Indian Journal of Advanced Physics (IJAP)
ISSN: 2582-8983 (Online), Volume-2 Issue-2, October 2022

Mung Seeds Under Constant Low Potential Difference During Post-Germination When Sprout Length Grows

A. Ghorai

Abstract: *Low potential difference* $0.0Volt$ $1.5Volt$, $3.0Volt$, $4.5Volt$, *and* $6.0Volt$ *are applied during the growth of sprout length after germination and post-germination of mung seeds in open-air conditions. The sprout length decreases with an increase in potential difference and graphs show non-linear variations. Thus, this potential difference produces a negative impact on the sprout length elongation of seeds. The decrease in the sprout length may be due to lesser diffusion through the cell wall or due to the weakening of the activity of the other cell components leading to a slower rate of cell division. This may have an impact on the process of preservation of seeds.*

Keywords: *Potential Difference, Seed, Germination, Sprout.*

I. INTRODUCTION

In this biomaterial age, lots of data and information due to the low potential difference (called hereafter pd) are pouring in, and applications of low doses of pd are used in different disciplines, like food processing, medical science, etc. The effect of low pd on the growth of sprout length of seeds has been tested earlier [1-4] because of its interesting nature at the time of germination of seeds. The earliest reference on this topic was given by Sidaway [5]. Germination commences when the quiescent dry seed begins to take up water (inhibition) and is completed when the embryonic axis elongates. Germination takes 4-5 days and after it, the seed splits with the growing of a whitish root. Here the variations of growth of sprout length of mung seeds (*vigna radiata*) with applied low pd will be dealt with. A uniform low pd is created by a dry cell between two parallel metallic plates.

II. GERMINATION IF SEEDS

A seed [6-7][8][9][10][11][12] is a small embryonic plant or an embryo with two points of growth (one of which forms the stem, the other the root) enclosed in a covering called the seed coat, usually with some stored food reserves, such as starch, proteins, or oils. This food reserve provides nourishment to the growing embryo. A typical seed includes three basic parts: (i) an embryo that is an immature plant from which a new plant will grow under proper conditions.

Manuscript received on 09 March 2022 | Revised Manuscript received on 10 June 2022 | Manuscript Accepted on 15 October 2022 | Manuscript published on 30 December 2023.
**Correspondence Author(s)*
A. Ghorai*, School of Science, SGIL Residenza, Block 1/3G, 66/63 Jangalpur Road, Kolkata (West Bengal), India. E-mail: amitavaghorai@rediffmail.com, ORCID ID: 0000-0003-3058-5532

(ii) A seed coat (or testa) develops from the tissue, the integument, originally surrounding the ovule. (iii) A supply of nutrients within the seed for the embryo that will grow as a seedling. Germination of seed is a process in which a plant or fungus emerges from a seed or spore and begins growth or it is a process by which a seed embryo develops into a seedling. It involves the reactivation of the metabolic pathways that lead to the growth and the emergence of the radical or seed root and plumule or shoot. Under favorable conditions, the seed begins to germinate and the embryonic tissues resume growth, developing into a seedling. Three fundamental conditions must exist before germination can occur. (a) The embryo must be alive, called seed viability, which is the ability of the embryo to germinate and is affected by several different conditions. (b) Any dormancy requirements that prevent germination must be overcome. (c) The proper environmental conditions must exist for germination. Seed vigor is a measure of the quality of the seed, and involves the viability of the seed, the germination percentage, the germination rate, and the strength of the seedlings produced. The germination percentage is simply the proportion of seeds that germinate from all seeds subject to the right conditions for growth. The germination rate is the length of time it takes for the seeds to germinate. Germination percentages and rates are affected by seed viability, dormancy, and environmental effects that impact the seed and seedling. Three distinct phases of germination of seed occur water imbibitions, lag phase, and radical emergence. For the seed coat to split, the embryo must imbibe (soak up water), which causes it to swell, splitting the seed coat. The uptake of water by seeds is called imbibitions, which leads to swelling and the breaking of the seed coat. The rate of imbibitions is dependent on the permeability of the seed coat, the amount of water in the environment, and the area of contact the seed has with the source of water. Germination of seed depends on both internal and external environmental conditions. The most important external factors include temperature, water, oxygen, and sometimes light or darkness.

Scarification mimics natural processes that weaken the seed coat before germination. Scarification, which allows water and gases to penetrate the seed, includes methods that physically break the hard seed coats or soften them with chemicals. Stratification also called moist-chilling is a method to break down physiological dormancy and involves the addition of moisture to the seeds so they imbibe water and then the seeds are subject to a period of moist chilling to after-ripen the embryo.

III. PLANT GROWTH

Plant growth is unique because plants have the capacity for unlimited growth throughout their life. It is the most conspicuous characteristic, irreversible, permanent increase in the size of an organ or its parts or even of an individual cell. The ability to grow is due to the presence of meristems at certain locations in their body [5-6]. The increased growth rate per unit of time is termed growth rate (a). The initial growth rate is slow and called the lag phase (LP). It increases rapidly thereafter and is called the exponential growth phase (EP). Here both the progeny cells following mitotic cell division retain the ability to divide and continue to do so. However, due to limited nutrient supply, the growth slows down leading to a stationary phase (SP). Thus, there are three phases LP, EP, and SP. We shall get a sigmoid or S curve and if g and g_0 be the final and initial size respectively and t be the time then mathematically

$$g = g_0 e^{at} \qquad \text{- (1)}$$

The essential elements for growth are water, oxygen, and nutrients. In addition, the optimum temperature range is best suited for its growth.

IV. EXPERIMENTAL

This experiment is similar to previous experiments with gram seeds (*Cicer arietinum*) [1-2], peas seeds (*Pisum sativum*) [3], and ground nut seeds (*Arachis hypogaea*) [4]. An inference was drawn that the electric field had an impact on the elongation of sprout length during the germination of different seeds. In the experimental set up a low pd is built up between two parallel metallic circular plates (about $0.1meter$ diameter) by connecting the outer surfaces of the plates to a dry cell of AA size as shown in a schematic diagram of figure 1(a). Thus a uniform electric field $E = \frac{V}{r}$ is created for the pd V between two parallel metallic plates with the distance between the plates r. The distance r is kept fixed at $60mm$ to keep the electric field uniform or constant. Five plastic teapots readily available in the market are taken and ten mung seeds are placed in each teapot over wet sand and soil mixture as shown in the photograph of Figure 1(b). Out of five such prepared teapots, one is kept at normal conditions. Four other teapots are placed within a pair of circular parallel plates kept at different low pd viz. $1.5Volt$, $3.0Volt$, $4.5Volt$, and $6.0Volt$ the distance between the plates is kept fixed to $60mm$. Different pd are generated by different series combinations of dry cells. During the experiment, the highest and lowest room temperatures are recorded every day by a sensitive thermometer and the average of it is noted to be 33°C and 22°C. The pd in all four sets is measured every day by a voltmeter to ensure its constancy of it during the experiment.

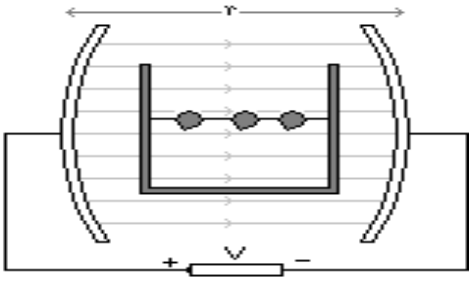

Figure 1: Schematic Diagram of the Experimental Set up

In this constant pd treatment germination will start in due course of time and sprout will grow. After one day of exposure, the seeds are taken away from pots one by one each day from constant pd condition for a short while for the measurement of sprout length accurately with the help of pointers and then kept inside the pot as it was before. The process is repeated for three to four more days till the budding of green leaves and the mean sprout length for each case is taken.

V. EXPERIMENTAL RESULTS

There are five variables and they are (i) pd V, (ii) distance between the parallel plates r, (iii) electric field $E = \frac{V}{r}$, (iv) sprout length l, and (v) time duration of growth of sprout length t. Generally, the mean or average of ten sprout lengths at a particular time of growth of sprout length for mung seeds (l) is plotted along a vertical axis and the time duration of growth of sprout length (t) along the horizontal axis for different applied low pd (V) with values $0.0Volt$ $1.5Volt$, $3.0Volt$, $4.5Volt$, and $6.0Volt$ and the fixed plate separation $60mm$. The nature of the $l-t$ graph for different V and constant r is shown in Figure 2. With the increase in pd, the graphs are almost straight lines and more parallel or less bend towards the horizontal axis. So we can say that the sprout length decays with the increase in pd V. The natural decay laws are in general exponential (viz. radioactive decay law) and the graph almost resembles the same nature.

Figure 2: Photograph of Experimental Setup

VI. DISCUSSIONS AND CONCLUSIONS

From these non-linear plots, it is clear that the sprout length variation of seeds depends on the magnitude of applied low pd (V) and the plate separation (r). The electric fields (E) corresponding to these low pd are $0.0Volt/mm$, $0.025Volt/mm$, $0.05Volt/m$, $0.075Volt/m$, and $0.01Volt/m$. The exact nature of the mathematical dependence of pd or electric field and the growth of the sprout length is still unknown. Therefore, it is difficult to propose any fitted equation for these non-linear plots. In addition, there exists a variety of fitting. In any case, the physical reasoning for it perhaps is due to the slower rate of cell division for increasing pd or electric field. The biological reason for this might be due to lesser diffusion through the cell wall or weakening of the activity of the other cell components.

The proposed lines in the figures show the continuity in the process of germination and post-germination while scatter plots will show discontinuity. This justifies the drawing of lines joining scatter points.

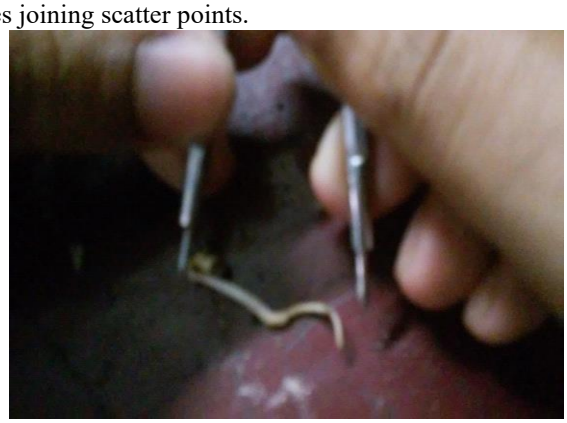

Figure 3: Measurement of the Sprout Length

The decrease in sprout length with an increase in low pd indicates a cut of pd value at which the growth of sprout length stops. Unless an exact $l - t$ relation for different V and constant r is obtained it is difficult to get the exact cut of value.

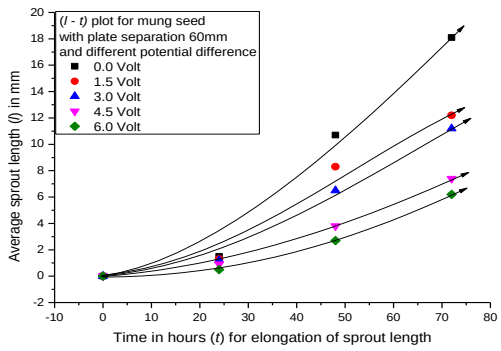

Figure 4: Variation of Sprout Length (l) with Time (t) for Different Pd (Potential Difference) V at Fixed Plate Separation $r = 60mm$ for Mung Seeds

ACKNOWLEDGEMENT

This whole experimental model set up is prepared by the author and measurements of different sprout lengths, highest and lowest temperatures, checking the constancy of pd are performed by five first-year undergraduate students of session 2014-17 (Sidra Mehtab, Muktajyoti Saha, Ankita Saha, Subhasis Roy, and Aditya Sen) of Department of Physics, Maulana Azad College, 8, Rafi Ahmed Kidwai Road, Kolkata-700013, West Bengal, India.

DECLARATION STATEMENT

Funding	No, I did not receive.
Conflicts of Interest	The author declares no Conflict of interest.
Ethical Approval and Consent to Participate	No, the article does not require ethical approval and consent to participate with evidence.
Availability of Data and Material	Not relevant.
Authors Contributions	I am only the sole author of the article.

REFERENCES

1. A. Ghorai, The electrical hazards on the germination of seeds, LAP LAMBERT Academic Publishing AG & Co. KG, Germany, 2012, ISBN – NR 978-3-8465-0921-0.
2. Alok Chattaraj, Sandipan Mallik, Tapati Das and A. Ghorai, Physics Education 25.1 p.5,2008.
3. Anaranya Ghorai and A. Ghorai, World Journal of Biology and Medical Sciences, 2(3), 39-56, 2015.
4. A. Ghorai, Sk. Abdul Mohid and Sarif Khan, Research Journal of Agriculture and Environmental Management 3(9), 472-476, 2014.
5. G. H. Sidaway, Nature 211, 303, 1966. https://doi.org/10.1038/211303a0
6. B.B. Buchanan, W. Gruissem and R.L. Jones, Biochemistry and Molecular Biology of Plants, I.K. International Pvt. Ltd., Kolkata, 2000, p.1041.
7. L. Taiz and E. Zeiger, Plant Physiology, Sinauer Associates Inc. USA, 4th ed. 2006, p.719.
8. Physiology, Productivity and Cotton Plant Adaptation under the Conditions of Soil Salinity. (2019). In International Journal of Recent Technology and Engineering (Vol. 8, Issue 2S3, pp. 1611–1613). https://doi.org/10.35940/ijrte.b1293.0782s319
9. Widowati, H., Sulistiani, W. S., Sutanto, A., Huda, M., & Rosman, A. S. (2019). The Effect of Washing and Processing of PB-Polluted Vegetables towards their Levels of PB and Vitamin C. In International Journal of Innovative Technology and Exploring Engineering (Vol. 8, Issue 11, pp. 1735–1739). https://doi.org/10.35940/ijitee.k1528.0981119
10. Sapate, N. M., & Deshmukh, Dr. R. R. (2019). Spectral and Numerical Analysis of Hyper spectral Data using Vegetation Indices. In International Journal of Engineering and Advanced Technology (Vol. 8, Issue 6, pp. 2156–2162). https://doi.org/10.35940/ijeat.f8578.088619
11. Kindie, B., & Mengistu, S. (2022). Agro morphological Trait Evaluation of Garlic (Allium Sativum L.) Response to Fertilizer. In Indian Journal of Advanced Botany (Vol. 2, Issue 1, pp. 1–5). https://doi.org/10.54105/ijab.a1014.042122
12. Natesan, Dr. B., Paneerselvam, U., & Narayanasamyc, Dr. D. (2022). Cyanotis Ceylanica Hassk. (Commelinaceae), First Record to India from Eastern Ghats of Tamil Nadu, India. In Indian Journal of Advanced Botany (Vol. 2, Issue 2, pp. 1–4). https://doi.org/10.54105/ijab.d2008.102222

AUTHORS PROFILE

Dr. A. Ghorai was a retired Associate Professor and served different Government Colleges in West Bengal. He did his doctoral work on the 'Study of point defects in solids and thin films' at IACS, Kol-32 and received Ph.D. degree from Jadavpur University in 1989. Presently Dr. Ghorai is interested in theoretical study of transport phenomena in solids, especially investigation of intricacies of different defect and diffusion properties of metallic solids, cubic metals and alloys using quantum mechanics. He did several pedagogic experimental projects works with undergraduate students and almost all projects have been published. He has published 43 journal papers and six books.