



Effect of Water TDS, on the Growth of Plant (*Phaseolus vulgaris*)

Aditya Raj ^{a*}, Ankita Gupta ^a, Neha Gupta ^a
and Sameer S. Bhagyawant ^a

^a School of Studies in Biotechnology, Jiwaji University, Gwalior, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2023/v35i122977

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/94423>

Original Research Article

Received: 04/10/2022

Accepted: 08/12/2022

Published: 13/05/2023

ABSTRACT

Water is the major constituent of life for the growth of animals and flora species. Water is available around the world with different Total Dissolved Solids (TDS) levels and minerals. On the basis of TDS, the hardness and softness of water are determined. (Underground water and oceanic water are found to have higher TDS than fresh water).

Aim: To understand the effect of TDS on the growth of plant.

Objectives: A study was conducted on the basis of the TDS of water to observe the effect of TDS on the growth of *phaseolus vulgaris* (kidney bean) plants and to check whether the water TDS is responsible for the growth of the plants or not.

Methods: Water of different TDS levels was collected from Gwalior district (Gwalior, Gwalior fresh water Takenpur, and distilled water). Water has different TDS levels ranging from 95ppm (Parts Per Million), 750ppm, 2000ppm, distilled water with 0ppm TDS, and acidic distilled water (pH 3.5–4, by adding HCl acid). The kidney beans (*phaseolus vulgaris*) were purchased from a local mart and sowed into the washed sand with a neutral pH of 7, and the growth was observed under sunlight. (Each pot containing 7 beans).

Results: The result of the experiment was positive as required, as the water TDS level affects the growth of plants. It has been observed that distilled water with a TDS of 0 ppm shows almost no

*Corresponding author: E-mail: aditya17092000@gmail.com;

growth, but a TDS of 750 ppm shows the maximum growth. Therefore, it has been concluded that TDS is also responsible for the growth of plants, and this practice can be done on a large scale also for the best result of growth.

Keywords: *Phaseolus vulgaris*; total dissolved solids (TDS); parts Per Million (ppm); HCl acid; growth.

1. INTRODUCTION

In India agriculture (farming) is one of the basic practices of the nation. Farming is one of the major constituents in building the economy of the country. Farming is backbone of India in terms of economy. It provides employment prospect to the agricultural and non-agricultural laborers [1]. It also plays an important role in importing and exporting goods in international trade. *Phaseolus vulgaris* also call as kidney beans in India with vernacular name “rajma” (rajmah). Growing kidney beans is also a popular crop in India, in the state of Himachal Pradesh, Jammu and Kashmir, Kerala, Karnataka, Maharashtra, west Bengal, Uttarakhand, Tamil Nadu, and Uttar Pradesh (major kidney beans producing states in country).

So, for the enhancement of growth of different crops, research is conducted on the basis of TDS (total dissolved solids) level of water, collected from different areas of Gwalior division (Gwalior {fresh water} Gwalior city, Takenpur, and distilled water). Common kidney bean (Rajma) is used for observing the primary growth of the plant. Kidney beans are sowed in washed sand with a neutral pH 7, so as to clearly observe the effect of TDS of water on the plant. Five different TDS of water were used, 95ppm (Parts Per Million) [Gwalior, fresh water], 750 ppm (Gwalior city), 2000 ppm (Takenpur), 0ppm (distilled water), 0ppm with HCl acid (water pH 3.5-4). Growth was observed and it is found that water from Gwalior city of TDS 750ppm shown best growth, While the distilled water of TDS 0ppm and its acidic modification shows almost no growth in the meantime.

2. HYPOTHESIS

It is predicted that, after watering *phaseolus vulgaris* (kidney bean) plant with water of different TDS, the growth must vary depending upon the TDS of water {without fertilizers}, because of presence of solids, salts and minerals in it. Presence of solids, salts and minerals varies the TDS of water. The result is positive as required and TDS level shows its effect on the growth of plant. 0ppm TDS and its acidic

modification shows no growth while other shows positive growth rate.

3. TDS

TDS is an abbreviation for TOTAL DISSOLVE SOLIDS or SALTS. These are compounds inorganic in nature that are found in water such as heavy metals, salts and some traces of organic compounds. Among of all these substances some are essential in nature and some are harmful for health. These are the solids refer to as extremely small dissolved particles in surface water such as Nitrate, Sodium, Potassium Chloride, Phosphates and Calcium [2]. Turbidity, water temperature, and dissolved oxygen (DO) levels can all be impacted by high amounts of total suspended particles. Because the suspended particles absorb more heat and use up more oxygen, the water may heat up more quickly as a result, which may be harmful to aquatic life. By decreasing light transfer, higher amounts of solids also hinder the photosynthesis of aquatic plants. Too much or too little TDS might restrict the growth of aquatic plants [3].

4. METHODS

4.1 Preliminary Experiment

Prior to the experiment, the growth rate of *Phaseolus vulgaris* (kidney beans) [4] was compared against that of *Coriandrum sativum* [5] (cilantro leave) to determine which would grow faster. Using two pots filled with cotton, in one pot five kidney beans were sowed and five coriander seed in another pot. Both were left under sunlight to check which would attain shoot earlier till first leaf growth. Coriander was found to attain shoot in 5 days but it does not show any further height growth, it grows at very low height. Whereas on the other hand, kidney beans it grows in 10-11days and shows a promising height as it over took the coriander shoot after one and a half week (approximately 10-12 days), after the seeds were sown.

“Hence it was decided to use the common beans for this experiment.”

4.2 Equipment

- Five plastic flower pot, for planting the beans.
- Five regular filter paper so as to prevent sand from leaking out if the flower pot.
- Washed and de-contaminated sand.
- Kidney beans (freshly packed {mfg. date}, organic) [purchased from local mart].
- Water of different TDS collected from Gwalior division.
- Distilled water (single distilled water)
- Sterile water container, for storage of water.
- HCl acid for making acidic water.
- Scale for measuring height.
[Idea from the Indian gardening website How to Grow Rajma Plant | Growing Kidney Beans in Pots (indiagardening.com)] [6]

4.3 Procedure

- 1) Collect the sand and wash it with a running water and let it dry
- 2) Place the filter paper in the bottom of pot so as to prevent drainage of sand from the flower pot.
- 3) Now fill all the five-flower pot 75% with the washed sand.

- 4) Place the flower pot under the sunlight.
- 5) Now sow five kidney beans in each of the respective flower pot.
- 6) Mark the flower pot with numbers (1,2,3,4,5), and the TDS unit in ppm, so as to easily distinguish between them.
 - a) First pot was labelled 0ppm,
 - b) Second pot was labelled acidic with 0ppm,
 - c) Third pot was labelled with 95ppm,
 - d) Fourth pot was labelled with 750ppm,
 - e) And the fifth pot was labelled 2000ppm.
- 7) For making acidic water, in distilled water of TDS 0ppm, hydrochloric acid (HCl) was added drop by drop till it's pH appeared in between somewhere of 3.5-4 on pH strip.
- 8) Using water of different TDS, sprinkle water with the help of sprayer in each pot, 3-5 times a day.
- 9) Observe the growth of the plant under sunlight.
- 10) After observing first leaf, remove the plants from the sand and measure its heights using scale after sticking it on to the white sheet.
- 11) Repeat the above experiment five times so as to get the accuracy in the result.

4.4 Diagrams

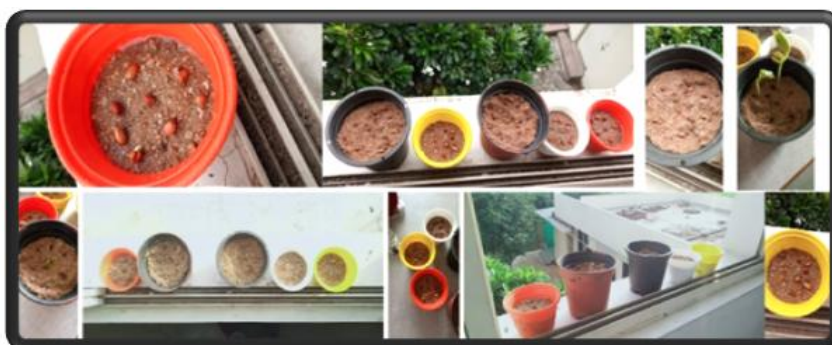


Fig. 1. Growth of plant *Phaseolus vulgaris*

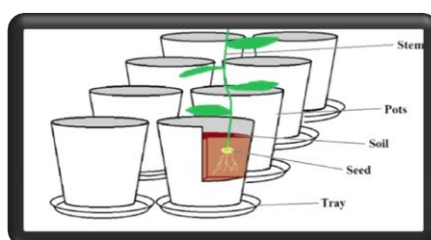


Fig. 2. Model diagram



Fig. 3. Measurement of sample

4.5 Risk Assessment

- The usage of concentrated Hydrochloric acid is required for this experiment. If HCl acid comes into touch with skin, it is corrosive and irritating, and it can cause burns. When handling acid and watering the plants, use a lab coat, protective goggles, and rubber gloves, and put them in a sealed container when not in use.

- If acid is spilled on the ground, neutralize it with sodium bicarbonate and then gather all shards with a thick cloth.

5. OBSERVATION AND RESULTS

When an experiment is processed, it is been observed that TDS of water does affect the growth of plant. Results of different parameter is observed, which tells us the maximum growth of plant, *Phaseolus vulgaris* is found to be from the TDS of 750ppm and relatively low from TDS of 2000ppm in the mean time of 9 days under sunlight, with reference to fresh water from the dam the growth is quite least in the mean time of 9 days under sunlight.

The observation are as follows:

In the Table 3 set of experiment, we have planted 7 seeds of *Phaseolus vulgaris* in each pot and around 60% of the seeds are germinated in the sample of 95ppm, 750ppm and 2000ppm, while in case of 0ppm and acidic 0ppm (3.5-4pH) no comparative growth is observed (one or two seeds just popped).

Table 1. Average growth rate against each treatment (1st plantation)

1ST plantation								
TDS level	Seed 1	Seed 2	Seed 3	Seed 4	Seed 5	Seed 6	Seed 7	Average growth
95PPM	9.5CM	N/A	N/A	9.4CM	9.5CM	N/A	9.2CM	09.40cm
750PPM	N/A	14.2CM	15.3CM	N/A	N/A	N/A	14.9CM	14.80cm
2000PPM	13.7CM	15CM	N/A	N/A	13.9CM	N/A	N/A	14.20cm
0PPM	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
0PPM (3.5-4pH)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 2. Average growth rate against each treatment (2nd plantation)

2nd plantation								
TDS level	Seed 1	Seed 2	Seed 3	Seed 4	Seed 5	Seed 6	Seed 7	Average growth
95PPM	N/A	9.3cm	9.1cm	N/A	N/A	9.5cm	9.7cm	09.40cm
750PPM	15.1cm	15.4cm	N/A	14.9cm	15.8cm	N/A	N/A	15.30cm
2000PPM	N/A	13.84cm	N/A	N/A	14.3cm	14.2cm	14.3cm	14.16cm
0PPM	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
0PPM (3.5-4pH)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 3. Average growth rate against each treatment (3rd plantation)

3rd plantation								
Tds level	Seed 1	Seed 2	Seed 3	Seed 4	Seed 5	Seed 6	Seed 7	Average growth
95PPM	11.2cm	N/A	10.30cm	09.80cm	09.7cm	10.5cm	N/A	10.30cm
750PPM	15.5cm	N/A	15.6cm	N/A	15.8cm	15.5cm	N/A	15.60cm
2000PPM	N/A	13.8cm	N/A	N/A	N/A	14.6cm	14.8cm	14.40cm
0PPM	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
0PPM (3.5-4pH)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 4. Average height in all three-plantation

Water TDS	1st plantation (avg)	2nd plantation (avg)	3rd plantation (avg)	Average plantation	Mean time
95PPM	09.40cm	09.40cm	10.30cm	09.70cm	9DAYS
750PPM	14.80cm	15.30cm	15.60cm	15.23cm	9DAYS
2000PPM	14.20cm	14.16cm	14.40cm	14.21cm	9DAYS
0PPM	no growth	no growth	no growth	00.00cm	9DAYS
0PPM(3.5-4pH)	no growth	no growth	no growth	00.00cm	9DAYS

From the above set of experiment of all three-plantation average height is also calculated and the table is as follows Table 3.

6. DISCUSSION

The idea of study was done on the idea that we drink water which contain different minerals and they are measured in terms of TDS (Total Dissolved Solid). So as we know that plants are grown with the help of water as excess amount of water suppresses the growth of plant and is termed as water stress [7]. Study is been conducted on the saline stress which affects the growth of plant in different parameter and they have shown a big concern in the field to control it, as it is leading to land loss for farming [8]. Different researches has been done in the field against polluted water effect on the growth of plants but no one has ever shown a concern related to the topic of water TDS. Effect of TDS is also been observed on the aquatic Organisms [9] and specifically on the growth of phytoplankton [10] in different studies.

7. CONCLUSION

The aforementioned studies were conducted to determine the part that water TDS plays an important role in plant growth. As can be seen from the above table, TDS has an impact on plant growth. And we can use this parameter in the field of agriculture.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Kaur, Simrit, Kulkarni, Vani, Gaiha, Raghav, Pandey, Manoj. Prospects of non-farm employment and welfare in rural

areas. Australian National University, Australia South Asia Research Centre, ASARC Working Papers; 2010.

- Hussain, Muhamm ad. Total Dissolve Salts (TDS); 2019. DOI:10.13140/RG.2.2.11858.30406
- Solids, Total and Dissolved (TSS and TDS) - Water Quality Parameters | Hach; Solids, Total and Dissolved (TSS and TDS) - Water Quality Parameters | Hach
- Shelef LA. In Encyclopedia of Food Sciences and Nutrition (Second Edition); 2003.
- Anbazhagan, Thirugnanavel, Deka, Bidyut, Kumar, Rakesh, Rengnamei, Lily, Meyasae, Megokhono, Rabi, Kolom. Evaluation of rajma bean landraces for growth, yield and quality under low altitude condition of Nagaland. International Journal of Current Microbiology and Applied Sciences. 2018;7:2641-2648.
- How to Grow Rajma Plant. Growing Kidney Beans in Pots (indiagardening.com)]
- Lisar, Seyed Yahya, Motafakkerazad, Rouhollah, Hossain, Mohammad, Rahman MM, Ismail. Water Stress in Plants: Causes, Effects and Responses; 2012. DOI:10.5772/39363.
- Wang W, Vinocur B, Altman A. Plant responses to drought, salinity and extreme temperatures: towards genetic engineering for stress tolerance. Planta. 2003;218:1–14. DOI:https://doi.org/10.1007/s00425-003-1105-5
- Weber-Scannell, Phyllis, Duffy, Lawrence. Effects of total dissolved solids on aquatic organisms: a review of literature and recommendation for salmonid species. American Journal of Environmental Sciences. 2007;3. DOI:10.3844/ajessp.2007.1.6.

10. Li R, Xu QJ, Zhang GS, Cheng XY, Sai B. Effects of various total dissolved solids (TDS) on the growth of phytoplankton. *Research of Environmental Sciences*. 2013;26: 1072-1078.

© 2023 Raj et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:
The peer review history for this paper can be accessed here:
<https://www.sdiarticle5.com/review-history/94423>