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Research Article

IMPACT OF SEWAGE WATER ON SEED GERMINATION AND VIGOUR INDEX OF *CICER ARIETINUM* L. AND *PISUM SATIVUM* L.

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ABSTRACT
The study aimed to determine the effects of domestic sewage water on seed germination and seedling growth of *Cicer arietinum* and *Pisum sativum* plants under laboratory conditions. The effect of sewage water was compared to that of control (distilled water). Different concentrations such as 10, 20, 30, 40, 80 and 100% of sewage water on seed germination and vigour index of *C. arietinum* and *P. sativum* were studied. It has been concluded that sewage water has significantly affected the germination and growth of seeds and seedlings of *Cicer arietinum* and *Pisum sativum.*

Key Words: *Sewage, Cicer arietinum, Pisum sativum, Vigour Index*

INTRODUCTION

Human evolution has led to immense scientific and technological improvement. In recent times new challenges have to be taken in the field of environmental protection and conservation due to worldwide development (Bennett *et al.,* 2003). Due to industrialization and urbanization natural resources have been exploited extremely by men. Water is quite essential natural element for all kinds of life. The quality of water is vital concern for mankind since it is directly linked with human welfare. The major sources of organic pollution in fresh water aquatic eco-systems are sewage which includes domestic, hospital and small scale industrial wastes operating under municipal area.

Huge volume of sewage water is being produced in metropolitan cities due to ever increasing population. Sewage disposal is a major problem in most of the cities in India. In most of the cases the untreated sewage either finds way to the nearest water bodies or is intentionally put into the agricultural fields by the farmers as a substitute for irrigation. The water collected through sewerage system in outskirts of the city is discharged to agricultural lands without treatment which has both toxic and fertilizer values. There is an increase in the use of sewage water for irrigation especially in the out skirts of the cities, particularly in the dry area where there is scarcity of natural water (Girisha and Raju, 2008).

Sewage and other industrial effluents rich in organic matter and plant nutrients are finding agricultural application as cheaper way of disposal (Nath *et al.,* 2009; Nagajyothi *et. al.,* 2009). The use of industrial effluents for irrigation has emerged in the recent past as an important way of utilizing waste water. There are several advantage and disadvantage in using this sewage water for irrigation purpose (Raman *et al.,* 2002; Saravanmoorthy and Ranjitha Kumari, 2007). Sewage water contains higher amounts of nutrients which increases crop yield substantially and reduce the need for fertilizer, and ultimately decreases overall cost of production. In addition to providing large quantities of water, waste water from different sources contains considerable amount of organic matter and essential nutrients (N, P, K, Ca, S, Cu, Mn & Zn) which may prove beneficial for plants and has been reported to increase the crop yield (Pathak *et al.,* 1998; Pathak *et al.,* 1999; Ramana *et al.,* 2001; Niroula 2003; Lubello *et al.,* 2004; Nath *et al.,* 2009; Nagajyothi *et al.,* 2009). According to Otobbang *et al.,* (1997) sewage sludge consists of multi-element organic wastes that are also used commonly as manure.

Continuous use of sewage waste water may lead to environmental problems such as soil sickness, soil and ground water contamination and phytotoxicity (Karunaichamy *et al.,* 1990; Hicks and Hird, 2000). Use of industrial effluent and sewage sludge on agricultural land has become a common practice in India as a result of which the toxic metals present in the effluent can be transferred and concentrated into plant

tissues from the soil. Sewage water adversely affects root crops such as radish during maturity stage and as a result the production decreases substantially leafy vegetables like, cauliflower, cabbage, spinach etc., grow quite well in the presence of sewage water (Bakhsh and Hassan, 2005). Although some efforts have been made by different workers to determine the effect of different effluent discharged from various sources on seed germination of various crops (Doke *et.al.*, 2011; Fendri *et al.*, 2013; Rajesh *et al.*, 2013; Singh *et al.*, 2013), no comprehensive study of effect of sewage on seed germination of *Cicer arietinum* and *Pisum sativum* has not been investigated in details. Therefore, an attempt has been made to know the physico-chemical properties of sewage water and their effect on the seed germination and seedling vigour of *Cicer arietinum* and *Pisum sativum* at different concentrations.

MATERIALS AND METHODS

Water Sampling

Sewage water sample of about 1 litre was randomly collected from Naihati, North 24 Parganas, West Bengal, India in polyethylene bottles from the point where the sewage water enters the field for irrigation of *Cicer arietinum* and *Pisum sativum* crop. Water samples were transported to laboratory and analysed for various physico-chemical parameters.

Physical and Chemical Properties of Sewage Water

Sewage water was analyzed for different physico-chemical parameters such as pH, temperature, electrical conductivity, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), sulfate, chloride, total dissolved solids (TDS), total solids (TS), total suspended solids (TSS), hardness, total alkalinity, nitrogen through the method laid down in APHA (2005).

Effect of Municipal Sewage on Seed Germination

Different variety of *Cicer arietinum* and *Pisum sativum* seeds were surface sterilized with 0.1% $HgCl_2$ solution. After $HgCl_2$ treatment, seeds were washed thrice to remove all the traces of mercury. Then seeds were soaked for 2-3hrs in distilled water. Different concentrations of effluent (10%, 20%, 30%, 40%, 80% and 100%) were prepared along with control (0% effluent). Fifteen seeds were placed in pre-labelled Petridishes (lined with filter paper). Then 5ml of each treatment (effluent concentration) were added in respective Petridishes, which were then kept in dark for 2 days for germination, after 3 days Petridishes were shifted to light. Nutrient solution was made and effluent concentrations were prepared with nutrient solution. On third day of germination, 15ml of nutrient solution was given and seedlings were harvested after 10 days of growth.

Determination of Vigour Index

Germinated seedlings were evaluated for vigour index (VI). The root and shoot length of germinated seedling were measured and vigour index was calculated using the formula given by Abdul-Baki and Anderson (1973).

VI = (MRL + MSL) x PG

Where, VI = Vigour index; MRL=Mean root length; MSL= Mean shoot length; PG = Percentage germination.

RESULTS AND DISCUSSION

In the present study sewage water which is used for irrigation of *Cicer arietinum* and *Pisum sativum* fields was analyzed to know the physico-chemical parameters of sewage water and its effect on seed germination and vigour index. The results of physico-chemical parameters are given in the Table 1. Several authors have studied the physico-chemical properties of sewage water with reference to irrigation (Devi, 1991; Garg, 1998). Although the sewage water is a source of many nutrients, it also contains a significant amount of heavy metals. Extensive use of this effluent for irrigation purposes may result in an upsurge of such metals in soils and various crops.

The sewage water used for the present study was dark in colour with unpleasant odour. The average values of various physico-chemical characteristics of the 100% sewage exhibited high chemical oxygen

demand (348 mg/l), total dissolved solids (2140 mg/l), chloride (1002mg/l) and sulfate (1087mg/l). The sewage was alkaline in nature.

Table 1: Physico-chemical parameters of water

Parameters	Sewage water	Fresh water
pH	8.3	7.3
Temperature (^oC)	30	28
EC (µS/cm)	15.97	400
DO	1.7	5
BOD	165	100
COD	348	250
TDS	2140	500
TSS	760	19
Nitrogen	70.9	0.20
Total alkalinity	480	300
Chloride	1002	200
Sulfate	1087	200
Hardness	890	300

Except pH, temperature and EC all others parameters are expressed in mg/L

In the study it was observed that *Cicer arietinum* showed response to sewage water treatment. Seed germination percentage was higher at 10% and 20% sewage water than that of the control (95.2%). Increase in sewage concentration from 30% onwards reduced the percentage of seed germination (Table 2).

Table 2: Effects of different concentration of sewage water on seed germination percentage of *Cicer arietinum*

Sewage water concentration (%)	Percentage of germination
Control	95.20
10	100.00
20	100.00
30	93.34
40	80.67
80	80.00
100	66.67

The vigour index of *Cicer arietinum* was found to be maximum at 20% sewage concentration (Table 3) over control. So it revealed that 20% sewage concentration was found to be suitable for higher seed germination and vigour index. The dry weight of seed was maximum in 20% sewage concentration.

Higher concentration of sewage water reduced the dry weight of *Cicer arietinum* seed (Table 5). The nutrient supplemented sewage water, however showed less vigour index at 10% and 20% sewage concentration that that of control (Table 4).

Table 3: Effect of different concentration of sewage water on vigour index of *Cicer arietinum*

Sewage water concentration(%)	MRL (cm)	MSL (cm)	PG	VI= (MRL + MRL) x PG
Control	1.300	0.286	95.20	150.98
10	1.100	0.500	100.00	160.00
20	1.660	0.806	100.00	246.60
30	1.596	0.750	93.34	218.97
40	1.166	0.599	80.67	152.97
80	1.073	0.233	80.00	104.48
100	0.633	0.140	66.67	51.53

Table 4: Effect of different concentration of sewage water on vigour index of *Cicer arietinum* (after nutrient supplement)

Sewage water concentration(%)	MRL (cm)	MSL (cm)	PG	VI= (MRL + MRL) x PG
Control	3.953	24.566	95.20	2715.00
10	4.333	12.900	100.00	1723.30
20	3.766	14.366	100.00	1813.20
30	3.837	11.560	93.34	1437.15
40	2.666	6.700	86.67	811.75
80	0.593	3.073	80.00	293.28
100	0.206	1.366	66.67	104.80

Table 5: Dry weight of *Cicer arietinum* seed

Sewage water concentration (%)	Dry weight (g)
Control	3.17
10	3.15
20	3.22
30	3.09
40	3.05
80	2.95
100	2.80

In case of *Pisum sativum* seeds, it was observed that the seed showed response to sewage water treatment. Seed germination percentage was higher in the control set than that of the other sewage concentration; increase in sewage concentration from 10% onwards reduced the percentage of germination (Table 6).

Table 6: Effect of different concentration of sewage water on vigour index of *Pisum sativum*

Sewage water concentration (%)	Percentage of germination
Control	100.00
10	90.00
20	80.00
30	80.00
40	70.00
80	50.00
100	40.00

The vigour index of *Pisum sativum* was found to be maximum at 0% sewage concentration (Table 7) over control. So it revealed that 20% sewage water was not found to be suitable for higher seed germination and vigour index. The dry weight of seed was maximum in 0% sewage concentration. Sewage water reduced the dry weight of *Pisum sativum* seed (Table 9). The nutrient supplemented sewage water, however showed less vigour index at 10% and 20% sewage concentration that that of control (Table 8).

Table 7: Effect of different concentration of sewage water on vigour index of *Pisum sativum*

Sewage water concentration(%)	MRL (cm)	MSL (cm)	PG	VI= (MRL + MRL) x PG
Control	2.24	1.26	100.00	350.00
10	1.66	0.59	90.00	202.50
20	1.10	0.29	80.00	111.20
30	1.20	0.26	80.00	116.80
40	0.54	0.15	70.00	48.30
80	0.34	0.05	50.00	19.50
100	0.17	0.01	40.00	7.20

Table 8: Effect of different concentration of sewage water on vigour index of *Pisum sativum* (after nutrient supplement)

Sewage water concentration(%)	MRL (cm)	MSL (cm)	PG	VI= (MRL + MRL) x PG
Control	3.88	21.35	100.00	2523.00
10	3.35	14.18	90.00	1577.70
20	4.35	16.15	80.00	1640.00
30	2.83	11.65	80.00	1158.40
40	2.54	9.65	70.00	853.30
80	0.67	2.63	50.00	165.00
100	0.25	1.40	40.00	66.00

Table 9: Dry weight of *Pisum sativum* seed

Sewage water concentration (%)	Dry weight (g)
Control	3.50
10	3.20
20	3.10
30	3.10
40	2.70
80	1.90
100	1.50

The present results attributed that higher concentration of sewage inhibited seed germination due to production of various enzymes (Agarwal *et al.*, 1981; Shukla and Pandey, 1991) or prevention by enriching the salinity (chloride content) and conductivity of solute being absorbed by seed before germination (Neelam and Sahai, 1998) or sometimes the seeds undergo physiological stress due to high salinity (Rao and Nanda Kumar, 1983) or due to excess quantities of micronutrients, heavy metals and toxic chemicals (Dollar *et al.*, 1972; Indra and Sivaji, 2006). Present work is intended on germination behaviour of *Cicer arietinum* and *Pisum sativum* seeds at different dilutions to find out the effect of sewage water.

Conclusion

Though sewage water is used frequently now a day for irrigation purposes due to its fertilizer value but it should be cautious of using sewage regarding pollutant perspective. Still the use of waste water for irrigation purposes is found to be beneficiary for crop plants, as it is the safe disposal of sewage effluents. Otherwise it possesses adverse effects on the environment as well as human health. Besides through the irrigation the sewage water can be recycled. In the present study, sewage water is used for cultivation of *Cicer arietinum* and *Pisum sativum* fields was analyzed to know the physico-chemical properties of sewage water and its effect on seed germination and vigour index. Regarding physico-chemical characteristics, sewage water exhibited high COD, TDS, chloride and sulfate. The sewage was throughout alkaline in nature. In case of gram seeds seed germination percentage was higher at 10% and 20% sewage concentration than that of control. Increase in sewage concentration from 30% onwards reduced the percentage of germination. The vigour index of *Cicer arietinum* was found to be maximum at 20% sewage concentration over control. So it to reveal that 20% sewage concentration was found to be suitable for higher seed germination and vigour index. The nutrient supplemented sewage water however, showed less vigour index at 10% and 20% sewage concentration than that of control. In case of *Pisum sativum*, it was found that the vigour index is maximum at control and it revealed that sewage water is not suitable for its higher seed germination and vigour index.

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