [3]. The concept of bio-photovoltaic device has been thoroughly enhanced, leading to high demand for their electricity production through the biological photovoltaic systems. This is also known as microbial fuel

cells or plant microbial fuel cell [4]. The bio-photovoltaic device technology was first developed Bombelli in 2011 by *Physcomitrella patens* to create natural electricity. Some of the bacteria produced electricity through microbial fuel cell system that process is known as exoelectrogens, these bacteria oxidized the organic substrates which enables electrons to trap by conductive electrode which is used as electricity from microbial fuel cells [5]. The free energy saves as a battery for power difference between electrodes thus generates electricity for small electronic device such as scientific calculator, watch and LED bulb etc. [6]. This energy is Gibbs free energy which provides a minute amount of total energy in system which is accessible for useful work which is also known as chemical potential. The transform free energy is mentioned as ($\Delta G°$) and free energy considers for break down molecule of H_2O into H_2 and O_2 is equivalent to 1.23 eV [7]. Hence, as a result of the carbon dioxide, protons and electrons are produced. This energy source plays an important role in the alternative way for harvesting electricity. The biochemical response occurs in the BPVs device as shown in below equation 1 and 2 [8, 9].

Anode reaction: $C_6H_{12}O_6 + 6H_2O \longrightarrow 6CO_2 + 24H^+ + 24e^-$..... (1)

Cathode reaction: $6O_2 + 24H + 24e \longrightarrow 12H_2O$ ..... (2)

The grass species *Cynodon dactylon* is a genus in the family of Poaceae which is normally grown in the saline soil like terrestrial plant which is also called as Dooba ghas in India. In this study, Bio-Photovoltaic device is constructed in a grass *e*-table technology. This grass *e*-table is a concept product which demonstrates a prospective potential of future technology for green energy production along with various conditions changes in the bioelectric potentials was also observed.

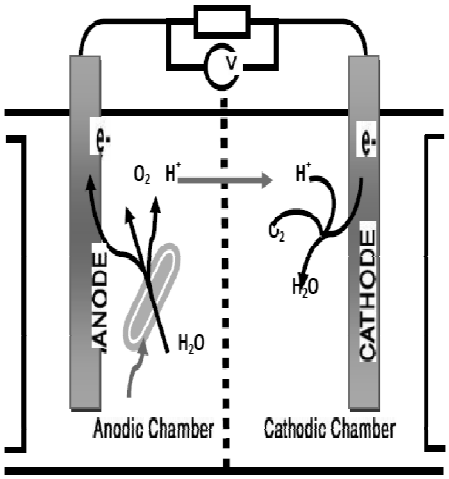

Fig no: 1 Schematic diagram of BPVs device generation [3]

MATERIAL AND METHODS

Plant Material

In this study, Bermuda grass seeds of *Cynodon dactylon* were procured from Farm seed(TM) through online purchasing as depicted in Figure 2. The seeds were soaked in 10-20 ml of distilled water and kept for 24 hrs in ambient condition as wet seeds germinate quickly. Thereafter, wet seeds were collected approx. 5-10 seeds were transplanted in BPVs pots as described by [10]. While the other set of without seeds (control) was simultaneously prepared.

Fig no: 2 A grass seeds of *Cynodon dactylon*

Experimental Setup of Single Chamber of Bio-Photovoltaic Device

The bio-photovoltaic device constituted with anode and cathode sites in garden plastic pots with appropriate weight of 105-115g for plastic pots with soil. The container of plastic pot dimension was 8.5 cm × 9 cm x 8.5 cm. The anode (zinc) electrode in the size of 7 cm × 4 cm with plastic film located at the bottom and filled with natural soil after that zinc electrode inserted into the plant rhizospheres. The cathode (copper) electrode consists of the copper plates in the size of 7 cm × 4 cm were placed in the cathode chamber which was inserted in soil-surface. The two electrodes were used as copper plate and zinc rod. Single chamber of BPVs device was no used any types of proton exchange membrane during electricity generation. Copper plate and zinc rod electrodes were connected to the external circuits, copper wire used as current collector from single chamber of BPVs device. The voltage reading was recorded from digital multimeter as described by Bombelli, [3].

Formulation in Grass *e*-table Device

After single chamber of BPVs pot was configured for the reason of creates electricity. Afterwards, single chamber of BPVs device were formulation in Grass *e*-table with BPVs device appropriately constructed in the same configuration of grass seeds were used for the production of green electricity. The performance of the Grass *e*-table device can efficiently be improved by connecting 12 BPVs device for enhanced the power density, which is connected in series arrangement of 12 BPVs device pots. This Grass *e*-table device was kept in natural condition for the time period of 10 am to 5:30 pm per day for 30th days respectively as well as observed the voltage reading taken by digital multimeter. The whole experiment was performed without connecting any resistance load. After days of the proper maintains of growth and development of plants, set of water was added and electricity potentials in BPVs device and measurement of electricity with digital multimeter [3].

RESULTS AND DISCUSSION

Garden cylindrical plastic pots were used and configured of anode and cathode in BPVs device. Garden soil enriched with organic matter and indigenous microbial community was packed in the system without any pretreatments to provide the natural condition for electricity generation.

Electricity Generation in Single Chamber of Bio-Photovoltaic Device

Bio-Photovoltaic device is system for *in-situ* green electricity generation during the natural condition. BPVs open circuit voltage (OCV) increased steadily from day one and reached the potential difference observed as 0.60 ± 0.2 V and 0.34 ± 0.2 V seedling free (control) was observed at 10th days of incubation as illustrated in Fig 3 and graphical representation in fig 4. In the beginning after lower potential of difference was observed just because the plant was adapting to the new environment. The voltage for each BPVs cell blown up clearly starting from 7 to 8th day and gradually increase with variation similarly as mentioned by [11]. It is well known that photosynthesis is necessary for electricity generation from living plants [12]. They also included two different types of living plants (*Oryza sativa*) and a competing weed (*Echinochloa glabrescens*) for maximum electricity creation for light phage 3-4 and 6-8 hrs, respectively [13]. Schamphelaire *et al*. [1] analyzed a biodevice with an anode fixed in rhizosphere of rice plants. The resulted of the rice plants gave the cell's current production seven times higher because the plant constantly produces biomass near the anode area. Bombelli, *et al*. 2011 [2] also seen in carbon fiber network for their anode which is conservative to shape and size of plant-root for the larger exterior area in system. Therefore, light source is not simply affecting factor for energy generation but it is depended on the plant physiology performance in BPVs system.

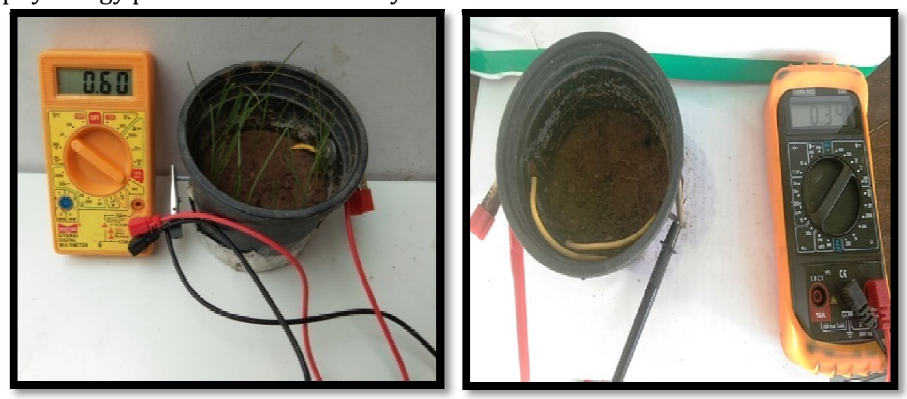

Fig no: 3 BPVs pot generates in voltage with plant and without plant

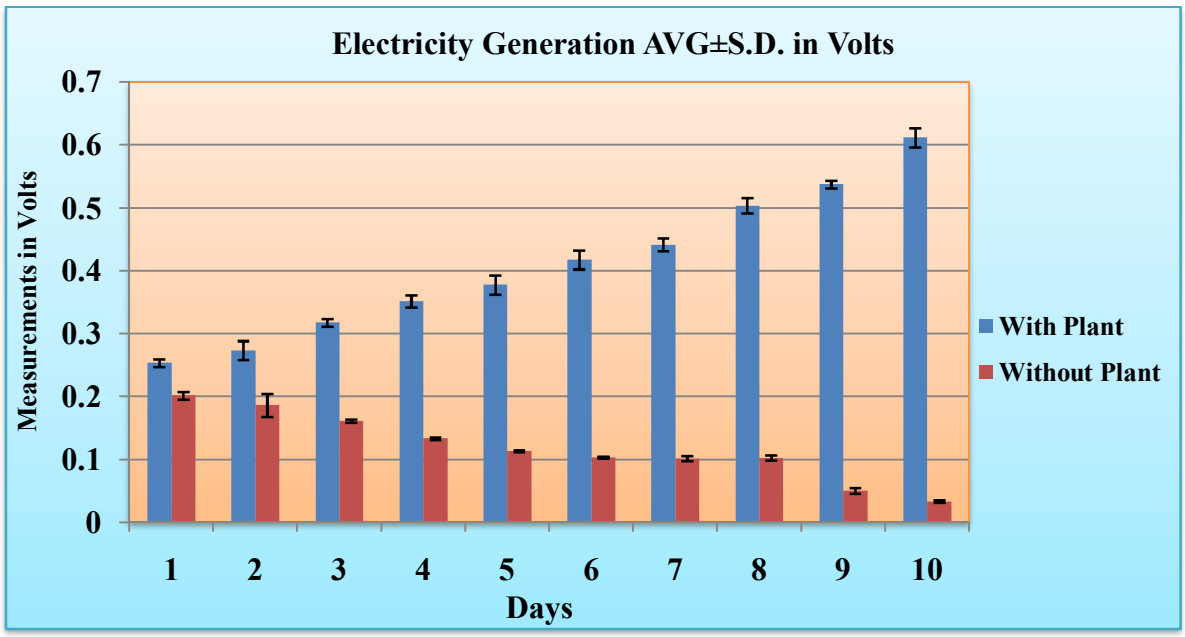

Fig no: 4 Electricity generations in voltage from with plant and without plant

Bio-Electricity Generation in Grass *e*-table

Cynodon dactylon is one of the most commonly occurring grasses in India. It is a fast growing resembles plant and naturally adopted for saline conditions. The mutual interaction of living plants and microbes can produce electricity by mechanisms of biochemical reaction. These biochemical reactions which are able to make electron and protons by metabolism and catabolism reaction thus producing green energy which is the principle based in simple redox reaction in electrolytic cell. Moreover, a few bacteria can decomposed the dead roots, slough of cells and soil organic matter itself which is not needy on the photosynthesis for dark condition. Strik *et al*. [9] observed the electricity generation by using *Reed mangrass*; Ueoka *et al*. (2016) [14] rice and paddy plants to produce bioenergy; Timmer's *et al*. 2010 [15]; Moqsud *et al*. 2014 [16] worked on the *Spartina anglica* and grass cutting and leaves mold of rice bran to produced energy respectively. The present study we evaluated the grass *e*-table designed and production of electricity from *Cynodon dactylon* in BPVs was utilized for energy sources. The present grass *e*-table for electricity generation with a maximum voltage of 4.24 ± 0.2 V on 30th days of incubation was a potential device Figure 5 and graphical representation in Figure 6.

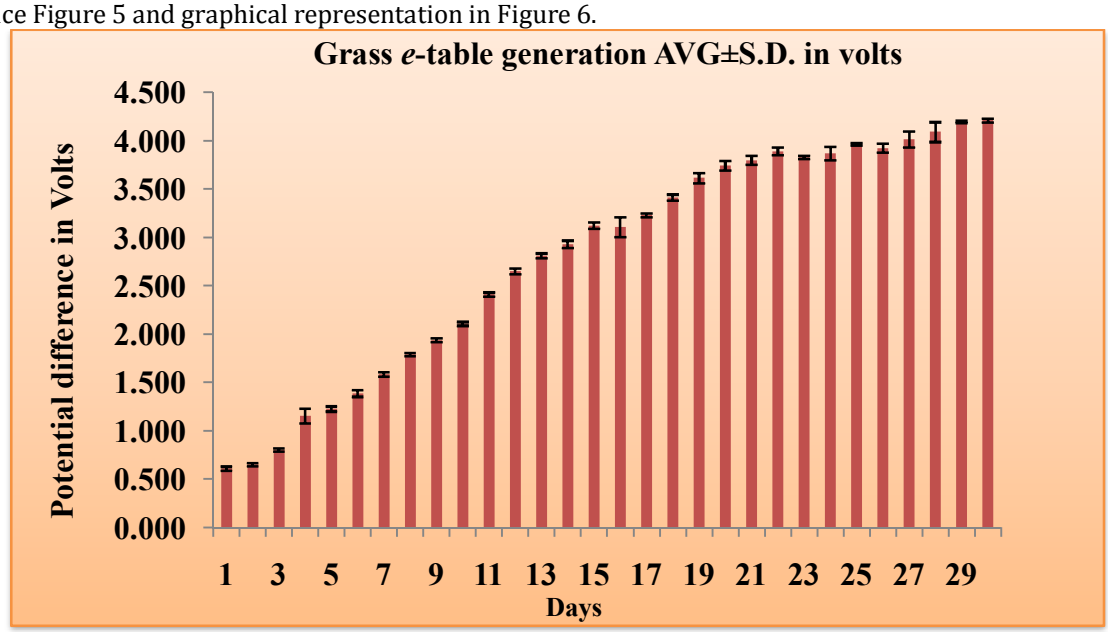

Fig no: 5 Electricity generations in volts from grass *e*-table with respectively of standards errors bar

Fig no: 6 A showing of grass *e*-table Generation

CONCLUSIONS

Cynodon dactylon is the grass species belong to the family of Poaceae which is available access amount in rural and urban areas. Therefore, conventionally this grass is utilized for grazing but we tried to create electricity as it is primary producer energy from sun light. Photosynthesis is the main important role of the living plants to make their own food by sunlight. A plant-root excretes the organic matter which is subjected to be utilized different microorganism and in returns discharge electrons that are trapped in conductive electrodes to the complete circuit thus generates electricity. The plants and microorganisms work in synergistic to create clean, safe and renewable electricity. This process of electricity generation is non-destructive and also useful to living plant. In this experiment, *Cynodon dactylon* potential for bioelectricity generation was exposed at natural condition in BPVs device. Further, formulated in grass *e*-table which easily electricity produced anywhere without any damage to living plants and environments. Further, research needs to optimization *in-vitro* condition, electrogenic potential of bacteria and surface area etc. it's may improve electricity production in BPVs device. The Bio-Photovoltaic device technology is cost-effective along with their eco-friendly nature for green energy production.

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CONFLICTS OF INTERESTS

The authors declare no conflict of interest incorporated in this research work.

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