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RESEARCH PAPER

Assessment of biological parameters in tomato cultivars irrigated with fertilizer factory wastes

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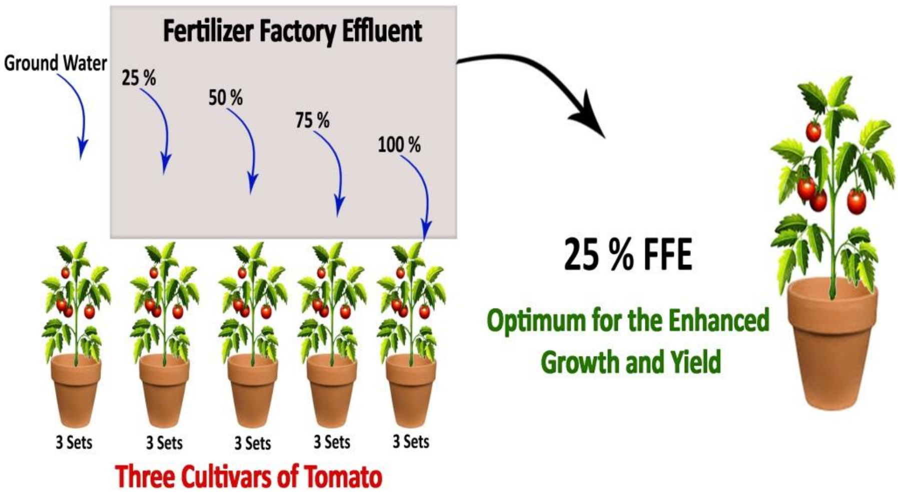
Highlights

- Disposal of industrial effluents and wastes is a main problem of modern world.
- The environment is dramatically affected by wastes from the fertilizer factories.
- Accumulation of solid and dissolved solids in plants has negative correlation with growth response in tomato varieties.

Graphical Abstract



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Abstract

In the present evaluative study, an effort has been made to assess different biological parameters like seed germination and growth of plants, etc. in three varieties of tomato. Fertilizer factory liquid wastes contain nitrogenous and ammonical substances which showed a promotional impact on percent seed germination and growth parameters due to these nutritional supplements present in it. The incremental effects have been recorded up to the extent of lower dilutions of fertilizer wastes. Lower concentration of waste (i.e.25%) found to be growth-promoting while rest higher concentrations of fertilizer wastes showed a decrement impact on growth parameters. Growth of tomato plants such as length of root and shoot under different effluent concentrations viz. 25, 50, 75, and 100% shows significant variation over the control. The results clearly show that with the increase of dilution of effluent, percent germination and growth parameters also changes. This may be due to the accumulation of certain solid and dissolved solids in plants that have a negative correlation with growth response in tomato varieties studied.

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1. Introduction

Disposal of industrial effluents and wastes is a main problem of modern world. They contain numerous toxic and hazardous chemical substances in the form of dissolved and suspended solids. There has been great initiative worldwide for the proper management of industrial effluents during last decade of rapid industrialization. Similarly, untreated waste water irrigation in urban and suburban lands has long been practiced in different parts of the globe due to high content of nutrients and also due to improper drainage and lack of infrastructure (Gilcreas, 1996). Fertilizer factory effluents are not only rich in organic and inorganic matter like that of nitrogen, phosphate, nitrate, chloride, sulphate and ammonia etc. Use of fertilizer factory wastes as ferti-irrigation increases percent germination of seeds and growth of plants up to an extent (Bhateria and Dhaka, 2017). But continuous use of such effluents in high concentrations, are harmful for both seed germination and the growth parameters. Industrial wastes pollution of rivers and agriculture soils is one of the most serious ecological problems of the world (Shukry, 2001). The environment is under severe threat from solid and liquid wastes emanating from the fertilizer factories. Their by-products cause pollution unless treated chemically prior to liberation in water streams, fresh water bodies and soil (Fashola et al., 2016; Ijaz et al., 2019).

Irrigation water is one which becomes costlier due to ever increasing demand for over population. This has brought more land under cultivation with attention on fertilizers and irrigation water. To meet out this irrigation water requirements, one has turned to non-conventional resources. Among them, one of the most important irrigation as well as nutritional resources in fertilizer factory waste water, which consists of about 99% water and the rest as organic and inorganic nutrients. Since its disposal is a big issue in most of industrial areas, applying industrial liquid wastes to agricultural fields instead of disposing off in water bodies and rivers can make crops grow better due to the presence of various nutrients like N,PO_4, SO_4, Cl, and NH_4 etc. There can be both beneficial and harmful effects of irrigation with waste water on various crops (Bargougui et al., 2019). It is needed to assess waste water quality and requirement of different plant species before using treated waste water for the crop improvement (Mapanda et al., 2005).

Fertilizer wastes contain several nutritional substances like ammonia and nitrogen and phosphate etc. that provide ferti-irrigational benefits to many crops up to an extent. But in certain instances, excess of nutrients to the plants requirement, imposes detrimental effects in the form of lower vegetative growth, poor yield and enhanced root-knot galling. It may be noted that the continuous use of high concentration of fertilizer effluent resulted in the reduction in the percent germination of seeds and stunted root- shoot growth. In addition to it, regular supply of low concentrations of fertilizer effluent shows positive correlation with seed germination and growth parameters as it contain nitrogenous substances as nutrients (Dixit, 2017). However, higher concentrations of fertilizer wastes have high value of dissolved and solid substances along with other organic and inorganic load. The chief motive of this research is to find out the appropriate concentration of fertilizer wastes as ferti-irrigational usage in Vegetable crop for better plant growth for good yields.

2. Materials and Methods

A split pot experiment was performed at the botanical garden of the department of Botany, Upadhi PG College, Pilibhit (India) to study the comparative efficacy of different dilutions of fertilizer factory effluent on certain biological parameters on three cultivars of tomato.

2.1. Physicochemical parameters of the effluent

The earthen pots are grouped into 15 sets for each cultivar, out of which 3 sets received groundwater (GW), 3 sets received 25% (3:1), 3 sets 50% (1:1), 3 sets 75% (3:1), and the remaining 3 sets received 100% FFE. The fertilizer factory effluent was collected from the drain of Kribhco Fertilizer Factory situated at Piprola, Shahjahanpur (UP), and India (Dixit, 2017). As the main source of the fertilizer factory and going to Garrahi branchlet of the river Garrah it is used as ferti-irrigational purposes by the farmers living nearby to them. The physicochemical parameters such as pH, temperature, total dissolved solids (TDS), total suspended solids (TSS), biological oxygen demand (BOD), chemical oxygen demand (COD), total Kjeldahl nitrogen, ammonia, and phosphate, etc were estimated (Pasqualone et al., 2017). Freshly collected fertilizer liquid waste was brought instantly from the fertilizer factory site to the Botany laboratory for the Physicochemical analysis of the samples by using AAS (Atomic Absorption Spectrophotometer) to determine different chemical substances present in it while the pH was calculated by digital pH meter while TDS by gravimetric and COD by the open reflex method.

2.2. Seed germination

Pot culture studies were initiated at the Botanical garden by the filling of pots with equal amount of garden soil, sand and cow dung in the ratio of 1:2:1. The present study was conducted with the seeds of three cultivars of tomato. The seeds were purchased from government seed agency for their better germination, high purity and best biological parameters. Equal number of seeds was sown in each pot and irrigated with calculated quantity of FFE. Total number of germinated seeds was counted at 24 hours interval starting from the day 3^{rd} of sowing up to 11 days and % germination was recorded (Karunya et al., 1994).

2.3. Plant growth

In each pot, five seeds of tomato were sown and allowed for germination. Ferti-irrigation was done periodically with calculated quality of FFE. Length of shoot was taken at every 72 hours for 15 days. After that plants were uprooted and thoroughly washed with running water after that length of roots was recorded. (Okanume et al., 2017; Abdel-Razzak et al., 2019).

2.4. Root and shoot length

Five seedlings were selected from each set and their root and shoot lengths were measured in centimeter with the help of a measuring scale. Values were recorded in the mean of three replicates.

2.5. Statistical analysis of data

Designing of the experiment was done in a random way. Tabulated data was analyzed statistically at P= 1% P by using ANOVA, with the help of a computer. Standard deviation and means were calculated and presented in table.

3. Results and Discussion

Table 1. Physicochemical characteristics of 100% concentration of fertilizer factory effluent (FFE). All determinations are in mg/l or as specified.

Determinations	Result
Color	Greenish
pH	7.2
Temperature (°C)	25.5
TDS	2610.0
TSS	38.4
TAN	28.9
Chemical Oxygen demand	125
Biological Oxygen demand	25.8
Phosphate as PO_4	3.0
Nitrate as Nitrogen	17.0
Chloride as Cl	910.0
Sulphate as So_4	800.2
Total Kjeldahl Nitrogen	52.5
Free ammonia	12.0
Dissolved Oxygen	0.10

The analysis of FFE (Table 1) showed that the pH is 7.2 which indicate its acidic nature. The waste liquid has considerably high BOD and COD than the groundwater; it determines the pollution power or requirement of oxygen of microbes for complete stabilization (Radziemska et al., 2019). The data for percent seed germination (Fig. 1, Table 2) revealed that a low concentration of FFE (25%) showing a favorable correlation with seed germination due to sufficient nutrient uptake by the germinating seeds (Rathi and Madan, 2019). In general, biological parameters of tomato were increased with 25% FFE application as it is evident from increased growth of root and shoot over the control (Figs. 2 and 3, Table 3) in all three tomato cultivars while treatments of higher concentrations of FFE showed a detrimental influence on all the growth parameters (Kiran et al., 2016; Rahman et al., 2019).

Table 2. Effect of FFE Concentrations on percent seed germination in three cultivars of tomato.

Treatments	Tomato Cultivars		
	Pusa 120	Pusa Hybrid 8	ArkaVishesh
F_0	86.00	86.80	90.00
F_1	87.14	86.20	93.25
F_2	70.88	72.26	78.54
F_3	60.05	61.97	67.23
F_4	42.00	44.07	55.37

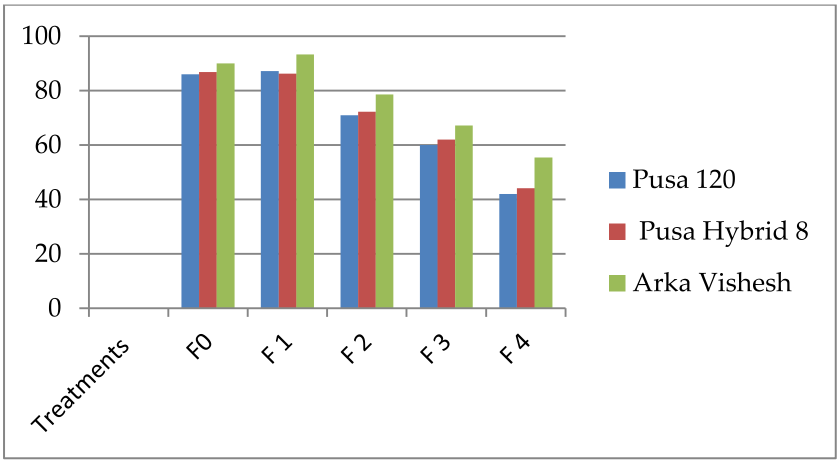

Fig. 1. Effect of FFE concentrations on percent seed germination in three cultivars of tomato.

Table 3. Effect of FFE concentrations on shoot length (cm) of three cultivars of tomato.

Treatments	Tomato Cultivars		
	Pusa 120	Pusa Hybrid 8	ArkaVishesh
F_0	25.07	30.00	30.13
F_1	28.60	31.47	32.07
F_2	23.20	25.03	27.39
F_3	19.65	23.49	21.32
F_4	13.50	21.02	20.00

Table 4. Effect of FFE concentrations on root length (cm) of three cultivars of tomato.

Treatments	Tomato Cultivars		
	Pusa 120	Pusa Hybrid 8	ArkaVishesh
F_0	21.30	26.18	26.03
F_1	27.00	29.39	30.33
F_2	24.26	21.37	27.15
F_3	18.02	19.47	20.10
F_4	12.66	17.00	18.07

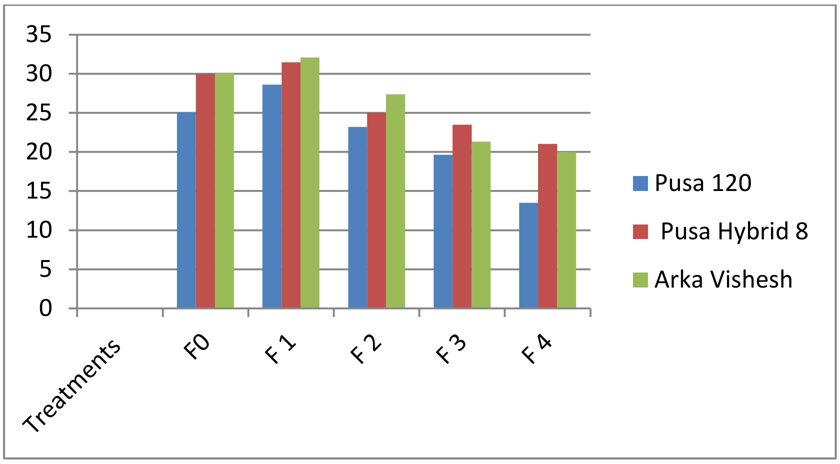

Fig. 2. Effect of FFE concentrations on shoot length (cm) of three cultivars of tomato.

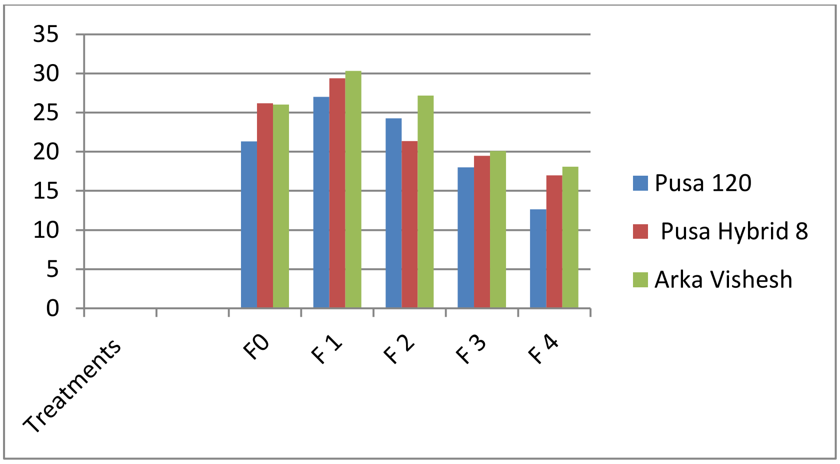

Fig 3. Effect of FFE concentrations on root length (cm) of three cultivars of tomato.

In the tables and figures a possible conclusion of research results have been displayed after the statistical analysis at 1% P and found F1 concentration of fertilizer wastes is statistically significant.

4. Conclusions

Fertilizer factory effluent has a good source of urea and nitrogenous compounds and hardness in wastewater are higher than that of groundwater. The concentration of dissolved and suspended solids in mg/l in wastewater is high in pure FFE. It proved superior for the growth parameters, giving better shoot length and root length along with higher seed germination. This may be because of the presence of essential nitrogenous contents in FFE, like ammonia, nitrogen, phosphorus, sulphate, chloride, and some of the micronutrients (Table 1), resulting in increased growth of plants.

The industrial liquid wastes are released directly or indirectly in the rivers through nearby flowing natural water channels, mostly untreated. Hence, the environment, natural water resources, groundwater, agriculture land, crops, and animals, and also human health are extremely in danger. For the rapid growth of population, urbanization, industrialization, consumption of raw material, and energy from nature also increases in multifold. Most of the rivers in India receive flux of domestic, industrial effluents, and wastes that lead to several toxic and harmful chemicals.

Fertilizer industries contribute significantly towards the green revolution, employment in the agriculture economy. Different chemicals released from fertilizer factories are polluting air, soil, and water of nearby areas by affecting plants, animals, and human beings. They interfere with physiological activities of the plants like mineral uptake of certain ions and nutrients absorption and reduce plant growth subsequently. The reuse of industrial wastes and effluents forferti-irrigation of crop plants after proper treatment with water is a very effective method (Rehman et.al, 2007). In this regard, fertilizer factory effluent can be diluted with groundwater before release from the fertilizer factory outlet and reutilized as ferti-irrigation for agriculture purposes and also act as a good growth promoter (Dixit, 2017).

Due to high level of dissolved solids contained salinity and conductivity of the solute, high concentration of FFE imposes an inhibitory effect on seed germination. The salinity of the FFE outside the seeds has a negative correlation with germination by restricting the water absorption through osmosis which resulting in less germination of seeds (Dixit, 2017). The stress of salt on the other hand alters the metabolic processes and decreases the synthesis of enzymes essential for seed germination

The decrease in root length of seedling treated with F_3 and F_4 effluent concentration over the control was recorded. This may be due to the increase in organic load of various chemicals present in the FFE. These results are in accordance with the previous experiments on the effect of fertilizer factory wastes on the Brassica seeds. Similarly, a gradual decline in the length of shoot is observed in the seedlings treated with F_3 and F_4 which may be due to excessive amount of dissolved and suspended solids present in them to retard the growth of seedlings. These findings are in confirmatory with the earlier report of effect of fertilizer factory effluent on sesamum. Who have recorded that the different concentration of fertilizer wastes showed negative impact on seedling growth with the increase in concentration of effluent.

The higher the concentration of FFE, the lower the percent seed germination in all three cultivars of tomato. This may be due to a lower supply of oxygen to the germinating seeds which also retards the growth and development of seedlings. The roots of the seedlings preserve a contact by effluents and thereby could affect the process of cell proliferation and on the growth of the plants. In comparison to the ground or natural water, fertilizer factory liquid waste contain a number of essential nutrients, and its ferti-irrigation and reutilization in the diluted form not only increased plant growth and yield but also for the better quality of produce. Thus it may be concluded that FFE can be profitably used for the cultivation of tomato, as it proved more efficient in promoting the growth and productivity of the crop under cultivation. 25% concentration of the FFE (F_2) proved optimum for the enhanced growth and yield. Among the three tomato varieties studied, cvArkaVishesh responded very well for percent seed germination and plant growth. In this way, reutilization of FFE for the ferti-irrigation is highly recommended as it may reduce the pressure on the synthetic fertilizers as well as meager freshwater resources.

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