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Original Article

Impact of Different Sources of Water and Verapamil on Seed Germination & Stem Length

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ABSTRACT

The present study investigates the impact of different sources of water and the calcium channel blocker verapamil on seed germination and stem length. The experiment aimed to determine how varying water quality and the presence of verapamil influence early plant growth. Seeds were irrigated using four water sources—tap water, distilled water, rainwater, and river water—with and without the addition of verapamil at a fixed concentration. Germination percentage, germination rate, and stem length were recorded over a fixed period. Results indicated that water quality significantly affected both germination and stem elongation, with distilled and rainwater promoting the highest germination percentages and longest stems. The inclusion of verapamil generally reduced both germination rate and stem length across all water treatments, suggesting that calcium channel inhibition interferes with cellular processes essential for seed germination and growth. Overall, the study highlights the importance of water composition and ion transport regulation in early plant development.

Keywords: seed germination, stem length, water quality, verapamil, calcium channel blocker, plant growth

INTRODUCTION

Seed germination is a critical stage in the life cycle of plants, marking the beginning of growth and development that determines subsequent yield and productivity. The success and rate of germination are influenced by both internal factors, such as genetic makeup and hormonal regulation, and external factors, including water quality, temperature, and chemical exposure. Among these, water plays a fundamental role, as it initiates the metabolic processes required for embryo activation, enzyme synthesis, and cell expansion.

Different sources of water—such as tap water, distilled water, rainwater, and wastewater—differ in their chemical composition, pH, salinity, and presence of minerals or contaminants. These variations can significantly influence seed germination and early seedling growth. For instance, water with high salinity or heavy metal content can inhibit germination and reduce stem elongation, whereas pure or mineral-balanced water may promote healthier growth.

Verapamil, a calcium channel blocker commonly used in medical treatments for cardiovascular conditions, has also been studied for its physiological effects on plants. Calcium ions play a crucial role in cell wall stability, membrane permeability, and signal transduction during germination and growth. By interfering with calcium transport, verapamil may alter these processes, potentially affecting germination rate and stem elongation.

Investigating the combined effects of different water sources and verapamil on seed germination and stem length provides insight into how environmental and chemical factors interact to influence plant growth. Such studies can contribute to understanding plant stress physiology and may have implications for agricultural practices, environmental pollution monitoring, and the selection of appropriate irrigation sources.

MATERIALS:

Glass jars, mesh, labels, green gram, fenugreek, waters (Alkaline water, distilled water,groundwater,Industrialwater,Lemonwater,Mineralwater,Seawater& Tapwater),Spatula.

Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

APPARATUS: AnalyticalBalance&Measuringscale.

DRUG: Verapamil (Calciumchannelblocker).

METHODS:

STEP-1:

EXPERIMENT-1

Seeds are rinsed in water. The split or otherwise obviously damaged seeds are discarded. The best sprouting resulted seeds are purchased which are specially labeled for sprouting, which are usually tested to guarantee a good germination rate. At the very least, organic seeds are purchased. Many organic seeds sold for consumption are specially treated not to sprout. The multiple samples of water were collected from different resources i.e. alkaline water, distilled water, groundwater, Industrial water, Lemon water, Mineral water, Salt water &Tap water and labeled them.

STEP-2:

5gm of seeds were accurately weighed and placed in previously weighed 100 ml of each labeled water sample jars

STEP-3:The jars were set upright and experimental waters were filled and left a side to soak for a period of 24hours.The sprouting lid which is a hollow ring plastic-mesh, is placed to the mouth Of the glass jars in away if the jars are tilted the un sprouted seeds will not pass through the size of the mesh

STEP-4:

On the 2nd day, the jars were placed in such a way which allows the excess water to drain out of the jar, and the jars were placed in such a way to circulate the air freely, for the sprouting.

STEP-5:

On the3rd day the sprouting of seeds were observed and measured with the help of a measuring scale of randomly selected sprouting seeds of each labeled jar are noted, the same type of waters were sprinkled on to the sprouting jars to promote growth.

STEP-6:

Every day we have taken 10 sprouts from each jar & growth was measured and average was taken, other 2 consecutive day the procedure was repeated.

STEP-7:

3days measured results were tabulated & the graph was drawn using Multiple samples of water on X axis and Growth on Y axis.

The above procedure was followed for green gram and fenugreek sprouting in multiple samples of water i.e, (Alkaline water, distilled water, ground water, Industrial water, Lemon water, Mineral water, Sea water & Tap water).

EXPERIMENT-2

The combination of lemon juice (Resembles Acidic P^H water) and Sea water (Resembles Basic P^H water) with ground water by above mentioned procedure for Fenugreek and Green gram seeds

Table 3: Combination of Lemon Juice & Ground Water

A) Combination of Lemon Juice and Ground water

LEMON JUICE(ml)	GROUND WATER(ml)
90	10
80	20
70	30
50	50
70	30
80	20
90	10

Table 4: Combination of Seawater & Ground Water

A) Combination of Sea water and Ground water

SEAWATER(ml)	GROUNDWATER(ml)
90	10
80	20
70	30
50	50
70	30
80	20
90	10

The stem length was measured for 3 consecutive days and the results were tabulated & graph was plotted using combination ratios on X axis and Growth on Y axis

EXPERIMENT-3

Sprouting using drug verapamil

Now let us know how the growth of seeds were done using green gram and fenugreek seeds.

- 2.5gm the seeds were accurately weighed in a jar.
- 1mg of drug was added to the same jar.
- Now all the jars were filled with 50ml of water sample sand the jars were labeled.
- The jars were mixed properly with the help of the spatula in order to dissolve the drug completely to get the good results of sprouting with drug and a point should be noted that the same spatula is not used for all the jars for mixing use the new or washed one for each sample. The sprouting lid, plastic mesh was placed to the mouth of the each jar
- The water was discarded on the2ndday and the jars are placed in a air free place.
- On the 3rd day the sprouting of seeds occurs, which are measured carefully for 3 consecutive days.
- The results were tabulated and the graph was plotted using Multiple samples of water on X axis and Growth on Y axis.

A) RESULTS OF GROWTH OF FENU GREEK SEEDS IN MULTIPLE SAMPLES OF WATER

Table 5: Results of Growth Fenugreek Seeds in Multiple Water Samples

Samples of water	Average of 10 observations on each day			Average growth in 3 days cm
	Day-1	Day-2	Day-3	
Alkaline water	0.11	1.86	2.19	1.38
Distilled water	0.10	1.75	2.36	1.40
Ground water	1.58	2.84	4.44	2.95
Industrial water	0.34	0.92	1.49	1.75
Lemon juice	_	_	_	_
Mineral water	1.27	1.93	2.47	1.34
Pond water	1.39	2.21	3.93	2.51
Seawater	_	_	_	_
Tap water	1.25	2.25	3.75	2.50

- Growth was observed in Fenugreek seeds with respect to composition of waters.
- The growth was totally inhibited in Lemon juice and salt water due to their P^H levels which is directly related to the growth rate.
- FinegrowthwasobservedinGroundwater-maybeduetothepresenceofCl,Ca,Mg, K & S which may be the reason for fine growth.
- The result shown from table 5 are graphically represented as graph 1 using Multiple samples of water on X axis and Growth on Y axis.

MULTIPLEWATERSAMPLES

A) RESULTS OF GROWTH OF GREEN GRAM SEEDS IN MULTIPLE WATER SAMPLES

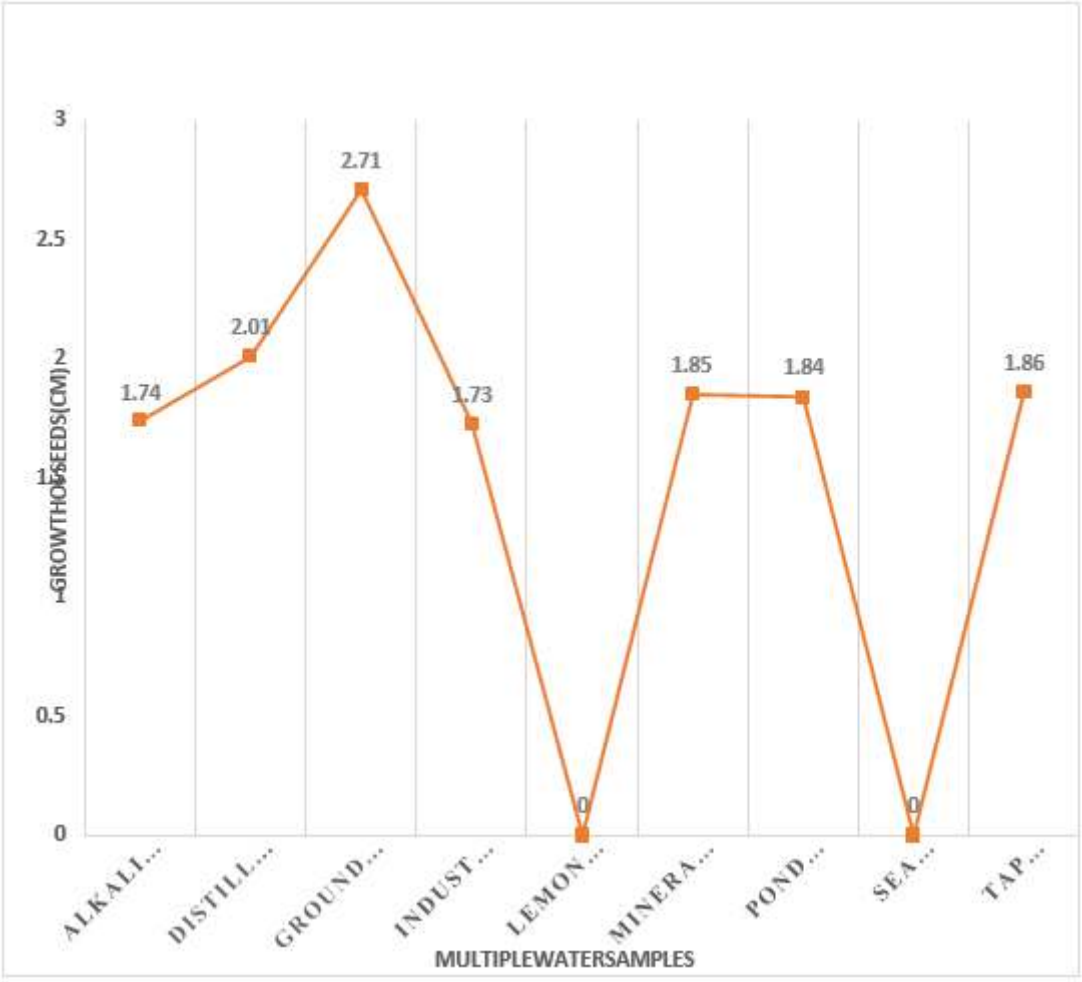
Table 6: Results of Growth of Green Gram Seeds in Multiple Water Samples

Samples of water	Average of 10 observations on each day			Average growth in 3 days Cm
	Day-1	Day-2	Day-3	
Alkaline water	1.2	1.74	2.28	1.74
Distilled water	1.23	2.31	2.5	2.01
Ground water	1.23	2.7	4.25	2.71
Industrial water	1.23	1.81	2.15	1.73
Lemon juice	_	_	_	_
Mineral water	1.17	2.16	2.22	1.85
Pond water	1.12	1.74	2.66	1.84
Seawater	_	_	_	_

Samples of water	Average of 10 observations on each day			Average growth in 3 days
Tap water	1.07	1.97	2.56	1.86

- Growth was observed in green gram seeds with respect to composition of waters.
- The growth was totally inhibited in Lemon juice and sea water due to their P^H levels which is directly related to the growth rate.
- Fine growth was observed in Ground water may be due to the presence of Cl,Ca,Mg, K & S which may be the reason for fine growth.
- The result shown from table 6 are graphically represented as graph 2 using Multiple samples of water on X axis and Growth on Y axis.





GRAPH-1 GROWTH OF GREEN GRAMSEEDS IN MULTIPLE WATER SAMPLES

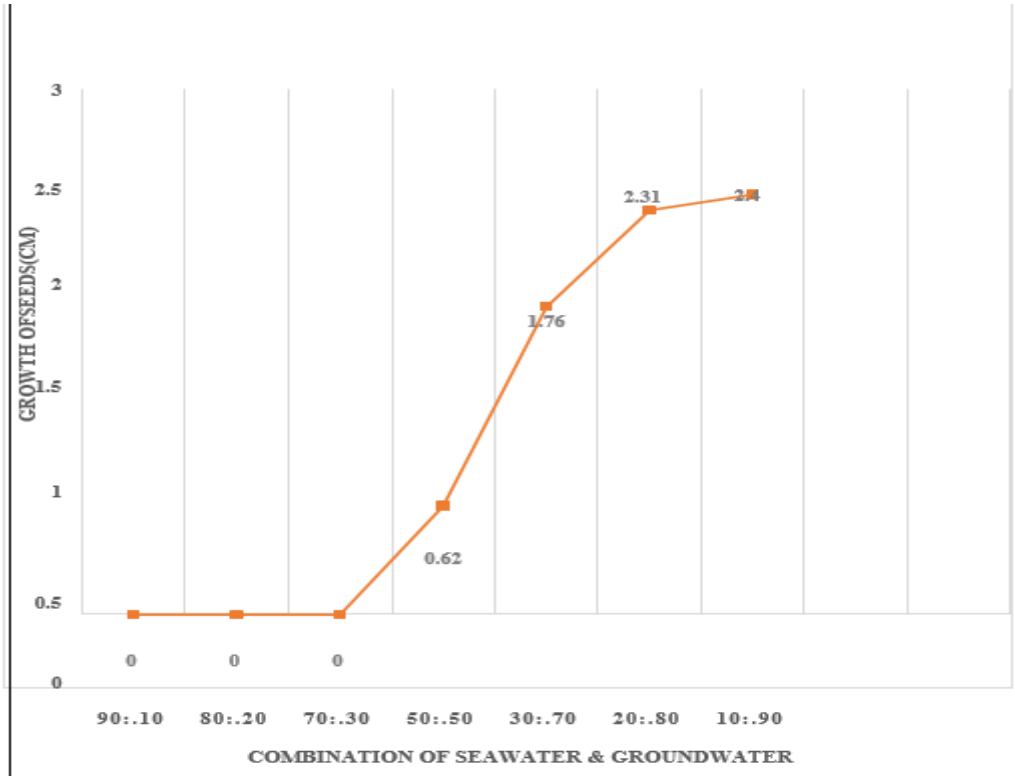
B) GROWTH OF FENUGREEK SEEDS IN GROUND WATER COMBINATION TO SEA WATER &

Table 7: Growth of Fenugreek Seeds in Combination to Sea Water and Ground Water

RATIOS OF SEA:GROUND WATER WATER(ml)	Average of 10 observations on each day			Average growth in 3 days Cm
	DAY-1	DAY-2	DAY-3	
90:10	-	-	-	-
80:20	-	-	-	-
70:30	-	-	-	-
50:50	0.62	-	-	0.62
30:70	1.22	1.72	2.35	1.76
20:80	1.38	2.56	3.01	2.31
10:90	1.56	2.61	3.03	2.4

- The growth of fenugreek was totally inhibited in salt water of ratios 90:10,80:20,70:30 due to more concentration of Na &Cl which alter in their P^H levels which is directly related to the growth rate.
- the growth was observed in ratios of 50:50, 30:70, 20:80, 10:90 as the ground water ratio is more may be due to the presence of Cl,Ca,Mg,K&S which may be the reason for fine growth.
- The result shown from table7 are graphically represented as graph3 using combination ratios of sea water & Ground water on X axis and Growth on Y axis.





Graph: 3 Growth of Fenugreek Seeds in Combination to Seawater & Ground Water

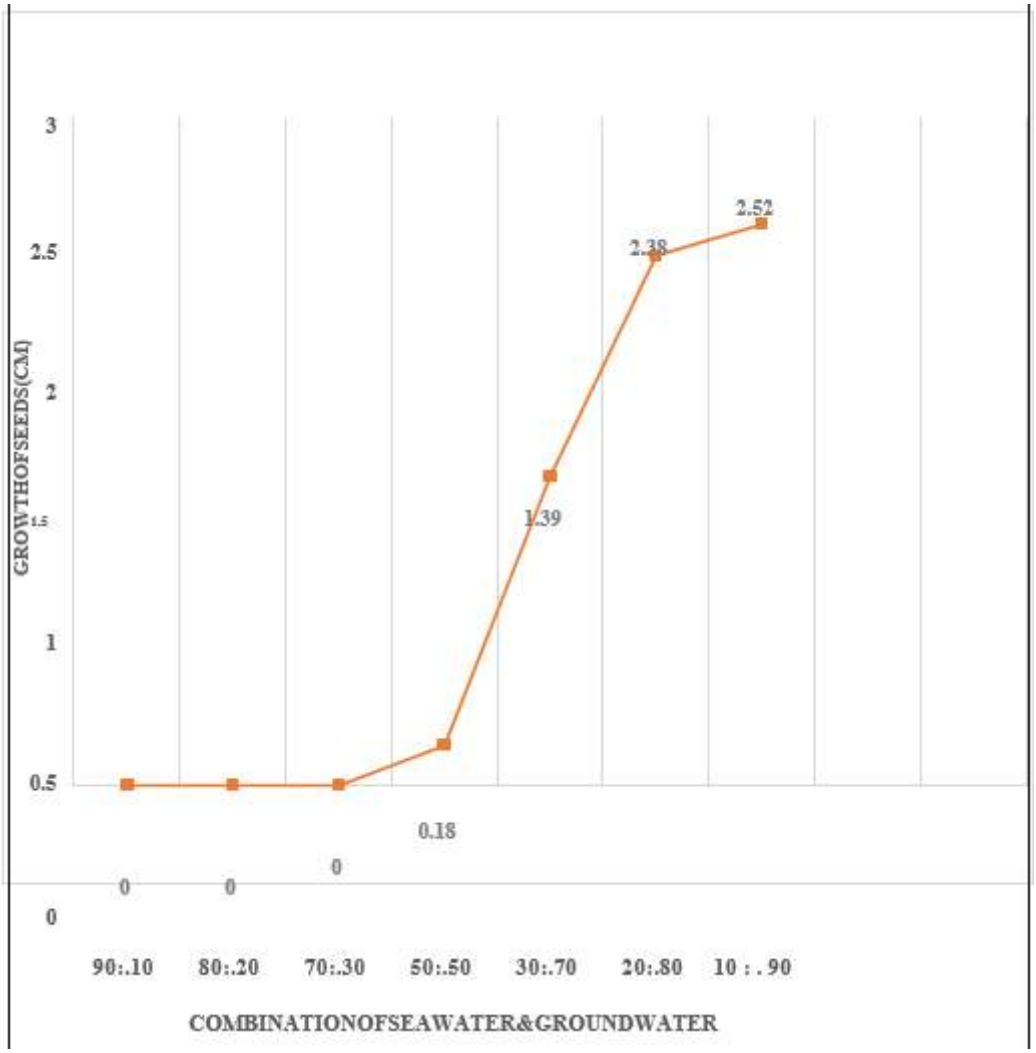
C) RESULTS OF DILUTION CONCENTRATIONS OF SEAWATER & GROUND WATER USING GREEN GRAM

Table 8: Results of Dilution Concentrations of Seawater and Groundwater Using Green Gram

RATIOSOF	Average of 10 observations on each day			Average growth in
SEA : GROUND WATERWATER(ml)	DAY-1	DAY-2	DAY-3	3days(Cm)
90:10	-	-	-	-
80:20	-	-	-	-
70:30	-	-	-	-
50:50	0.18	-	-	0.18
30:70	1.14	1.82	2.21	1.39
20:80	1.41	2.54	3.21	2.38
10:90	1.57	2.54	3.45	2.52

- The growth of green gram was totally inhibited in salt water of ratios 90:10, 80:20, 70:30 due to more concentration of Na &Cl which alter in their P^H levels which is directly related to the growth rate.
- the growth was observed in ratios of 50:50, 30:70, 20:80, 10:90 as the ground water ratio is more may be due to the presence of Cl,Ca,Mg,K&S which may be the reason for fine growth.
- The result shown from table 8 are graphically represented as graph4 using combination ratios of sea water & Ground water on X axis and Growth on Y axis.





Graph: 4 Growth of Greengram Seeds in Combination to Seawater & Ground Water

D) GROWTH OF FENUGREEK SEEDS IN COMBINATION TO LEMON JUICE & GROUND WATER

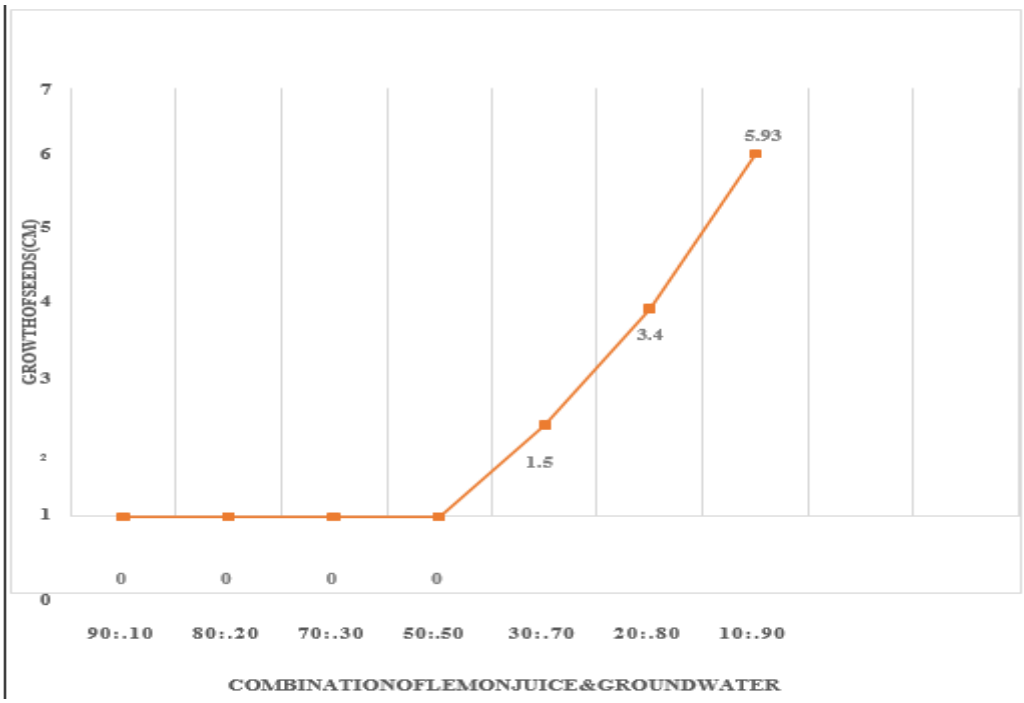
Table 9: Growth of Fenugreek Seeds in Combination to Lemon Juice and Ground Water

RATIOS OF LEMON:GROUND WATER(ml)	Average of 10 observations on each day			Average growth in3 days (Cm)
	DAY-1	DAY-2	DAY-3	

RATIOS OF LEMON:GROUND JUICE WATER(ml)	Average of 10 observations on each day			Average growth in3 days (Cm)
90:10	-	-	-	-
80:20	-	-	-	-
70:30	-	-	-	-
50:50	-	-	-	-
30:70	0.5	0.7	0.9	1.5
20:80	1.3	1.5	1.8	3.4
10:90	2.4	2.6	2.8	5.93

- The growth of fenugreek was totally inhibited in of ratios 90:10,80:20,70:30of lemon juice and ground water as they do not contain growth promoters and only contain carbohydrates, proteins, cellulose ,vitC which alter in their P^H levels which is directly related to the growth rate.
- The growth was observed in ratios of 50:50, 30:70, 20:80, 10:90 as the ground water concentration is more may be due to the presence of Cl, Ca, Mg, K&S which may be the reason for fine growth.
- The result shown from table9 are graphically represented as graph5 using combination ratios of Lemon juice & Ground water on X axis and Growth on Y axis.





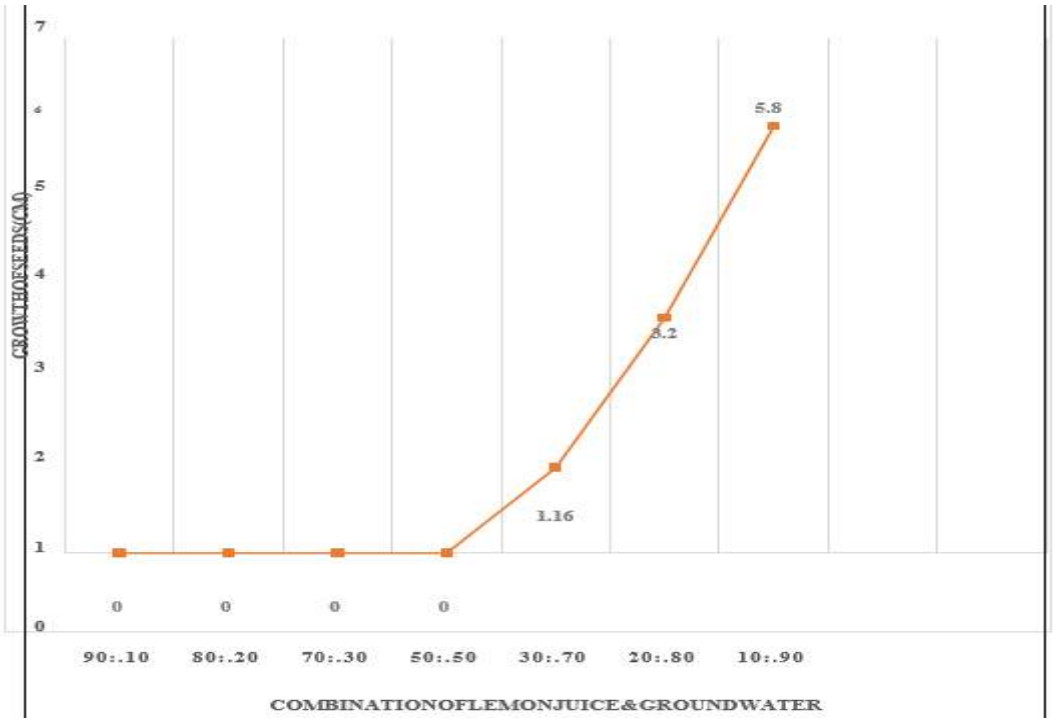
Graph: 5Growth of Fenugreek Seeds in Combination to Lemon Juice & Ground Water

E) GROWTH OF GREEN GRAM SEEDS IN COMBINATION TO LEMONJUICE & GROUND WATER

Table 10: Growth of Green Gram Seeds in Combination to Lemon Juice &Ground Water

RATIOS OF	Averageof10observationsoneach day			Average growth
LEMON:GROUND JUICE WATER(ml)	DAY-1	DAY-2	DAY-3	in3 days(Cm)
90:10	-	-	-	-
80:20	-	-	-	-
70:30	-	-	-	-
50:50	-	-	-	-
30:70	0.4	0.5	0.8	1.16
20:80	1.2	1.4	1.9	3.2
10:90	2.4	2.5	2.7	5.8

- The growth of green gram was totally inhibited in of ratios 90:10, 80:20, 70:30 of lemon juice and ground water as they do not contain growth promoters and only contain carbohydrates, proteins, cellulose, vitC which alter in their P^H levels which is directly related to the growth rate.
- the growth was observed in ratios of 50:50, 30:70, 20:80, 10:90 as the ground water concentration is more may be due to the presence of Cl, Ca, Mg, K &S which may be the reason for fine growth.
- The result shown from table 10 are graphically represented as graph 6 using combination ratios of Lemon juice& Ground water on X axis and Growth on Y axis.



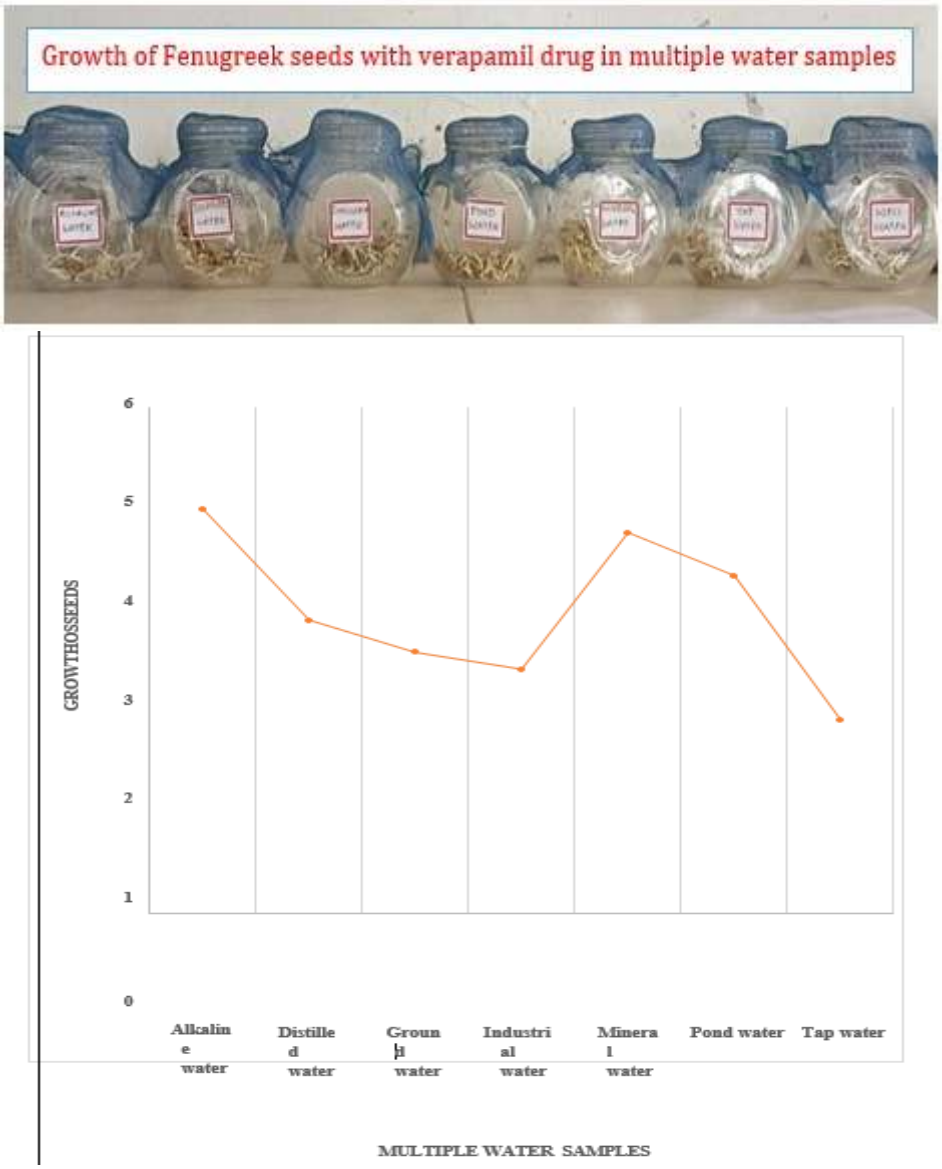
Graph: 6 Growthofgreengramseedsincombinationtolemon Juice & Ground Water

F) GROWTH IS FENUGREEKSEEDS WITH DRUG IN MULTIPLESAMPLES OF WATER

Table 11: Growth of Fenugreek Seeds with Drug Verapamil in Multiple Water Samples

Samples of water	Average of 10 observations on each day			Average growth in 3 days (Cm)
	Day-1	Day-2	Day-3	
Alkaline water	3.5	6.92	10	13.7
Distilled water	2.5	4.6	7.3	4.8
Ground water	2.8	3.5	8	4.7
Industrial water	2.3	4	6.3	8.4
Mineral water	3	5	9	11
Pond water	2	4.5	9.5	9.66
Tap water	2.8	3.1	5	7.56

- Growth was observed in Fenugreek seeds in the presence of drug with respect to composition of waters.
- The maximum growth was observed in Alkaline water and Mineral water as the composition contains Cl, Fe, Ca, Mg, K, S, Na which may be the reason for fine growth.
- The result shown from table 11 are graphically represented as graph 7 using Multiple samples of water on X axis and Growth on Y axis.



GRAPH7GROWTHOFFENUGREEKSEEDS INMULTIPLEWATER SAMPLES WITH VERAPAMIL DRUG

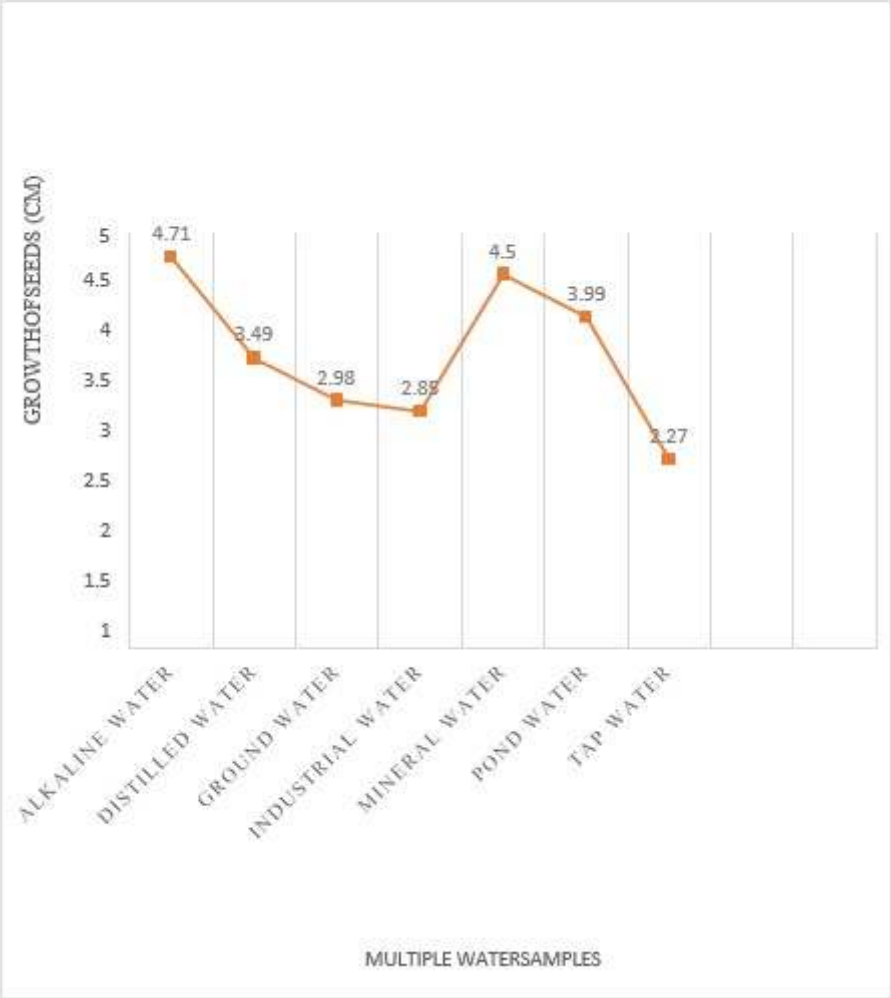
Table 12: Results of Drug Verapamil in Multiple Samples of Water Using Green Gram.

Samples of water	Average of 10 observations on each day			Average growth in 3 days (Cm)
	Day-1	Day-2	Day-3	
Alkaline Water	2.13	4.92	7.08	4.71
Distilled Water	1.63	3.32	5.54	3.49
Ground Water	1.39	2.98	4.37	2.98
Industrial Water	1.68	2.37	4.5	2.85
Mineral Water	2.01	3.18	6.8	4.5
Pond Water	1.62	2.28	7.17	3.99
Tap Water	1.79	2.37	2.76	2.27

G) RESULTS OF DRUG IN MULTIPLE WATER SAMPLES USING GREEN GRAM

- Growth was observed in green gram seeds in the presence of drug with respect to composition of waters.
- The maximum growth was observed in Alkaline water and Mineral water as the composition contains Cl, Fe, Ca, Mg, K, S, Na which may be the reason for fine growth.
- The result shown from table12 are graphically represented as graph8 using Multiple samples of water on X axis and Growth on Y axis.





Graph: 8 Growth of Greengram Seeds Multiple Water Samples with Verapamil

SUMMARY & CONCLUSION

The growth of fenugreek and green gram seeds were observed in multiple samples of water (Alkaline water, Distilled water, Ground water, Industrial water, Lemon juice, Mineral water, Pond water, Salt water & Tap water).

- Maximum growth was observed in Ground water.
- The reason for observing maximum growth of seeds in ground water may be due to the presence of the elements Cl, Ca, Mg, K & S, where the seeds utilized at required growth nutrients
- The growth of fenugreek and green gram seeds were totally inhibited in Lemon juice and Sea water. The combination of Lemon juice & Sea water observed growth in different dilutions along with ground water. Maximum growth was observed in (10 Lemon juice:90 Ground water) and in (10 sea water:90 Ground water).
- The growth of fenugreek and green gram seeds were also checked in collected water samples by adding Verapamil (0.1mg) (Calcium channel blocker).
- Surprisingly the maximum growth was observed in Alkaline water and mineral water where the calcium channel blockers may be reason for the growth.

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