Consortium for DEWATS Dissemination Society

Vermifiltration for Wastewater Treatment: Progress and Prospects in India

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An innovative Technology

to make gold from Garbage and Silver from Sewage:

Vermifiltration Technology

Background

Nation faces two severe problems

- Water Scarcity
- Sewage Disposal

Need of the Hour

- Treatment of wastewater
  - Sustainable method
  - Decentralized method
  - Eco-friendly method
- Re-use of treated water
  - In non potable uses
  - In Agriculture
  - Saves 80% water

Vermifiltration Technology

- Innovative Waste water treatment and Purification technology
- Detoxification and Disinfection by Earthworms
- Earthworms convert Waste water into Nutritive (NPK) water
- Purified water can be reuse in Agriculture and non-potable purposes

Pioneer Researcher on VFT System

- Prof. Maria Soto – Chile
- Dr. Rajiv Kumar Sinha – Australia
- Er. George Hahn – USA
- Prof. Upendra Patel – India
- Dr. Ashok k Ghosh - India

Commercialization of VFT System

TRANSCHEM Agritech. (TRANSPEK), Baroda, Gujarat, India

Features of VFT / Role of Earthworms

FEATURES

- Zero Waste Technology
- Self Promoted and Regulated
- Self Improved and Enhanced
- Easy to Construct
- Easy to Maintain and Operate
- No Odour and sludge
- No Chemicals used
- Liquid & Solid waste Management

EARTHWORMS

- Body act as a Bio-Filter
- From Sewage, Removes
  - BOD by 98 %
  - COD by 80-90 %
  - TSS by 90-95 %
  - TDS by 90-92 %
  - TURBIDITY – 95%
  - CH4 – 99%
  - C02 – 95 %
- Bio-accumulate
  - Heavy Metals / EDC
  - Toxic Chemicals
- Ceolomic Fluid
  - Anti- Pathogenic

Application and Advantage of VFT

APPLICATION

Sewage treatment

- Rural/panchayat projects
- Small Municipalities
- Factories
- Resorts / Hotels / Clubs
- Housing Colonies

Organic Industrial Effluent

- Dairy
- Vineyards / Distilleries
- Food processing units
- Fisheries/Meat/Poultry units

ADVANTAGES

- Simple and easy operation
- Low operating and maintenance costs
- Low energy input
- No sludge formation
- Contaminants convert into a Coin
- Treated water becomes nutrient rich
- Natural way of fertigation
- Cost saving on artificial fertilizers
- Aerobic process hence no odour

Research Objectives

Methodology

1. Fabrication of a Vermi-filtration unit for wastewater recycling
2. Bio-Physico-Chemical analysis of Vermiaqua and wastewater

Experiments

3. Growth Impacts of Vermiaqua on Rice Crops (*Oryza sativa*)
4. Performance of Vermiaqua on Onion (*Allium cepa*)
5. Vermifiltration of Arsenic contaminated water

1. Fabrication of a Vermi-filtration unit for wastewater recycling

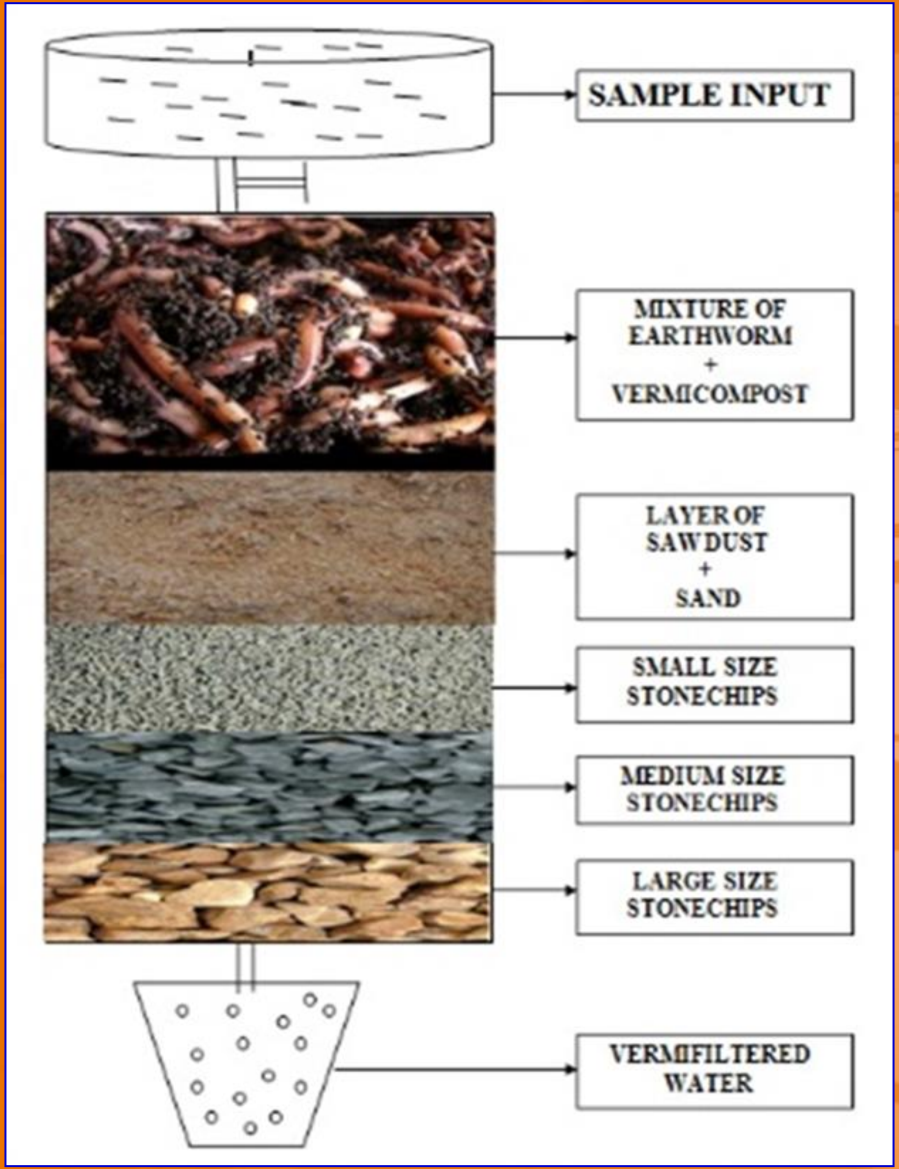


Fig.1. Microscopic view of Vermi-filtration unit

Fig.2. Fabricated Vermi-filtration unit

Fig.3. Wastewater sample

Fig. 4. Vermifiltered Vermiaqua

Table 1. Graded layers of vermibed

Layers	Layer thickness size (c.m.)	Materials	
		Test unit	Control unit
Top layer	30	soil + vermicompost + earthworms	soil + vermicompost
2nd layer	20	sand + sawdust	sand + sawdust
3rd layer	10	small sized pebbles	small sized pebbles
4th layer	10	medium-sized pebbles	medium-sized pebbles
5th layer	10	large sized pebbles	large sized pebbles
Bottom layer	01mm	cotton cloth layer	cotton cloth layer

2. Bio-Physico-Chemical analysis of Vermiaqua and wastewater

Table 2. Bio-Physico-chemical parameters analysis of wastewater, Control and Vermiaqua

Parameters analysed	Control	wastewater	Vermiaqua
Odour	Unpleasant	Unpleasant	Odourless
Colour	Hazy	Dark Brown	Pale yellow
Turbidity [NTU]	15.0	100	5.0
pH	8.2	8.8	7.5
Nitrate [mg/l]	3.0	1.0	10.0
Iron [mg/l]	1.5	3.0	0.3
Phosphorous [mg/l]	0.1	BDL	BDL
BOD [mg/l]	30	218	19
E. coli	++++	++++	---

BOD, Biological Oxygen Demand; +, Positive; -, Negative; Each Value is average of 3 observations; BDL, Below Detectable Limit

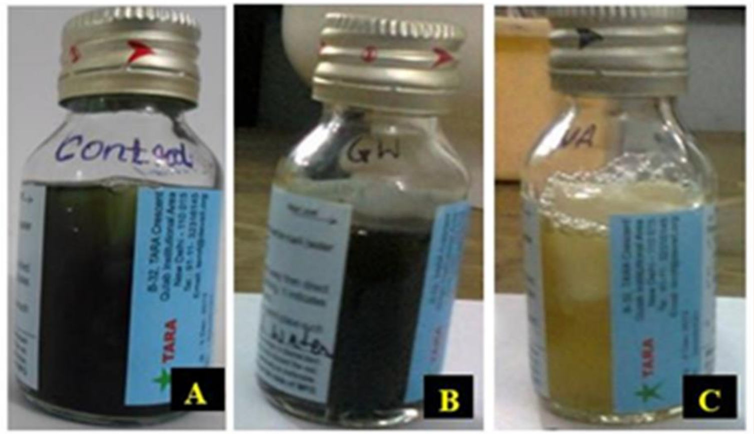


Fig.5. *E.coli* test vial

A = control, B= wastewater, C= vermiaqua

Experiment -1

Growth Impacts of Vermiaqua on Rice Crops (*Oryza sativa*)

Methodology

1) Selection of Rice (Oryza sativa) seeds

BIHAR BEEJ ―RAAJ SHRI‖ ―Bihar Rajya Beej Nigam Limited, Patna.

2) Inoculation of Seeds into Farm Soil

Seed was inoculated in farm at ten inch by ten" distance by ―SHRI VIDHI METHOD.

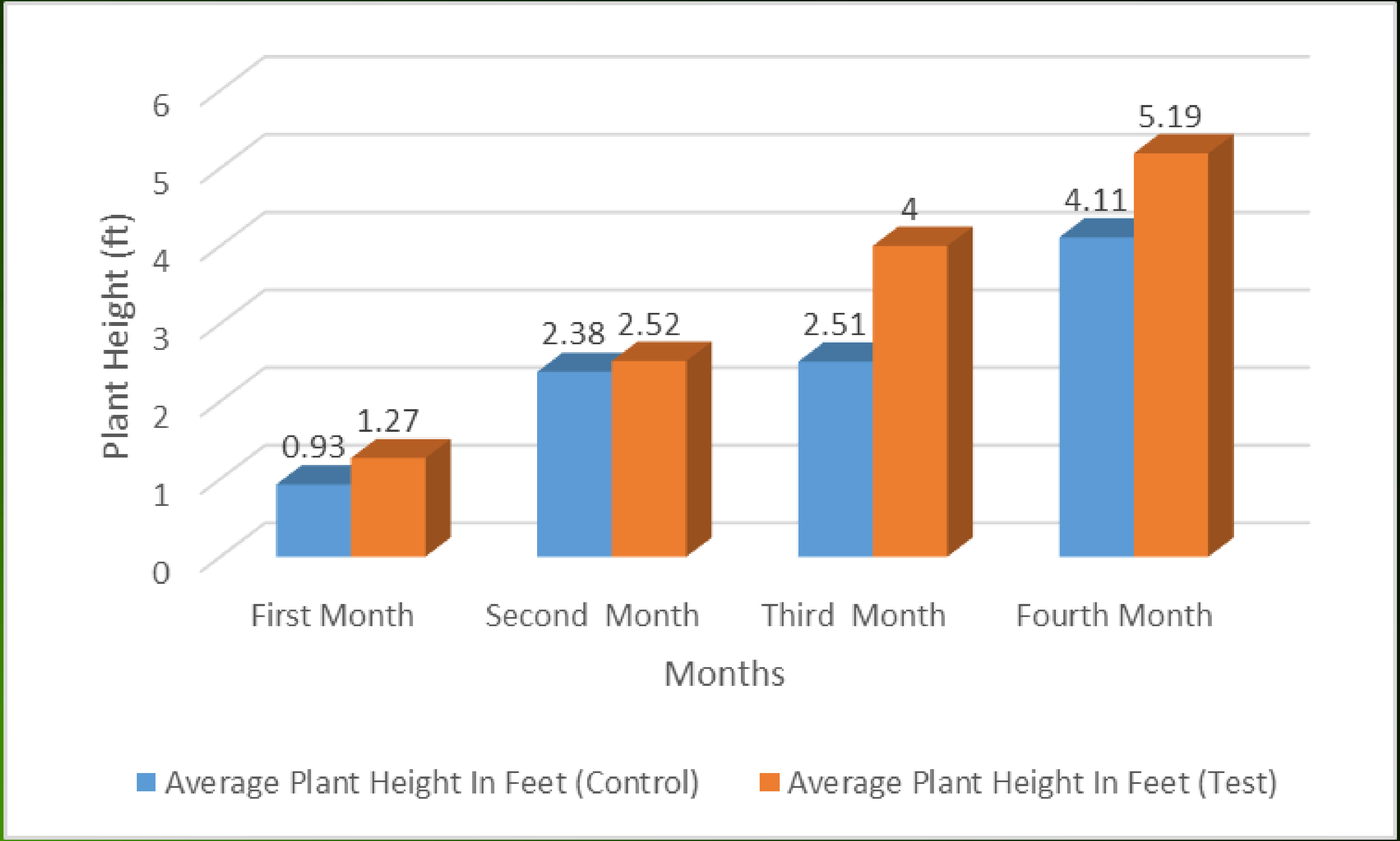
3) Use of Vermiaqua in farm of Oryza sativa

1 litre of Vermiaqua mixed with 9 litre of water was sprayed continuously on the plant at the interval of 15 days from top portion of the plant to root.

Results

1) Assessment of Oryza sativa Plant Height

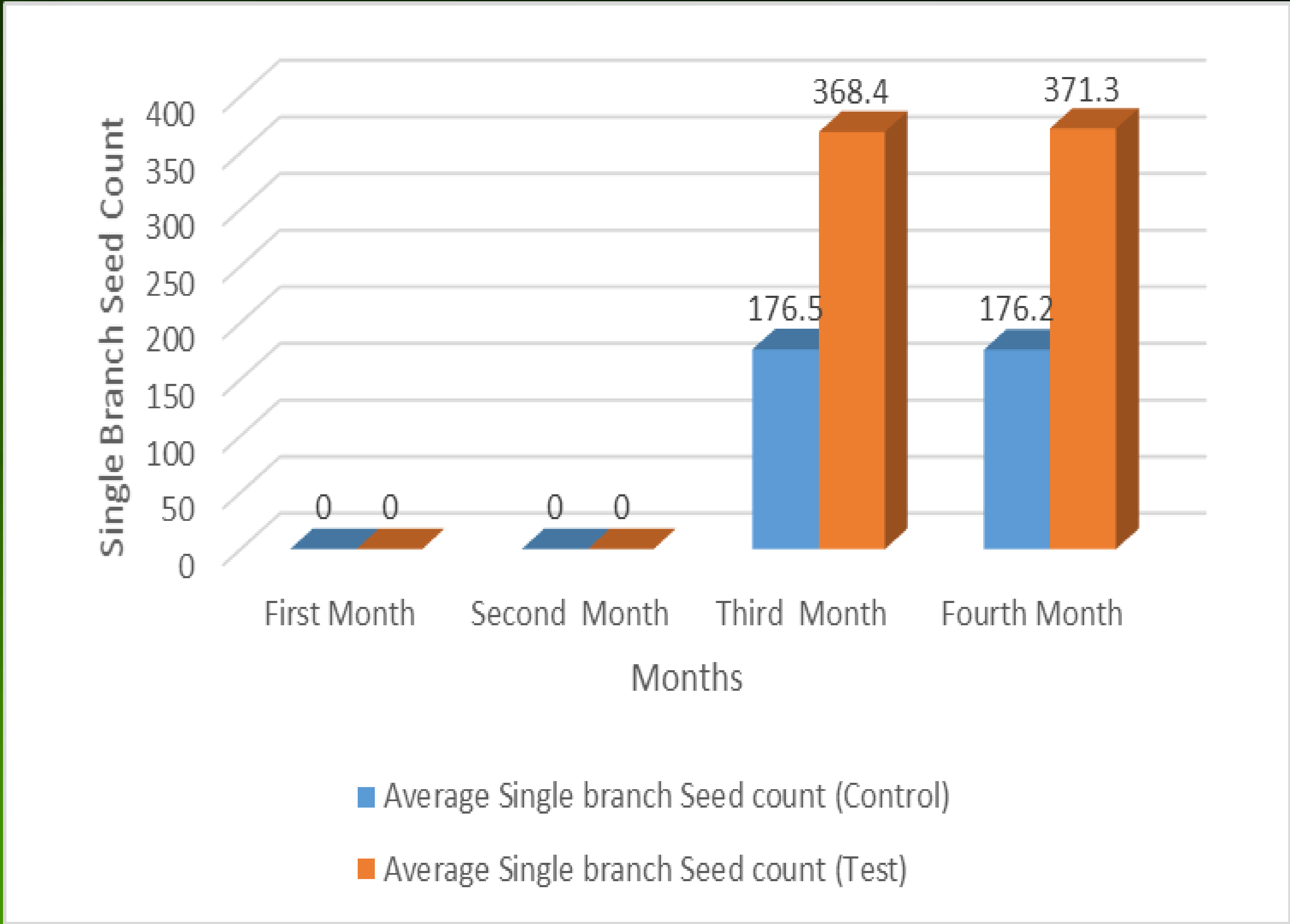
The plant height was increased by 26.77 % during entire period of study



Results

2) Assessment of *Oryza sativa* Single Branch Seed Count

The Seed count was increased by 110.72 %



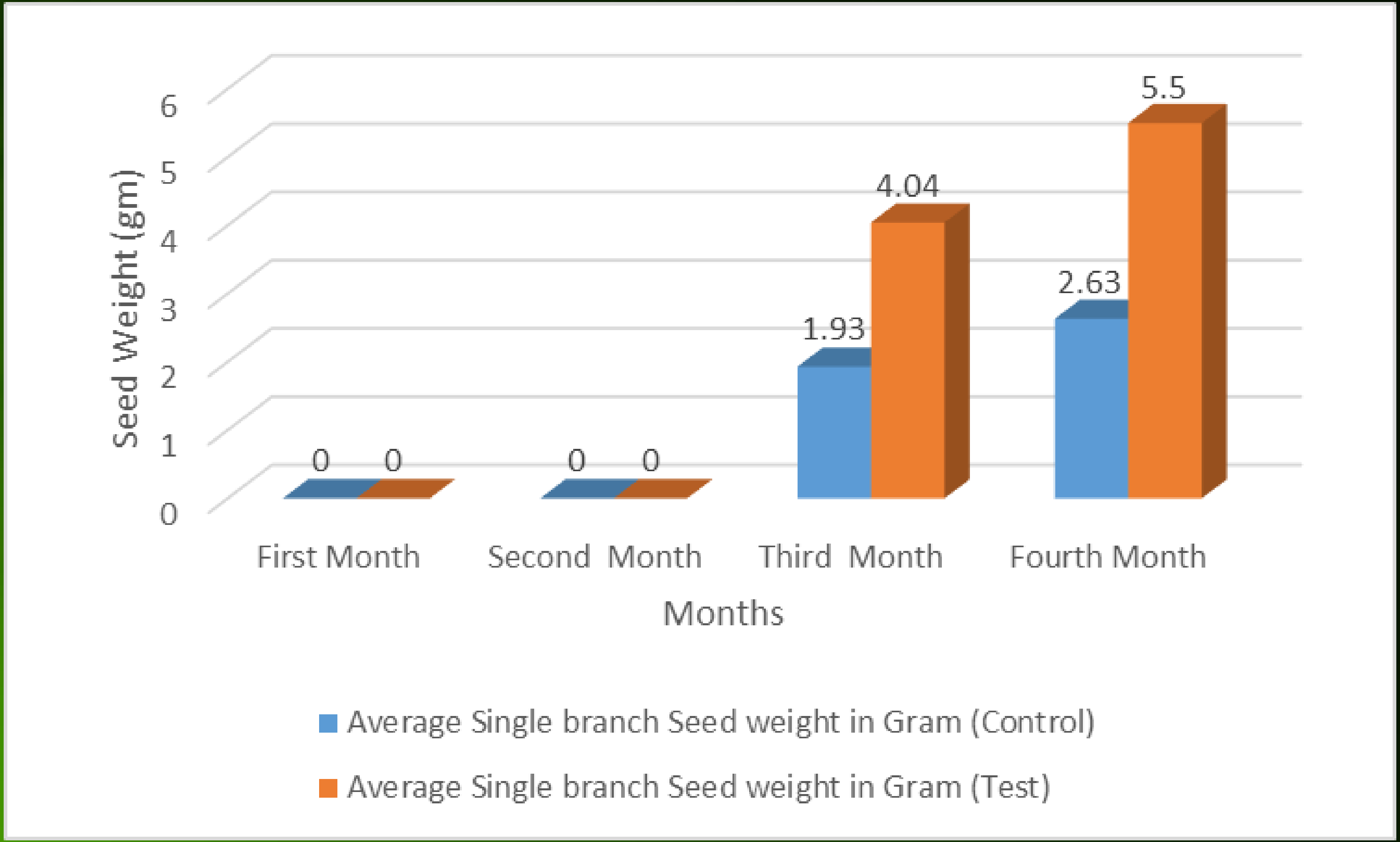
CONTROL

TEST

Results

3) Assessment of *Oryza sativa* Single Branch Seed Weight

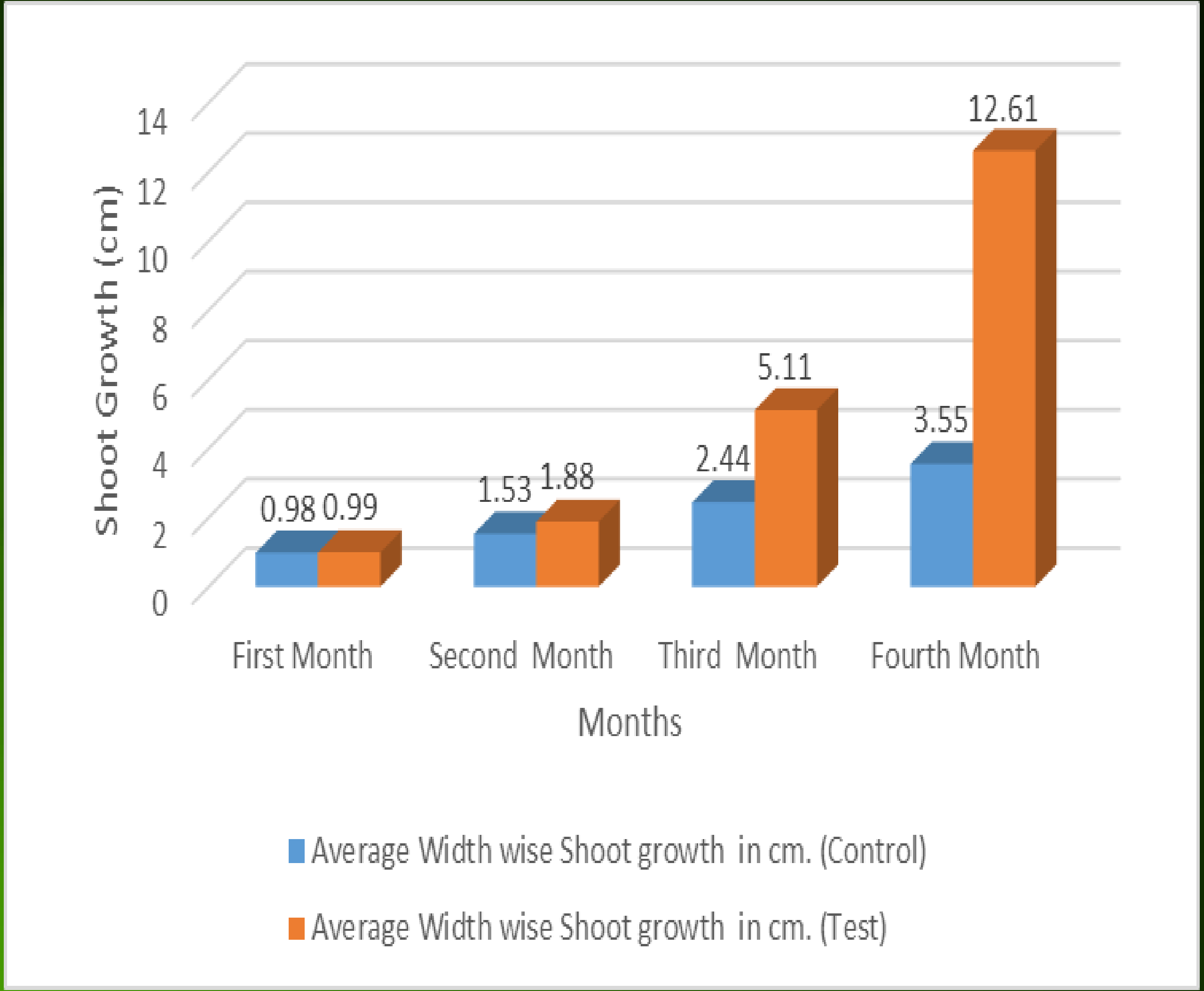
The Seed weight was increased by 109.12 %



Results

4) Assessment of *Oryza sativa* width wise shoot growth

The width wise shoot growth is increased by 255.21 %



CONTROL

TEST

Experiment -2

Performance of Vermiaqua on Onion (*Allium cepa*)

1. Allium cepa root germination at different concentration of Vermiaqua

Root Germination at 0 hr.

Germination at 5th Day

2. Morphological changes in root germination

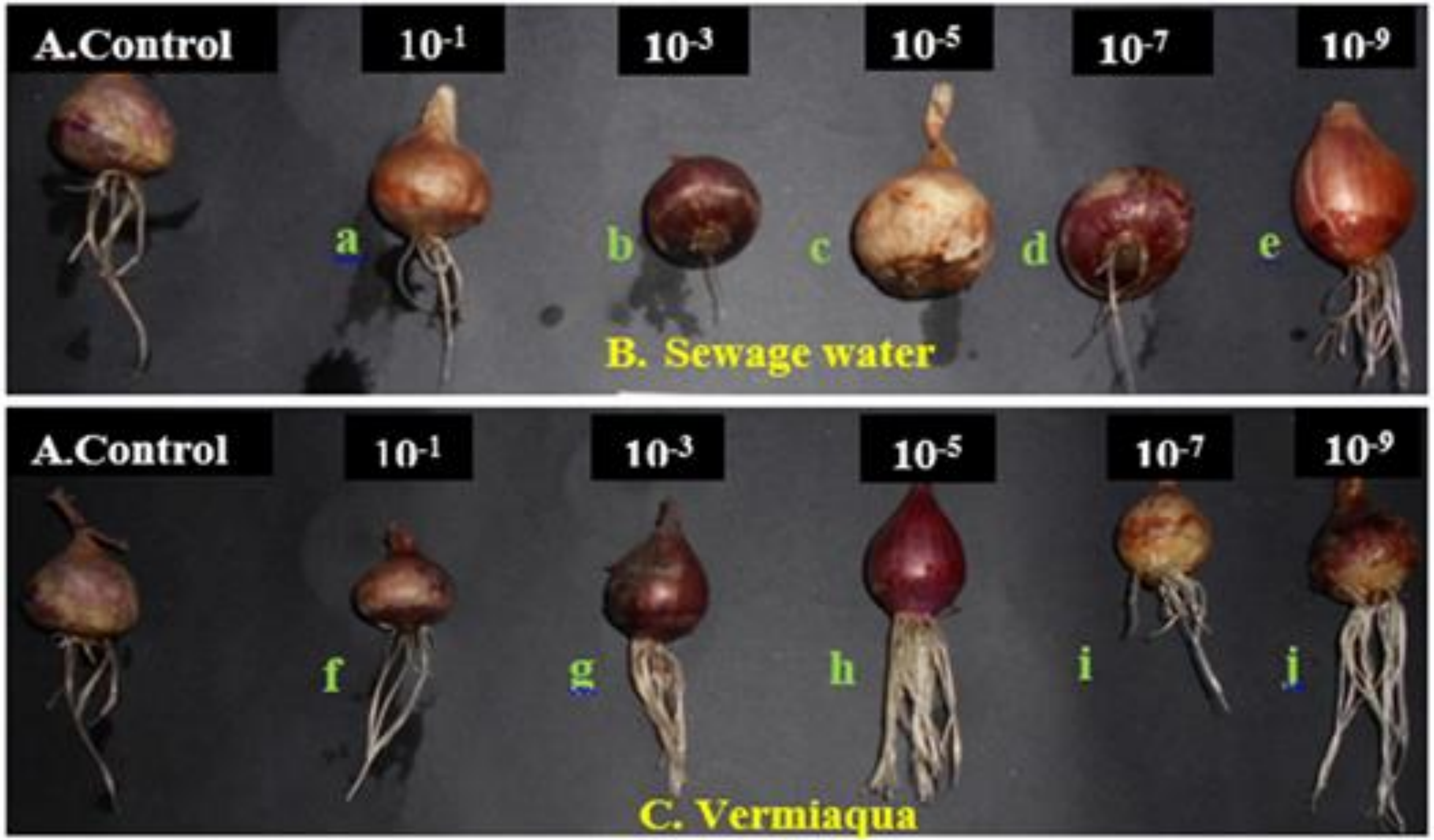
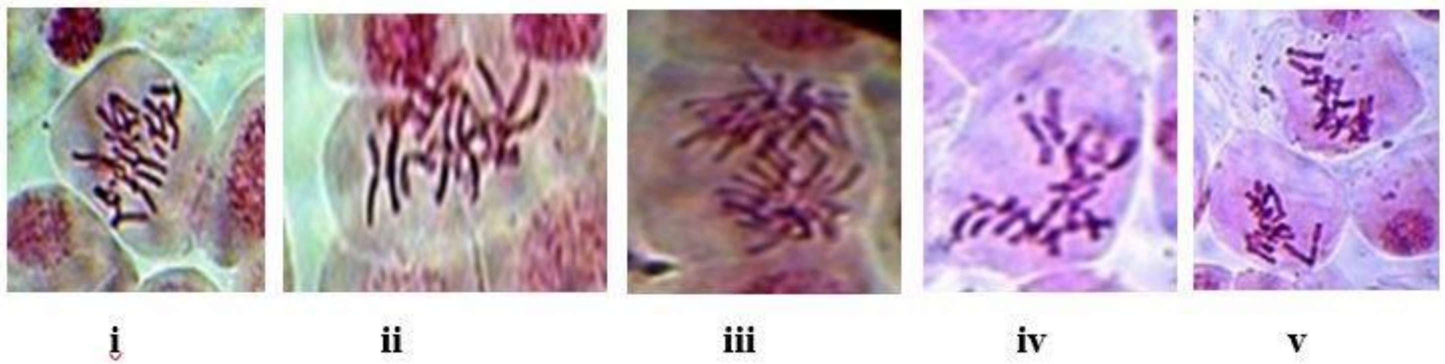


Table 3. Morphological Properties of Germinated roots

	Root quantity	Root Length[c.m.]	Root Colour	Root forms
Control	15	3.99	White	Normal and wavy
wastewater				
10^{-1}	11	1.78	White	Retarded and Crochet hook
10^{-3}	03	0.8	White	Inhibited
10^{-5}	00	0.0	White	Zero Germination
10^{-7}	04	3.6	White	Inhibited
10^{-9}	16	2.2	White	Stunted, Wavy and Curly
Vermiaqua				
10^{-1}	09	3.91	White	Accelerated and Straight
10^{-3}	26	2.49	White	Accelerated and Straight
10^{-5}	40	3.40	White	Accelerated and Straight
10^{-7}	21	2.70	White	Retarded, Wavy and Curly
10^{-9}	24	4.68	White	Accelerated and Wavy

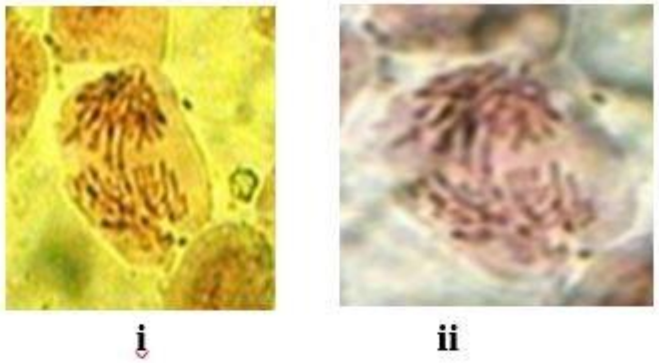
[c.m.] = Centimetre

3. Chromosomal abnormalities observed at 10^{-9} wastewater concentration



(i, Uneven Metaphase Chromosomal Separation; ii, Sticky Metaphase Chromosome; iii, Sticky Anaphase Chromosome; iv, Laggard Metaphase Chromosome; v, Metaphase Chromosomal Deletion)

4. Chromosomal abnormalities observed at 10^{-5} Vermiaqua concentration



(i, ii, Anaphase dibridges or Chromosomal dibridges)

Table 4. Cytological Properties of Germinated roots

	Chromosomal Abnormalities	
	wastewater [10^{-9}]	Vermiaqua [10^{-5}]
Interphase	No Abnormalities	No abnormalities
Prophase	No Abnormalities	No abnormalities
Metaphase	Uneven Separation	No abnormalities
	Sticky chromosome	No abnormalities
	Laggard chromosome	No abnormalities
	Chromosomal deletion	No abnormalities
Anaphase	Sticky chromosome	Dibridges
Telophase	No Abnormalities	No abnormalities

Experiment -3

Vermifiltration of Arsenic contaminated water

Methodology

1. **Preparation of different concentration of Arsenic trioxide sample**

   Different concentrations of 10,000 µg/L, and 20,000 µg/L were prepared

2. **Filtration of Arsenic through Vermifiltration process**

   Arsenic sample was allowed to pass 50 - 60 drops per minute through filter

3. **Analysis of treated Arsenic sample by AAS**

   50 ml treated Arsenic sample was analyzed

4. **Analysis of Earthworms' body tissue by AAS**

   0.5 mg treated Arsenic sample was analyzed

Result

	Control **10,000 µg/l**	**Test 1** **10,000 µg/l**	**Test 2** **20,000 µg/l**
Vermifiltered Arsenic Water	80.780 µg/l	7.716 µg/l	6.186 µg/l
Earthworms' Body Tissue (0.5 mg)	No Earthworms Were Used	127.9 µg/l	63.81 µg/l
Soil Testing (0.5 mg)	19.58 µg/l	144.7 µg/l	92.37 µg/l

Research Conclusion

1. Vermifiltration Units are Sludge-free, Noise-free and Low or No Electricity requiring systems for operation.

2. Earthworms upgrade the performance of Fabricated Systems with an integrated methods of Wastewater Purification - Biological, Chemical and Physical.

3. Vermiaqua highly promotes the germination of Roots Growth in Onion and also inhibited any Chromosomal Abnormalities, while the Raw Wastewater inhibited Germination, Growth and produced great Chromosomal Abnormalities.

4. Farmers should be advised NOT to use Raw Wastewater for Farm Irrigation which has become common practice due to growing Water Scarcity all over the world.

5. There is also need to commercialise this Vermifiltration Technology in the interest of Farmers. It will save huge groundwater (which is depleting resource all over world) for Farm Irrigation & also promote good Crop growth with less use of fertilizers as the Vermifiltered Water is also Nutritive.

Future Prospective

1. To analyze chemical conversion of wastewater and Arsenic through the Vermifilter pathway.
2. To identify the Gene/s responsible for toxic and Arsenic toxic tolerance capacity in Earthworms.
3. To identify the role of Microbes present in gut of Earthworms in conversion of wastewater and Arsenic

Avoid Using Clean Water

THANK YOU...