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Effect of Vermiaqua and Hospital wastewater on Bitter gourd (*Momordica charantia* L.)

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A B S T R A C T

For the survival of life water is very important and its scarcity is really a very big issue for us and our society. So, its conservation is most important. When any type of untreated wastewater has been discharged into municipal collection system or in rivers and that water is used for irrigation of plants, it affects our ecosystem. Due to which the risks of infection increase because it contains so many organic and inorganic pollutants, pathogens, antibiotics, drug metabolites, microbes and other chemicals. For the purification and reuse of impure water so many physical, chemical and biological techniques have been developed. To overcome these types of problems a new technique vermifiltration is introduced. Vermifiltration is a natural and biological technique that is self-regulated, odourless and cost-effective. In this technique earthworm's species (*Eisenia fatida*) has been used for purification purpose. They can bio-accumulate toxic substances, different chemicals, antibiotics and drug metabolites in their tissues. Their body works as biofilter because they can disinfect and detoxify different types of wastewater and the resulting filtrate (vermiaqua) is almost neutral, pathogen free and chemical free. The study of Bitter gourd (*Momordica charantia* L.) showed that vermiaqua promotes plant height, leaf size, flowering, fruiting and seedling growth.

Introduction

Water is a natural and essential resource for the development of life and other activities of human. The table of underground water is decreasing rapidly all over the world. Presently, its scarcity is a big problem which is a cause of great concern in our society.
In the world only 1% water is potable or usable, 2% is found in frozen and high hilly areas and 97% is found in sea areas according to the report of UNEP (United Nation Environment Program). 85 % fresh water is consumed in agriculture but due to the use of chemical fertilizers water demand for the chemically grown crops have increased.

Considering these things, today conservation of water is very important due to which so many techniques have been developed for the purification and reuse of impure water in the world.

According to epidemiological survey, last 20 years when the untreated wastewater is used for crop production then the risks of infection increases which is caused by pathogens and other chemicals present in wastewater. The chances of infection also increase when untreated hospital wastewater has been discharged in municipal collection system or sewage and that water is used for irrigation purpose (Suarez et. al 2009). Hospital wastewater contains so many materials like pharmaceutical ingredients, drug metabolites, disinfectants, chemical materials, pathogens, and organic matters (Pauwels and Verstraete 2006). To solve this problem reuse of wastewater is an alternative to reduce anthropogenic effects. Hence, it is necessary to develop a suitable method for the removal of these types of pollutants (Carballa *et al.*, 2004). Sewage Treatment Plants (STP) is a wastewater treatment plant which is used for the removal of these types of pollutants. Developing countries can't able to construct and maintain the STP unit because establishment and running cost of Sewage Treatment Plants (STP) are very high.

Various techniques are used for the treatment of wastewater, but these are expensive, space consuming, time consuming, electricity required, different chemicals required and also create air pollution. For the treatment of these kinds of wastewater biological measures are more suitable than the physical and chemical treatment methods. A new biological technique with earthworms has been introduced in the filtration system and is known as vermifiltration system. This is a natural system which saves time, money, electricity, energy, space and chemicals also. It is self-regulated, cost-effective, automated, low electricity, no noise pollution, maintenance free, sludge free, disinfected and detoxified process. There is no sludge formation takes place during vermifiltration of wastewater Thus, it is an eco-friendly system. Technically, vermifiltration is a synergistic and symbiotic activity of earthworms with microorganisms, here worms integrated with organic pollutants, present in wastewater and also increasing surface area which is suitable for the microbial activities and degradation also (Tomar *et al.*,, 2011, Arora, *et al.*,,2014 and Samal, *et al.*,, 2017).

Traditional sewage treatment plants (STPs) are not capable to remove Endocrine disrupting chemicals (EDCs), present in sewage but Earthworms can bio-accumulate it. It has been reported that the high concentrations of EDCs present in the tissues of earthworms specially in E. fetida living in the vermifilter beds and also in garden soil (Markman *et al.*, 2007).

Usually, the body of earthworm functions as a bioreactor. The body of earthworm works as a biofilter that absorbs pollutants present in wastewater and also reduces 95% BOD, 85% COD, 95% TSS, 90-92% TDS & 95% Turbidity and 99% fecal coliforms (E. coli) from wastewater (Sinha *et al.*, 20012). It also reduces BOD5, COD, TSS about 93%, 65%,89% and pH value are 7.24 from hospital wastewater (Ghobadi *et al.*, 2016).

According to Shokouhi (2020) vermifiltration system is also capable of treating hospital wastewater because it reduces 90% COD and 90% BOD from hospital wastewater (Shokouhi *et al.*, 2020).

Vermifiltered water also reduces the environmental risk of antibiotics which is present in hospital wastewater (Shokouhi *et al.*, 2020). Vermifiltered water is almost crystal clear, nearly sterile, neutral pH value, and also a nutritive organic fertilizer (NPK) which is rich in 2- 3% Nitrogen (N), 1.55 - 2.25% Phosphorus (P) and 1.85 - 2.25% Potassium (K) (Sinha *et al.*, 2008 & Sinha *et al.*, 2010).

The raw sewage water creates bad odour and reduces phosphorous from 4-8 to 1-2 ppm and ammonical nitrogen (NH4 -N) from 25-40 ppm to less than 1 ppm. In vermifiltered water the content of Nitrates (NO3), Phosphates (P2O5) and Potassium (K) increases from 10-20 to 50 ppm, 1-2 to 5-7 ppm & 10-15 to 20-25 ppm respectively (Sinha et. al, 2014 & 2015). Thus, vermifiltered water is highly nutritive and also saves water & fertilizers so, it is good for agriculture. It also helps the reuse of wastewater water in the society (Kumar and Ghosh 2019).

In this study, we investigated the impact of vermifiltered water and hospital wastewater for the growth of Bitter gourd.

Mechanism of earthworm's action in vermifiltration system

In the vermifiltration system both the microbial and warms process works together. Actually, earthworms promote the growth of decomposer bacteria in hospital waste water. They act as a crusher, grinder, aerator, biological stimulator and chemical degrader, thus its body functions as bioreactor and bio-filter (Dash 1978).

In vermifilter bed earthworms feed upon organic and inorganic substances present in wastewater and excrete vermicast. Vermicast increases hydraulic conductivity and adsorption power of vermifilter bed (Bhawalkar 1995). In earthworms Metallothioneins are present which bind metals and make them inactive (Ireland, 1983; Hartenstein *et al.*,, 1980; Haimi *et al.*,, 1992).

Materials and Methods

Designing and Construction of the Vermifiltration unit

For the construction of vermifiltration unit two plastic drums of 80 liter was taken. Both drums were filled with 25 cm of large, 25 cm of middle and 25 cm of small size gravels. Small size gravels were followed by 25 cm of sand layer. The top layer was consisting of garden soil with 5kg dry cow dung about 35 cm. 1.5kg earthworms (*Eisenia fetida*) were added on the top layer of (one plastic drum) the soil bed known as vermibed but another drum was organized in the same way except earthworms. Hospital wastewater was filtered through this vermifiltration system and collected in pre-treated effluent i.e. filtered water container as shown in Fig. 1. The vermifiltered water (Vermiaqua) was placed at room temperature in dark because light can influence its chemical properties. Vermifiltered water was used for the irrigation of Bitter gourd.

Features of Bitter gourd (*Momordica charantia* L.)

Bitter gourd (*Momordica charantia* L.) (2n = 22) is an annual, climbing herb belongs to the family Cucurbitaceae and is originated in Southern China and Eastern India. Its Botanical name is *Momordica charantia* and English name is Bitter gourd. It has grown extensively in kharif and summer seasons across the country and is consumed as a vegetable. It is a most popular vegetable in India. It possesses medicinal properties like anti-cancer, anti-oxidant, anti-viral, anti-microbial and anti- diabetic properties.

Selection of Bitter gourd (*Momordica charantia* L.) seeds

The seed named VNR seed was purchased from Magadh Krishi Kendra, Jamal Road, Patna, India. Use of hospital wastewater and vermiaqua for cultivation and irrigation of Bitter gourd 15 seeds of bitter gourd were sown in 3 different pots equally. First pot was treated with hospital wastewater (HWW), second pot was treated with tap water (C) and third pot was treated with 25% tap water and

75% vermifiltered water i.e. vermiaqua (VA). Every day 50 ml of each water was poured in all three pots. Hight of all three plants were measured at the interval of 10 days (Fig 2).

Bio- mass estimation

For the estimation of biomass 10 seedlings were taken and wrapped with aluminium foil. At first fresh weight was taken then dried in oven at 70∘ C for 48 h after this dry weight was taken. Biomass was calculated by the subtraction of dry weight from fresh weight and expressed in gram.

Results and Discussion

Morphological characteristics

Assessment of plant growth and hight of Bitter gourd

The graphic presentation of plant height of every 10 days was presented in Fig. 3. The hight of vermiaqua treated plant (VA) was 90 cm, Hospital wastewater treated plant (HWW) was 86 cm and tap water treated plant (C) was 88 cm in first month i.e. after 30 day. In second month i.e. after 60 day the hight of VA was 291 cm, HWW was 220 cm and C was 255 cm. In third month i.e. after 90 day the high of VA was 452 cm, HWW was 370 cm and C was 410 cm. In fourth month i.e. after 120 day the hight of VA was 632 cm, HWW was 502 cm and C was 565 cm. The hight of vermiaqua treated plant was always higher than control and hospital wastewater treated plants. Vermiaqua treated plant looked dark green, big and healthy than control and hospital wastewater treated plants. Hight of HWW treated plant was also increases significantly but it was looking unhealthy than the control and VA treated plants.

Assessment of leaf size of Bitter gourd

The graphic presentation of leaf size of every 10 days was presented in Fig. 4. The leaf size of plant was increased significantly. In first month i.e. after 30 days the size of vermiaqua treated plant (VA) was 8 cm, Hospital wastewater treated plant (HWW) was 6 cm and tap water treated plant (C) was 6 cm. In second month i.e. after 60 days the leaf size of VA became 9.5 cm whereas the leaf size of C was 8.5 cm and HWW was 8 cm. The leaf size of vermitreated plant was bigger than HWW treated plant and tap water treated plant.

Assessment of number of leaves

The graphic presentation of number of leaves of every 10 days was presented in Fig. 5. In a plant no. of leaves increased whole period of study. No, of branches and sub branches also increased. In vermitreated plants no. of branches and sub branches were more than the HWW and C treated plants. So, VA treated plant becomes so bouncy.

In first month i.e. after 30 days no. of leaves in vermiaqua treated plant (VA) was 40, Hospital wastewater treated plant (HWW) was 35 and tap water treated plant (C) was 38. In second month i.e. after 60 days no. of leaves of VA was 135 cm whereas no. of leaves of C was 110 cm and HWW was 98 cm respectively.

Assessment of flowering behaviour

The graphic presentation of flowering behaviour of Bitter gourd was presented in Fig. 6. The total number of male flowers per plant up to 30 days after the appearance of first male flower was significantly higher in vermiaqua treated plant (37) in comparison with control treated plant (24) and HWW treated plant (15). The graphic presentation of flowering behaviour of Bitter gourd was presented in Fig. 7. Total number of female flowers were higher in vermiaqua treated plant (31) when compared to control treated plant (10) and HWW treated plant (7) up to 30 days after the appearance of the first male flower, per plant. In vermiaqua treated plant (VA) 65 days were taken for the opening of first female flower while in control

(C) it was taken 72 days and in HWW treated plant it took 85 days (Fig. 7).

Assessment of size and weight of fruit

The graphic presentation of size of Bitter gourd fruit of every 10 days was presented in Fig. 8. The fruit size of vermiaqua treated plant (VA) was 17 cm, Hospital wastewater treated plant (HWW) was 8 cm and tap water treated plant (C) was 12 cm after 30 days. The fruit length was significantly higher in vermiaqua treated plant (VA) when compared to Hospital wastewater treated plant (HWW) and tap water treated plant (C). However, width and flesh thickness of fruit showed non-significant difference among all three conditions. Width of fruit was higher in vermiaqua treated plant (5 cm) as compared to Hospital wastewater treated plant (3 cm) and tap water treated plant (3.9 cm) (Fig. 9). The fruit weight was also significantly higher in vermiaqua treated plant (115.20 g) in comparison to Hospital wastewater treated plant (52.81 g) and tap water treated plant (70.23 g) as shown in Fig. 10

Fig.1 Vermifiltration unit assembled on the movable iron rack and placed in dark

Fig.2 Growth of plant treated with Control, Hospital wastewater and Vermiaqua

Fig.3 Graphic representation of Plant Height

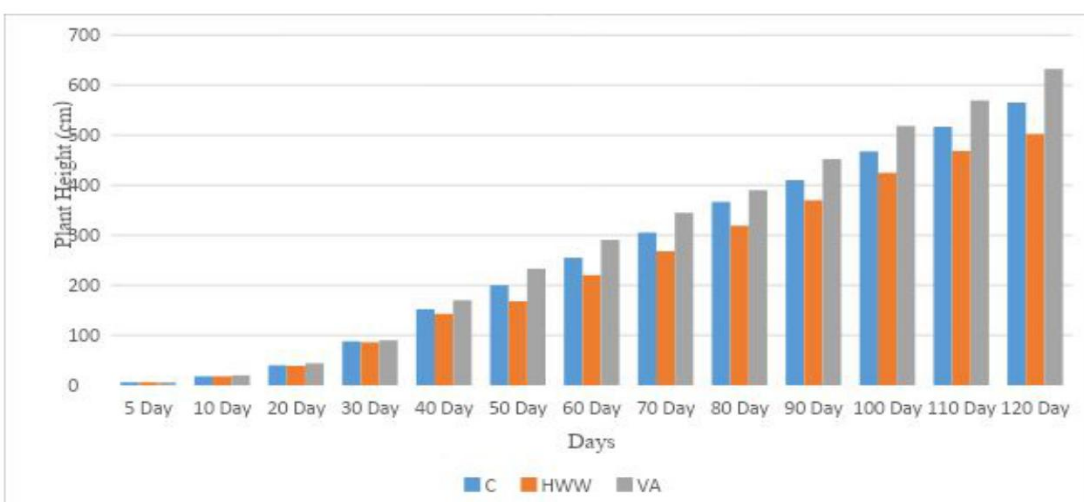


Fig.4 Graphic representation of Leaf Size

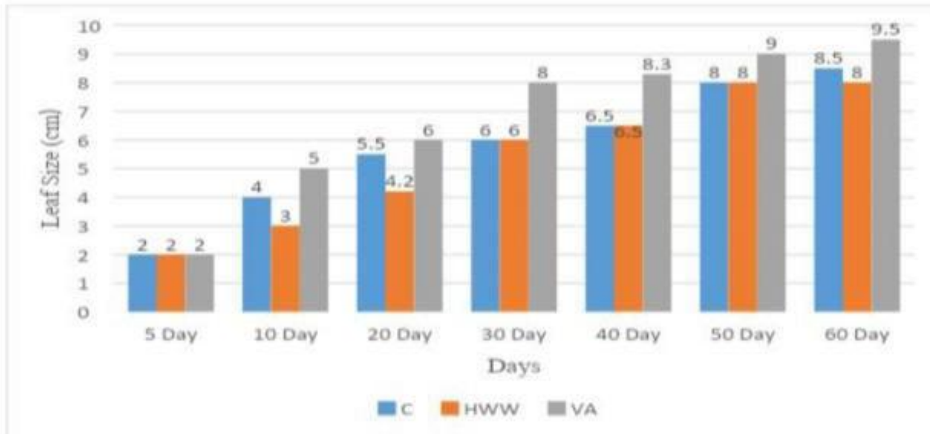


Fig.5 Graphic representation of number of leaves

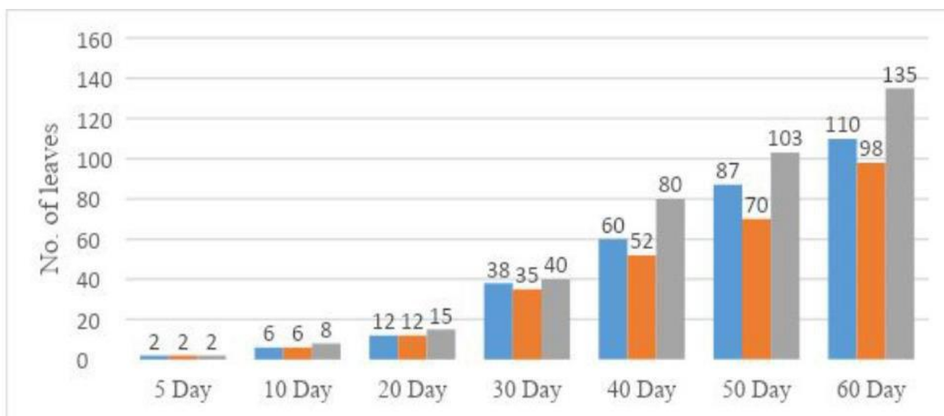


Fig.6 Graphic representation of no. of male and female flower per plant upto 30 days

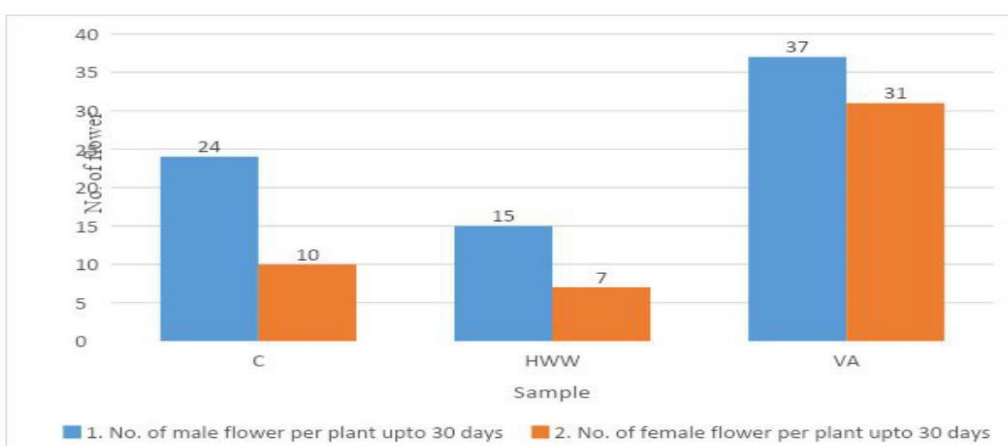


Fig.7 Graphic representation of opening of first female flower

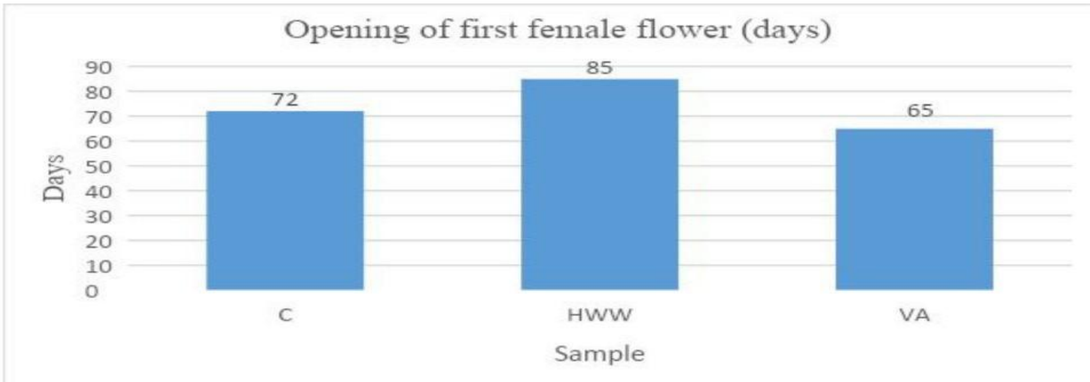


Fig.8 Graphic representation of length of fruit

Fig.9 Graphic representation of Width of fruit

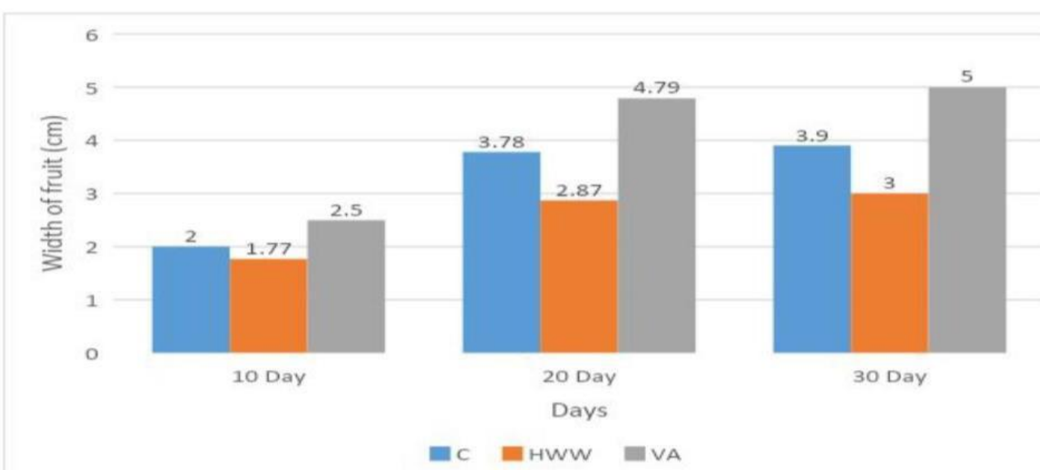


Fig.10 Graphic representation of weight of fruit

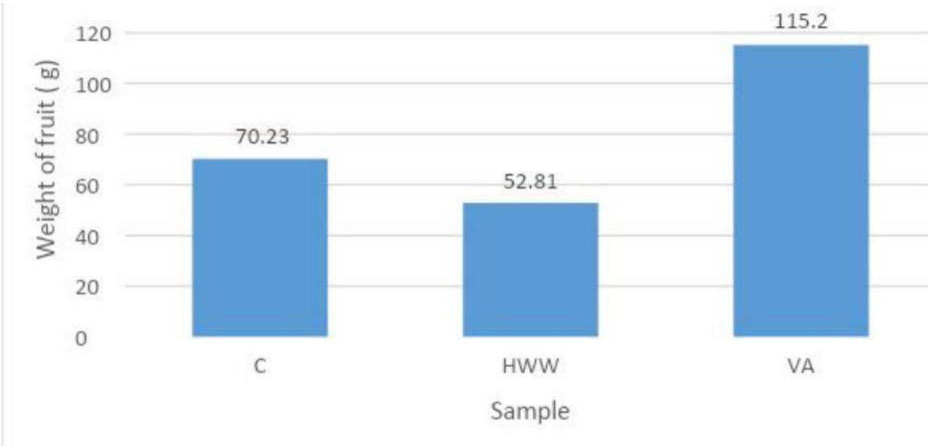


Fig.11 Graphic representation of no. of Seed per Fruit

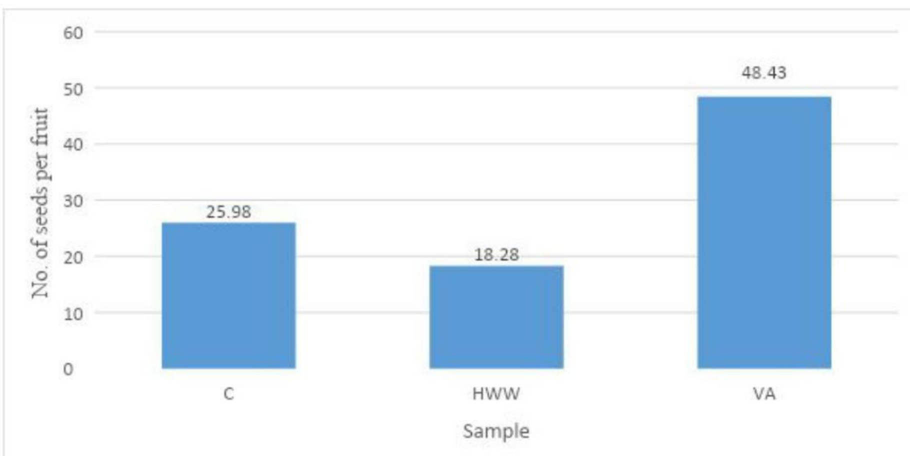


Fig.12 Graphic representation Seed Length and Width

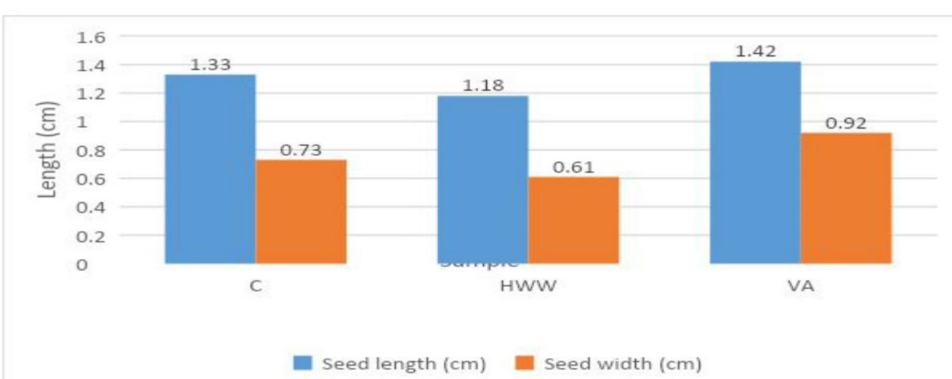
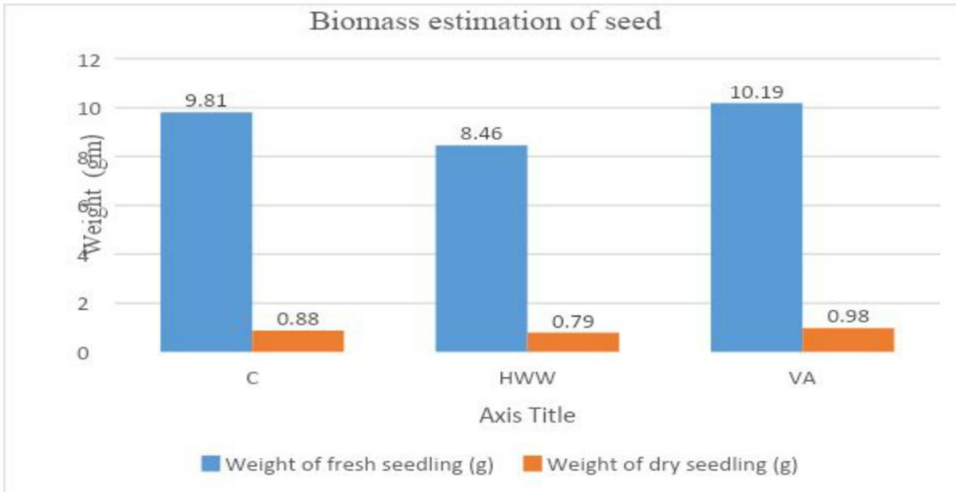


Fig. 13 Graphic representation of Biomass estimation of seed



Assessment of number, length and width of seed

The graphic presentation of number, length and width of Bitter gourd seed was presented in Fig. 11 & 12. Number of seed per fruit of vermiaqua treated plant (VA) was 48.43, Hospital wastewater treated plant (HWW) was 18.20 and tap water treated plant (C) was 25.98. Seed length of vermiaqua treated plant (VA) was 1.42 cm, tap water treated plant (C) was 1.33 cm and and Hospital wastewater treated plant (HWW) was 1.18 cm whereas seed width of vermiaqua treated plant (VA) was 0.92 cm, Hospital wastewater treated plant (HWW) was 0.61 cm and tap water treated plant (C) was 0.73 cm. Number of seeds per fruit was significantly higher in vermiaqua treated plant (VA) when compared to Hospital wastewater treated plant (HWW) and tap water treated plant (C). However, seed length and width showed non-significant difference.

Assessment of Bio- mass estimation of seed

The graphic presentation of Bio- mass estimation of Bitter gourd seedling was presented in Fig. 13. The weight of 10 fresh seedlings of vermiaqua treated water (VA) was 10.19g, Hospital wastewater treated (HWW) was 8.46 g and tap water treated (C) was 9.81 g whereas dry seedlings of vermiaqua treated water (VA) was 0.98 g, Hospital wastewater treated (HWW) was 0.79 g and tap water treated (C) was 0.88 g.

In conclusion, according to Sir Charles Darwin earthworms are friends of farmers. They are both plant growth promoters. So, Organic farming by using earthworms and their bio-products like vermifiltered wastewater & vermicompost can provide a sustainable solution to solve various problems created by agrochemicals in farm production all over world. Vermifiltered water is also responsible for the good growth and production of plants. These are disinfecting, detoxifying, neutralized and protective. We have to promote the vermifltration technology by using earthworms for the treatment of wastewater on a commercial scale. It is also an alternative way to save huge groundwater which is ending very fast all over the world. Vermifiltered water or vermiaqua also reduces the use of chemical fertilizers because it is highly nutritive and also NKP rich.

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