FORMATION OF PLANT BATTERY FROM XEROPHYTES

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Abstract:- *Plants have got abundant bio-energy in form of electricity which is conserved mostly in their stem as food, and out of their different families the xerophytes' have got the maximum energy due to their high conservation of food owing to adeptness of dry condition. The conserved bio-electrical power is produced actually across their eukaryotic cells due to formation of infinite primary cells according to the Nerst theory of Electrode potential. Now, since the nature has cascaded the cells in different fashion i.e. against the Ohm's law of electricity it is not possible to get the whole power additively directly in natural fashion The present study is to harness the total conserved bio-electrical power in form of a simple Plant battery to operate low power electrical instruments. This is a step forward towards a new bio-source of non-conventional energy.*

Keywords:-EPD , Stimulating , Ohmic circuit, eukaryotic cell, cascaded.

The nature has attributed abundant bio-energy to plants in form of electricity which is conserved as food in their organs mostly in their stems . Out of various families of plants, the cactaceae family that include xerophytics mainly have got the maximum energy ,obviously due to high conservation of food owing to their adeptness of dry conditions.

Several researchers, such as: Koppan et al (2)of Hungary and Morat et al(1) of Paris and Koppan et al (2)of Hungary have already worked on the Electrical Potential Difference(EPD) of the bio-energy conserved inside plant and have found that the EPD of a plant is directly proportional to the water potential and hence to the sap flux density. Now, since these quantities are maximum in xerophytes, the EPD in such plants

become maximum. Some other researchers, such as: Zimmermann et al(3) of Jena,USA has calculated the speed of electrical signaling in plant as 5-10 cm per minute owing to the EPD against enemies if the plant is wounded by cutting of its tissues .Further, the effect of oscillating / stimulating magnetic field on plant's pulsation which is created due to the EPD has also been observed by the author(4,5) and has been found to have excited the pulsation rate. The excitation of the pulsation rate has been well harnessed by the author (6) in replacing the use of fertilizers to increase the plant's growth.

The present study is to harness the total bio-electrical energy conserved inside the plants, specially inside the xerophytes, in form of a plant battery. This shall be a step forward towards a new source of bio-energy in a non-conventional form and shall add to the knowledge of bio-electrical power as well as of the science of plants.

Method:-We know that the total electrical potential of a group of chemical cells, called a Battery, is achieved by cascading them in obeyance of the Ohm's law of electricity i.e. by connecting positive polarity to negative polarity and negative polarity to positive polarity which is the cascading of the opposite polarities. But , as found experimentally, the nature has cascaded the plants' cells in different fashion. So it is not possible to get the total EPD of the bio-energy directly .Hence, a suitable process is developed here to extract the total EPD of the plant for formation of an useful Plant Battery as a bio-physical source of energy to operate an instrument. To measure the electrical parameters i.e. the EPD in unit of Volt, current I in milliammeter, internal resistance r and the corresponding load resistance R in ohm of a plant (under investigation) an Ohmic circuit is designed as shown below in Figure – 1.

Measurement of Electrical parameters of a Plant specimen through an ohmic circuit.

Figure-1
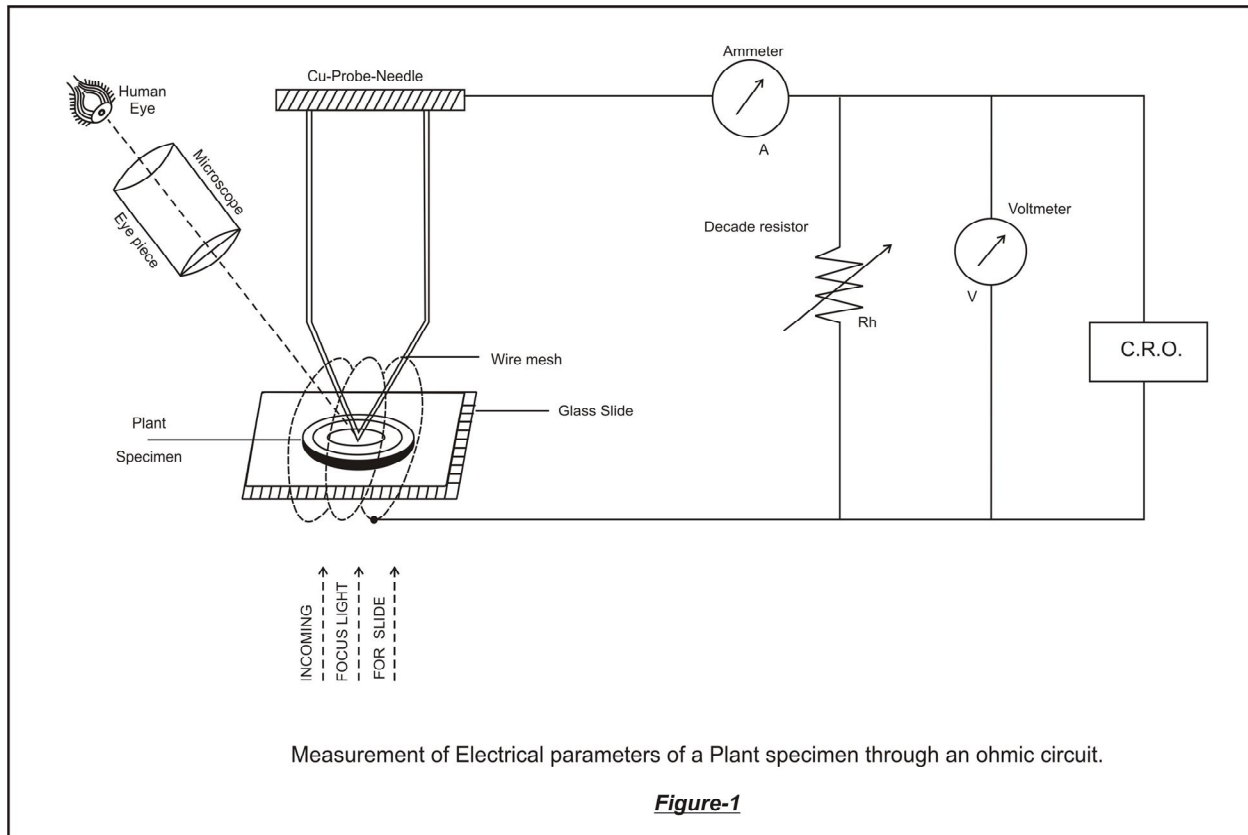
In the Ohmic circuit, a miliammeter for measuring the electrical current I and an external variable load resistor R are attached in series with the sample electrical source of plant's section(under experiment). Further, a D.C. voltmeter along with an Oscilloscope (for more accuracy) is attached across the load resistor R to measure the EPD in volts. Now several transverse sections of its stem cell are obtained by cutting it into the thickness of nearly 0.5 micron.

Then a sample section is placed on a glass slide covered with wire mesh of copper for seeking an external electrical connection from its lower surface .The wire mesh is used

to allow   the incoming focus light of the microscope into the slide The electrical connection from the upper surface of the section is taken through a copper- probe – needle. The two electrical connections are then introduced in an ohmic circuit as an electrical source. Now, according to Ohm's law of electricity,

The internal resistance of the cell is given as,

$$r = V / I - R \quad \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\text{(I)}$$

Now, at r = R ,the maximum power transfer resistor is given as,

$$r_1 = V / 2I \quad \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\text{(II)}$$

And the electrical power is given as,

$$P = V . I \quad \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\text{(III)}$$

For investigation, some xerophytic species of cactaceae family ,such as: Sanpedro cactus, Pentalobi Cactus,Opuntia dillenii, Opuntia elatior & Aloe vera were taken for the experiment where as some mesophytic species, such as Vaijantri, Calotropis procera were also taken for comparison. The aforesaid species are then placed into the aforesaid ohmic circuit (Fig.-1)as as electrical source one by one for measuring their electrical parameters. The values thus measured were computed in the aforesaid relations (I) ,(II) and (III) to calculate the internal resistance r ,electrical power P and the maximum power transfer resistor r_1.The variations of these values with the load resistor R have been well exhibited in the corresponding one to one graphs in Figure Sl. No.2 to 8 of R- versus-r and r_1 on the same axes and further in R-versus-V and versus-P graphs in Figures Sl. no. 09 & 10 .Here the r_1 - line intersects the r-line with the load line of R at the critical point making $r = r_1 \approx$ R. After knowing the values of the load resistor R at the critical points and then the corresponding EPDs (i.e. the

Voltages) from the 3D graph of R- versus – V in Figure Sl. no.09 a resultant bar –
diagram graph in between the Species and the EPD in then drawn in Figure Sl. No.11
for comparative study. of EPD's Further, for comparative study of the electrical power of
the species a 3D graph is also plotted in Fig.Sl.no.10 in between R-versus-Power .

Result :- It has been observed that the EPD of a plant cell varies for different area of
the stem section. It becomes maximum in the xylem to phloem areas where as it
reaches to its minimum value in the epidermis to the pith areas. The higher EPD areas
can be defined as conducting area due to presence of more sap water, where as the
less watery areas can be defined as non-conducting areas .Their variations in Figs..Sl.
No.2-10 reveal the aforesaid various positions of the EPD. It has been observed here
that the EPD varies from 6 to 10 milivolts up to the higher values of 70 to 83 mV in the
mesophytic species of Vaijantri and the Calotropis procera respectively ,where as it
reaches to its further higher value up to 140-180 mV in the xerophytic species. Out of
the xerophytic species the opuntia elatior and the Aloe vera have got the EPD up to the
maximum value of 176-180 mV. Further, their graphs of load resistance R-versus-the
internal cell resistance r & the maximum power transfer resistance r_1 (vide Figure
Sl.No.02 to 08) reveal that the value of r begins from its maximum value to its minimum
where as in reverse the value of r_1 starts from its minimum value up to its maximum. In
the aforesaid graph r- line intersects the r_1-line along with the load line of R at a critical
point where r = r_1 ≈ R .This critical point of intersection can be considered as the best
suitable value of the load resistor R for maximum smooth power transfer to external
circuit. However, in cases of the plant species Vaijantri and Opuntia Dillenii the load line
of R intersects the r-line not at the intersection point of R and r_1 lines but nearer to them.

This is possibly due to some experimental errors. So in such errorful cases for getting the aforesaid critical value of R the average of values of two intersecting points is taken which is clearly exhibited in the graphs in figure Sl.no.2 & 5.

It has been also found interestingly that the natural cascading of the sections of the stem cells have been set in a directions against the cascading of cells as per the Ohm's Law of electricity for i.e. after positive polarity negative polarity should come and after negative polarity positive polarity should come. The opposite natural cascading of plant's cells bring down the overall voltage to be minimum and the total resistance to be higher. With this result it has been found interestingly that the total internal resistance of the plant's cell increases with the increase of the thickness of the stem. Thus, or formation of a fruitful plant battery it is advisable at first to select the maximum energy contained species i.e. the opuntias or the Aloe vera out of the xerophytes as found from the comparative study of the EPDs from the 3D Graph of species -versus – EPD in its Figure Sl.no.09 along with the resultant Bar –diagram graph in figure Sl. No.11. Thereafter, the stem cells are cascaded in a battery like pot according to the Ohm's Law of cascading of cells of electricity i.e. after the positive polarity the opposite negative polarity is attached and after the negative polarity the opposite positive polarity is attached. The aforesaid result for higher electrical power of the species can also be observed by viewing the R- versus- Power 3D graph in Figure Sl.no.10. Then an external workable load resistor has to be so chosen to match with the aforesaid critical load resistor R for smooth functioning of the maximum battery power.

Discussion:-   The aforesaid bio-electrical power or the EPD of plants is produced actually across their eukaryotic cells, which is possibly due to formation of infinite

number of primary electrical cells across their living cell systems by dissolution of various metals(such as : N, P, K, Ca, Al, etc.) from high to low concentrations into the electrolyte formed in their food by photosynthesis from water. These metals are mostly found in the phloem area of vascular bundle in their different chemical form. The aforesaid formation of primary electrical cells are done actually in accordance with the "Nerst theory of Electrode Potential" in which the ionic action takes place between metals of high to low concentration into an electrolyte. Further, as stated above(1,2),as the bio-EPD across a cell is directly proportional to the sap flux density and as this quantity is found to be maximum in Aloe vera and opuntias,the EPD in these species are maximum. It is well exhibited in the graph of R – versus- V and R-versus- Power 3D graphs in Figure Sl. No.09 & 10 to be viewed along the resultant bar-diagram of Species- versus – EPD (Figure Sl. No.11). So for formation of a fruitful Plant Battery of maximum EPD i.e. of maximum bio-energy out of xerophytes it is advisable to form it out of the sections of the stem cells of opuntias or the Aloe vera and then to apply the critical value of the load resistor R for the best suitable power transfer state. For making electrical connections to the stem cells of selected species they first are covered with pressured copper plates and then cascaded as per the Ohm;s law of electricity in a battery box.   .

A Plant Battery thus formed out of the aforesaid xerophytic species are a good source of bio-energy which is very useful to operate low potential instruments. After formation of the battery if the exposed portions of the cells are covered with any insulating materials, such as wax ,lac, etc,,then the life of the battery can be extended even up to six months. However, it has got certain limitations, such as:

(i) High potential instruments can't be operated by this,

(ii) If the pressure on the copper plate covering the plant's stem section is increased beyond a threshold preset value, then the natural electrolyte i.e. the sap preserved inside the cell as food may leak out destroying the very formation of the cells and their bio-EPD as a whole.

(iii) Further, the battery should be protected from any short circuiting from outside as it may also destroy the plant cell generating the EPD.

FIGURE SL. NO.02

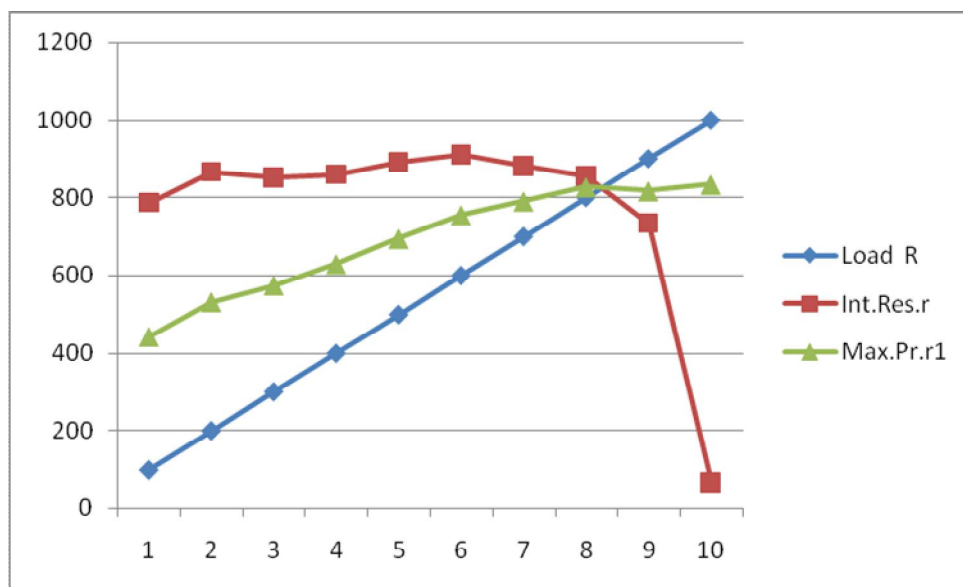Variations of Load Resistance R with Internal Resistance r and Maximum Power Transfer Resistance r_1 of the plant specie – ***Vaijantri***
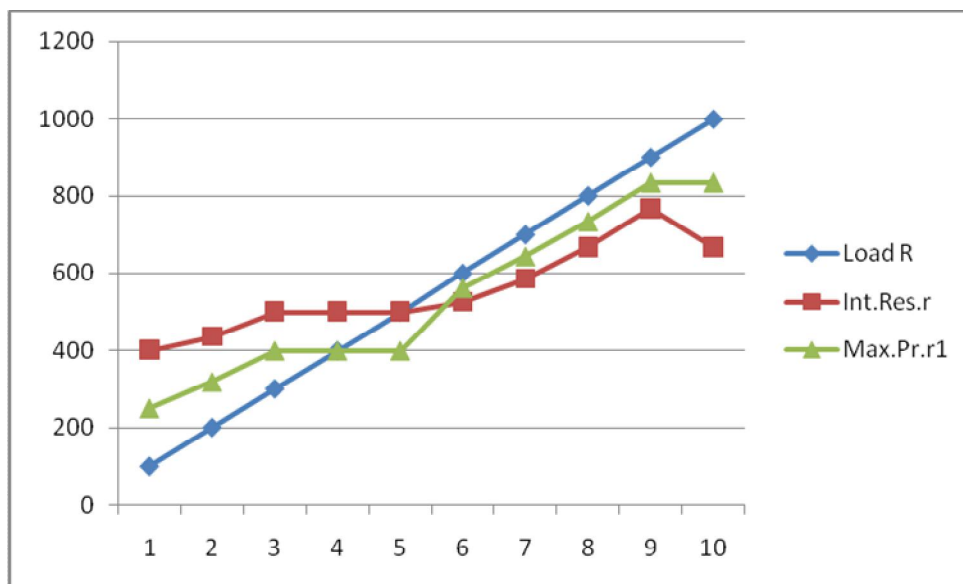
Here the load line R intersects the internal resistance line r at value of 500 ohms quite nearer (possibly due to some experimental errors)to the intersecting point of the two resistance line of internal resistance r and maximum power transfer resistance r_1 .

__Hence, the Inference at the intersecting point is $r = r_1 \approx R$ = Average: (562 + 500)/2 = 531 ohms__

FIGURE SL. NO.03

Variations of Load Resistance R with Internal Resistance r and Maximum Power Transfer Resistance r_1 of the plant specie – *__Calotropis Procera__*
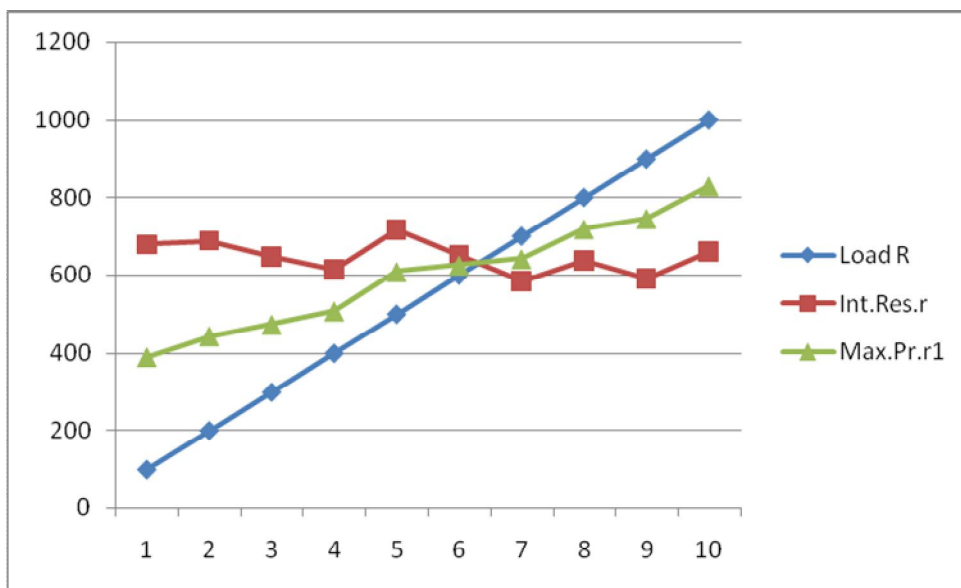
Here the load line R intersects at the two intersecting point of the internal resistance r and maximum

power transfer resistance r_1 at a value of 625 ohms.

<u>Hence, the Inference at the interference point is $r = r_1 = R = 625$ ohms</u>

FIGURE SL. NO. 04

Variations of Load Resistance R with Internal Resistance r and Maximum Power Transfer Resistance r1 Of the plant specie – ***<u>Sanpedro Cactus</u>***
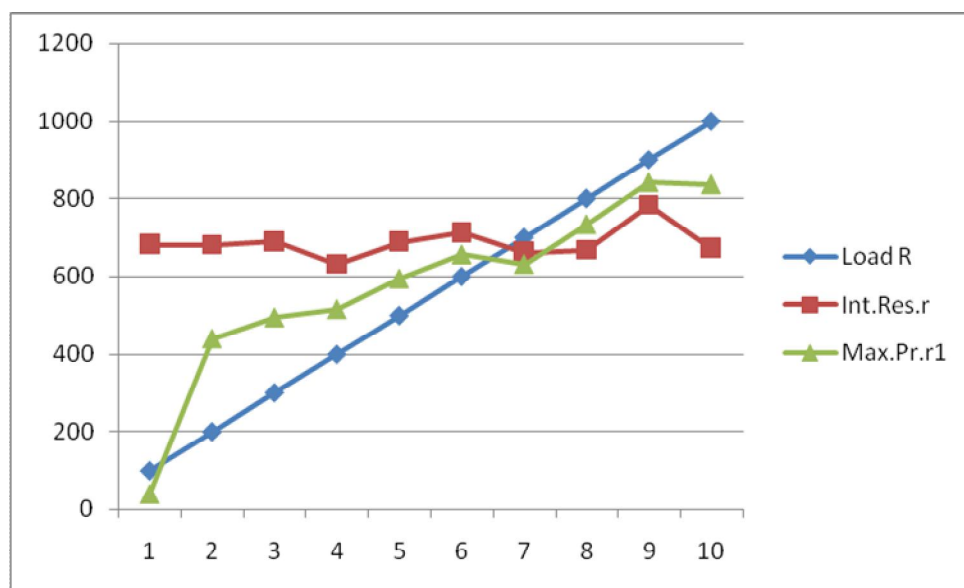
Here value all the three lines of load r ,internal resistance rand maximum power

transfer resistance r_1 intersect at a common point of 826.8 ohms.

<u>Hence, the Inference at the interference point is r = r_1 = R = 826.8 ohms</u>

<u>FIGURE SL. NO. 05</u>

Variations of Load Resistance R with Internal Resistance r and Maximum Power Transfer

Resistance r_1 of the plant specie – ***<u>Opuntia Dillenii</u>***
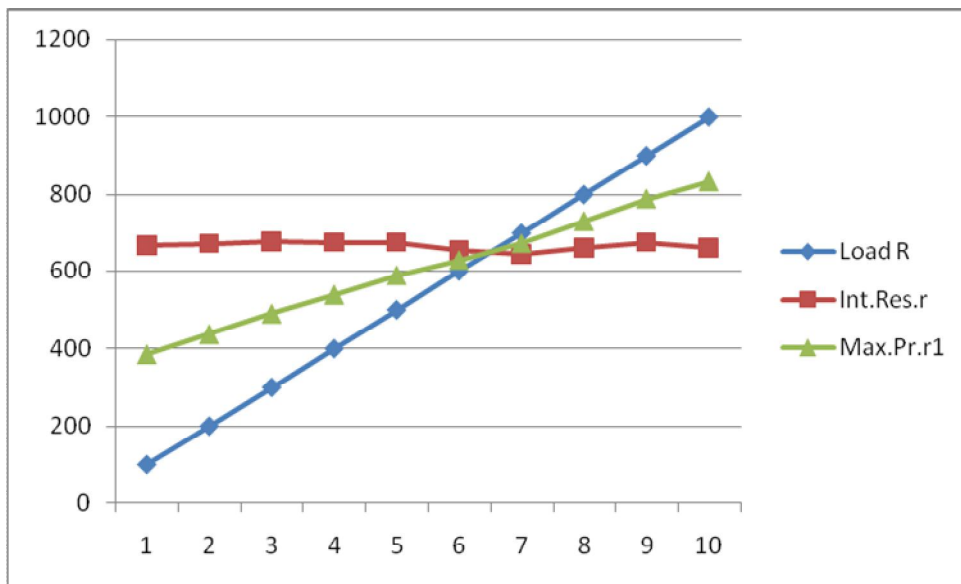
Here the load resistance line R intersects internal resistance line r at the value of 662.5 ohms

quite nearer (possibly due to some experimental errors)to the intersecting point of 631.2 ohms of

internal resistance r and maximum power transfer resistance r_1

Hence, the Inference, $r = r_1 \approx R = $ Average:(662.5+631.2)/2 =646.85 omhs

FIGURE SL. NO.06

Variations of Load Resistance R with Internal Resistance r and Maximum Power Transfer

Resistance r_1 of the plant specie – ***Pentalobo Cactus***
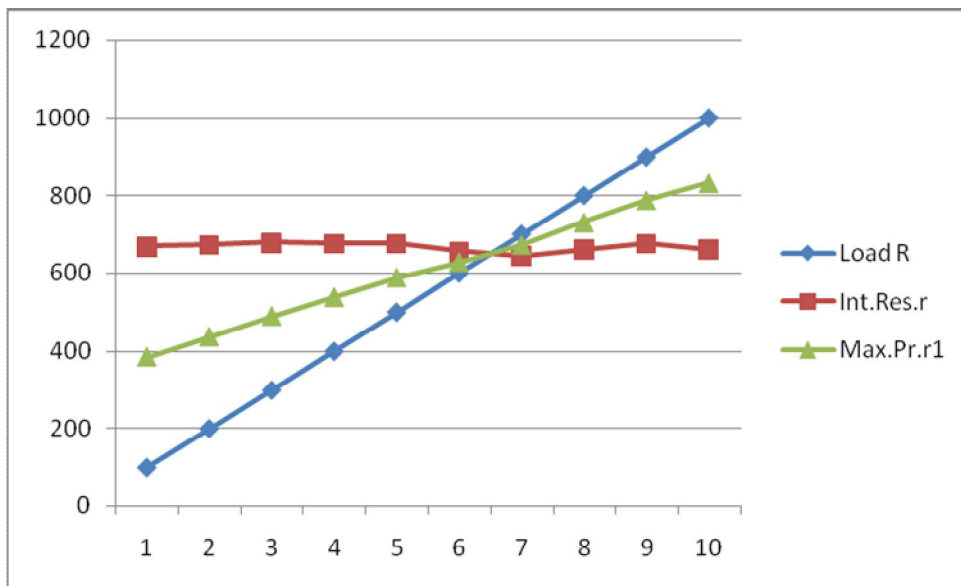
Here the load line R intersects the intersecting point of resistance liner and maximum power

transfer

resistance line r_1 at a value of 672 ohms.

Hence, the inference at the intersection point is r = r$_1$ = R =672 ohms

FIGURE SL. NO.07

Variations of Load Resistance R with Internal Resistance r and Maximum Power Transfer

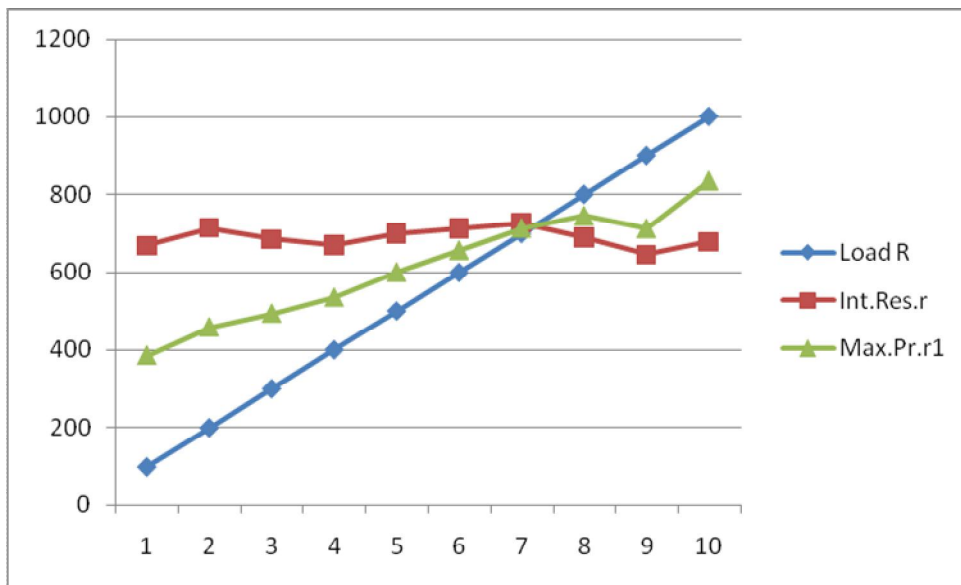Resistance $r_1$of the plant specie – ***Opuntia Elatior***

Here the load line R intersects at the two intersecting point of the internal resistance r and maximum

power transfer resistance r_1 at a value of 713.5 ohms.

Hence, the inference at the intersection point is r= r_1 = R = 713.5 ohms

FIGURE SL. NO.08

Variations of Load Resistance R with Internal Resistance r and Maximum Power Transfer Resistance r_1 of the plant specie – ***Aloe Vera***

Here the load line R intersects at the two intersecting point of the internal resistance r and maximum power transfer resistance r1 at a value of 713.5 ohms.

Hence, the inferenceat the intersection point is r= r₁ = R = 713.5 ohms

$$\text{Hence, the inference at the intersection point is } r = r_1 = R = 713.5 \text{ ohms}$$

FIGURE SL. NO. 09

**Variation of *EPD (i.e.voltage) as per the all species* taken for experiment in 3D positions**
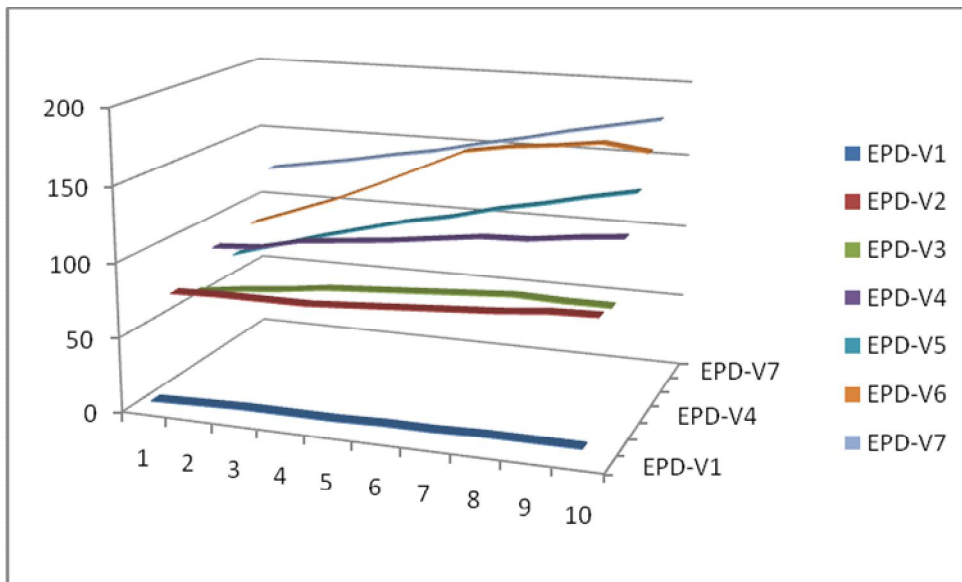
Here the 3D variation of the EPD shows clearly the independent rise of EPD of the species.In it the V1 represents as the specie Vajantri,V2 as Calotropis Procera,V3 as Sanpedro Cactus,V4 as Opuntia Dillenii,V5 as Pentalobi Cactus,V6 as Opuntia Elatior and V7 as Aloe Vera

Hence,the inference is that the mesophytic   Vaijantri has got the minimum EPD and the xerophytic Aloe Vera has got the maximum EPD very nearer to the Opuntia Elatior of the same family.

FIGURE SL. NO. 10

Variation of   Electric Power – versus -   all species taken for experiment   in 3D positions
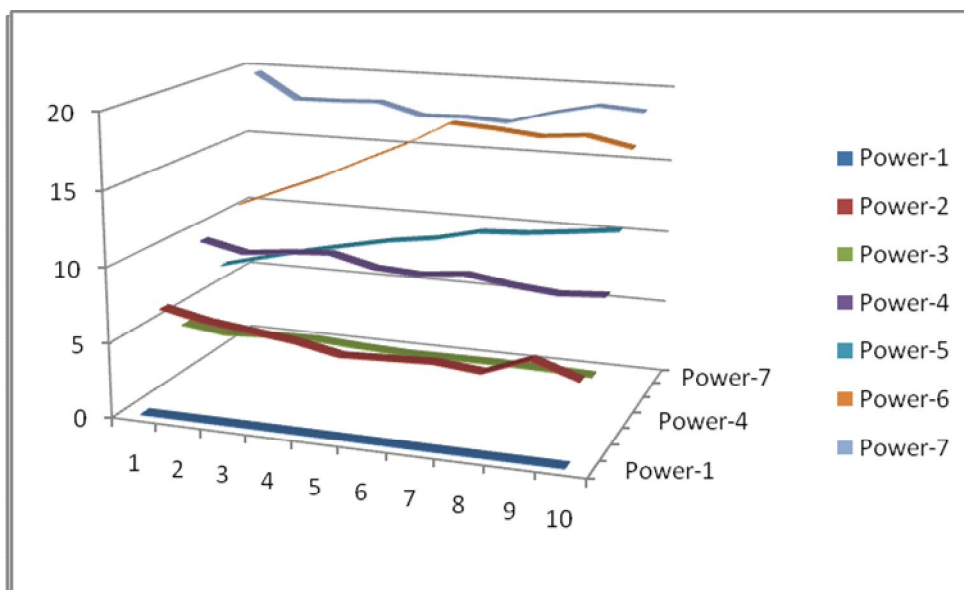

Here the 3D variation of the Electric Powers as per the species shows clearly the independent rise of the power of the species and is very nearer to that of variations of EPDs .In it the Power-1

represents   as the electric power of the specie Vajantri,Power-2   as that of Calotropis Procera,Power-3 as that of Sanpedro Cactus,Power-4 as that of Opuntia Dillenii,Power-5 as that of Pentalobi Cactus,Power-6 asthat of Opuntia Elatior and Power-7 as that of Aloe Vera.

<u>Hence,the inference is that the 3D variations of the electric powers almost resembles with that of the EPD i.e.the voltage which is in accordance with the electrical principles</u>

<u>FIGURE SL. NO.11</u>

Bar Diagram of <u>*Species –versus—EPD*</u> (i.e.voltage)
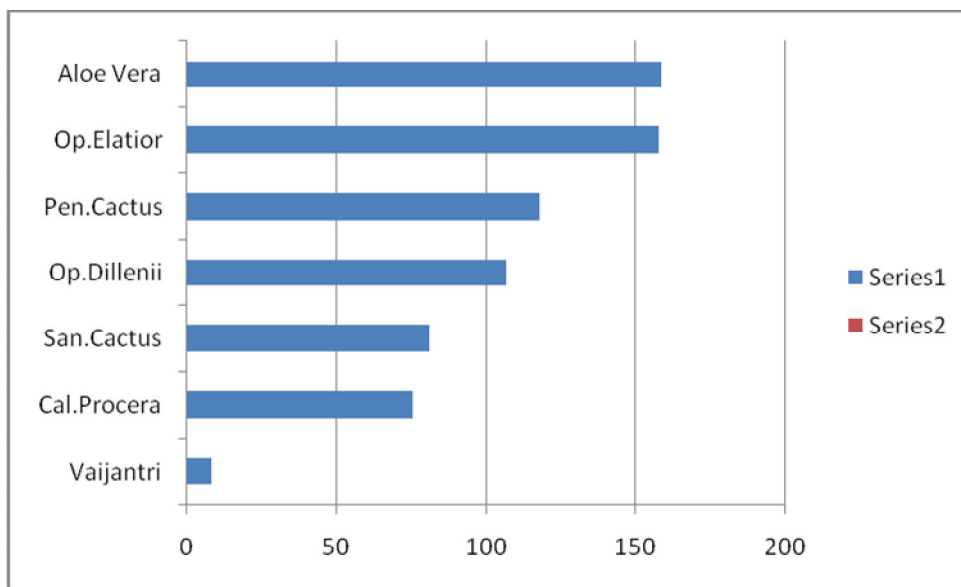
Here , a comparative variation chart of EPD as per the all species taken for experiment is shown.In it Op. Elatior is Opuntia Elatior,Pen. Cactus is Pentalobi Cactus,Op.Dillenii is

Opuntia Dillenii,San. Cactus is Sanpedro Cactus and Cal. Procera is Calotropis Procera in full term.

Hence, the inference is that the mesophytic Vaijantri has got minim,um EPD where as xerphytic Aloe Vera has got the maximum nearer to the same variety of Opuntia Elatior.

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