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Detection of Heavy Metals in Steel Factory Effluent and Their Effect on Seed Germination, Seedling Growth, Chlorophyll Contents, Growth and Yield of *Phaseolus mungo*

Suresh Kumar[1] and Vandana[2]

[1]*Department of Botany, Ramjas College, University of Delhi (North Campus), University Enclave, Delhi-11000, India*

[2]*Dpartment of Chemistry,Dyal Singh College,University of Delh,Lodhi Road, New Delhii*

ABSTRACT

Present study was carried out to see the effect of the industrial effluent discharged from steel factory which have several kinds of pollutants like heavy metals. The studies were done in different concentration of effluent. The result showed that low concentration was in favour of germination, seedling growth, chlorophyll contents, growth and yield of Phaseolus mungo while there was gradual decrease with increasing concentration of effluent in germination, seedling growth, chlorophyll contents, growth and yield of Phaseolus mungo. The maximum inhibition was found in pure effluent.

Keywords: Steel factory, Effluent, Heavy Metals, Germination, Seedling, Phaseolus mungo cv.T-9, Chlorophyll Content, Growth and Yield.

I. INTRODUCTION

Rapid industrialization is the need of modern world, but Industrialization and urbanization are the big source of pollution. Pollution not only damages environment, health, vegetations and materials but also interferes with the climate. Due to industrialization and modernization of agriculture a large number of chemicals in the form of pesticides, herbicides, Dyes, drugs and chemicals etc. are continuously released either deliberately or accidentally into environment and cause the pollution. Water pollution due to the discharge of industrial effluent in industrial area is the main problem in India. Ghaziabad is an important industrial town of Uttar Pradesh, with a variety of industrial establishment and Sahihabad is one of the most important industrial area of Ghaziabad, where the several types of industries are found such as distillery, papers and pulp, oil refinery, steel and tube, chemicals, pharmaceutical, rubber and textile. Industries are known to use various acids, organic and inorganic salts, toxic elements and heavy metals, which are to some extent discharged into water and make it unsuitable for human being and animal as it is also used for irrigating the crops. Heavy metals which are present in industrial effluents have created a great ecological crisis. Among the heavy metals mercury, cadmium, lead, nickle, chromium, zinc are most toxic elements (Britto and Geetha 1997) and have many deleterious effects (Nriago 1980).

II. MATERIALS AND METHODS

The samples of industrial effluent were collected from main discharge point of steel factory which is situated in industrial area site IV, Sahibabad District Ghaziabad, India and filtered with whatman paper and then analysed for some heavy metals including macronutrients on atomic absorption spectrophotometer by method of the (APHA 1989).

The seed of Phaseolus mungo cv.T-9 were obtained from pulse research Laboratory I.A.RI. Pusa New Delhi. Healthy and uniform seeds of Phaseolus mungo cv.T-9 were selected and surface sterilized with 0.1% $HgCl2$ for two minutes. The seeds were thoroughly washed with distilled water. Twenty seeds are placed in a petriplate and treated with different concentration of steel factory effluent (25%, 50%, 75% and 100%). These dilution of effluent are made in distilled water. A control set of distilled water was also kept for compression. Five replicates were taken for each set. The emergence of radicle was taken as criterion for germination 3rd, 5th and 7th day old seedling were selected from each petriplate, the measurement for length, fresh weight and dry weight of radicle, hypocotyl and epicotyl.

For chlorophyll estimation 600 mg fresh leaves at 15th, 30th, and 45th day from radicle emergence were taken and homogenized with 80% aceton. The optical density of the extract measured at 645 nm and 665 nm. The amount of chlorophyll 'a', chlorophyll 'b' and chlorophyll 'a+b' were calculated according to the formula of A rnon (1949).

Chlorophyll a (mg/l) = 12.72 A665-2.50A645
Chlorophyll b (mg/l) = 22.876 A 645-4.67A665
Chlorophyll a + b (mg/l) = 8.05 A 665 + 20.25 A 645

For plant growth and yield the soil samples were treated by different concentration (25%, 50% and 100%) of effluent at the time of seed sowing on 10th day and 20th day after germination. Five replicates were maintained for each concentration including the control. The plants samples were collected from the field for growth parameters like total length (height) of plant, root length, shoot length, fresh weight and dry weight of root, shoot and total plant, leaf area of first simple leaf pair and, first and third trifoliate leaf, fresh weight, dry weight of leaf/plant were measured at 15th, 30th and 45th day after germination. The yield observation were taken at the time of maturity, no. of pods per plant, fresh and dry weight of pod and no. of seeds per pod were studied for this purpose.

III. RESULTS AND DISCUSSION

The chemical analysis of effluent of steel factory revealed the presence of heavy metals (Zn, Cd, Pb, Hg, Cu. etc) and plant nutrient like Ca (Table 1). The percentage of germination was observed maximum in 25% concentration of effluent and it decreased with increasing concentration of effluent (Table 2). In pure efficient (100%) germination percentage was very poor over the control. This is in consonance with the earlier findings (Sneh lata et al. 2002). The data on effect of seeding growth of 3rd, 5th, and 7th days old seedling revealed the variation with respect to different concentration of the effluent. There was a gradual increase in the radicle, hypocotyl and epicotyl lengths of Phaseolus mungo cv.T-9 seedlings with the increase of dilution of the effluent upto 25% concentrations (Table 3 and Fig. C). This finding is in agreement with the observation of Kumar et. al (2001) and Kumar (2005).

Fresh and dry weight of the radicle hypocolyl and epicotyl have been reported in (Table 3 and Fig. A, B) which indicates that the growth of the plant i.e. radicle, hypocotyl and epicotyl were increasing from control to the 25% effluent this findings is in also corroborated with our previous observation in the variety of Phaseolus under the impact of steel factory effluent (Kumar et. al. 2001) and Nagajyoti et al. (2008).

Higher concentration of the effluent inhibited both seed germination and seedling growth. It may be due to the presence of nutrient (Ca) in the effluent (Arora et al. 1985). The reduction in growth of seedling (table-3) might be due to presence of excess amount of soluble salts like calcium and magnesium and solid materials effluents as they cause injuries to plant system (Israelsean and Hansen 1962). Thukral Kaur (1987) have already found the adverse effect of element such as copper and zinc on seedling growth.

The Chlorophyll contents (chlorophylls 'a', chlorophyll 'b' and chlorophyll 'a+b') of Phaseolus mungo c v.T-9 was increased at 25% of steel factory effluent (Table 6 and Fig. D), Shetty et al. (2000) noticed the similar results in different plant and industrial effluent. Some other worker fond the increment in chlorophyll content at lower concentration of effluent at 10% and 15%

concentration of fertilizer effluent by Goswami and Naik (1992). Sangeeta et al. (1998) studied total chlorophyll contents and dry matter production in gram and reported that it was adversely affected with irrigation.

The fresh and dry weight of cotyledon at 25% effluent concentration decreased considerably however it increased with increase in the effluent concentration from 25% on word (Table-3 and fig. a, b). This observations are in conformity with Rajannan and Oblisami (1979).

The growth reduction in the plant system is undoubtedly complex including toxic effects from the excess quantities of nutrients, heavy metals, and salt toxicity (Dolar et. al. 1972).

Growth and yield of Phaseolus mungo cv.T-9 were increased at 25% concentration of steel factory effluent. Whereas with increased concentration of effluent the growth and yield was decreased. (Table 4, and 5) Result of Simard et. al. (1998) was in agreement with our findings. Panneerselvan and Thamiziniyam (2008) and Singh and Mishra (1987) observed that lower concentration increased the growth (height of plant f resh and dry eight of plant, no. of leaf per plant, leaf area) and yield (number of pod per plant, fresh adn dry weight / number of seed per pod etc.) (Table-5) while same decreased at higher concentration.

Table 1: Heavy Metals and Macronutrients in Steel Factory Effluent

Heavy Metals / Nutrients	Concentration
Zinc	7.86 ppm
Cadmium	0.02 ppm
Lead	0.47 ppm
Nickel	Nil
Mercury	0.27 ppm
Copper	0.54 ppm
Chromium	Nil
Calcium	26.1 ppm
Iron	Nil

Table 2: Impact of Different Concentration of Steel Factory Effluent on Seed Germination of Phaseolus mungo cv.T-9

Concentration of Effluent	Germination Percentage
Control	96%
25%	100%
50%	91%
75%	84%
100%	82%

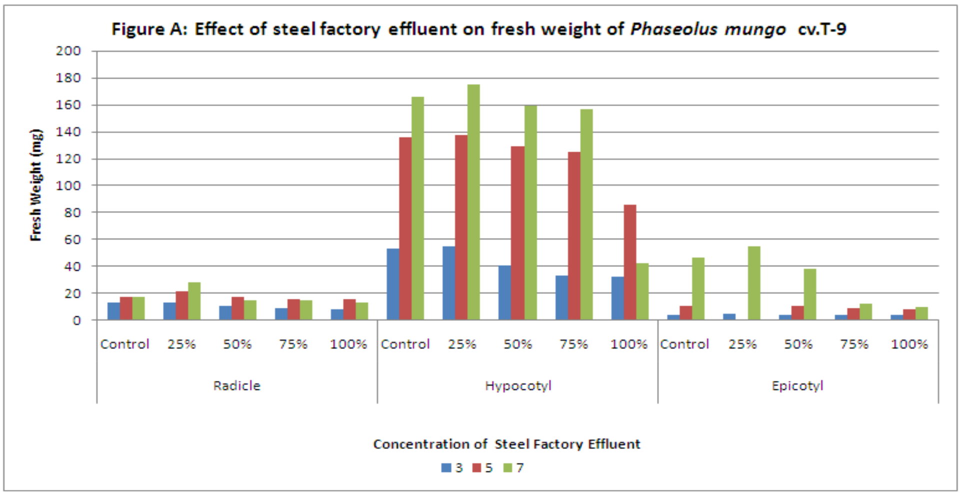

Figure B: Effect of steel factory effluent on dry weight of *Phaseolus mungo* cv.T-9

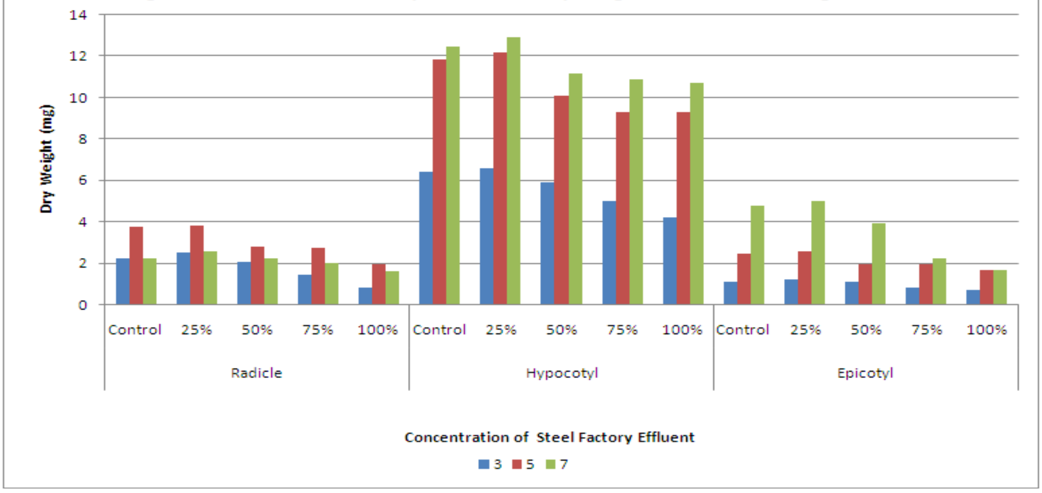

Figure C: Effect of steel factory effluent on length of *Phaseolus mungo* cv.T-9

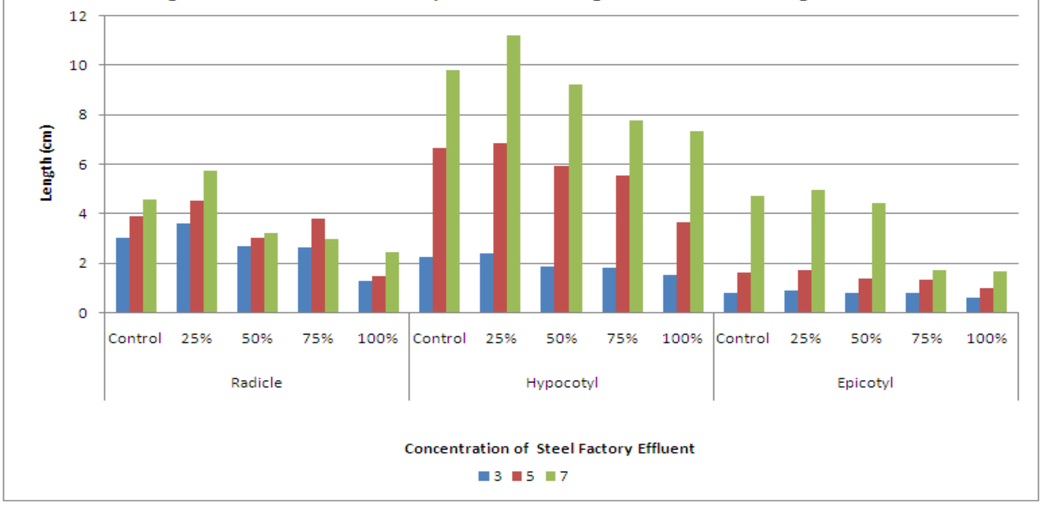

Figure D: Effect of Steel Factory Effluent on Chlorophyll of *Phaseolus mungo* cv.T-9

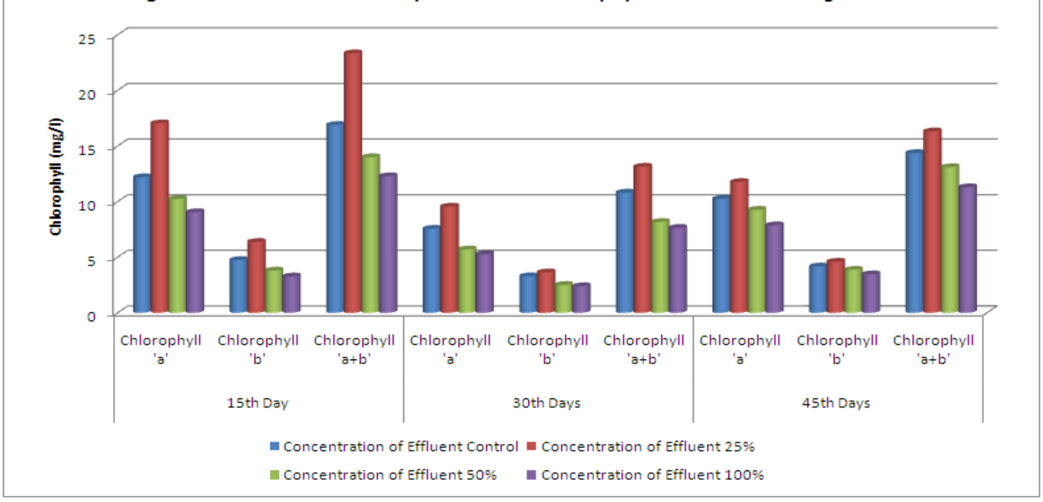

Table 5 : Effect of Steel Factory Effluent on Yield of Phaseolus mungo cv.T-9

Concentration of effluent	Numbers of pods per plant	Length of pod	Fresh weight of pod	Dry weight of pod	Number of seed per pod
Control	6.00	3.80	475.00	135.60	4.70
	±0.85	±0.41	±29.00	±11.14	±1.34
25%	7.00	4.25	575.00	178.40	5.00
	±0.77	±0.05	±40.11	±12.36	±0.89
50%	5.00	3.78	528.00	110.40	4.70
	±0.59	±0.17	±36.90	±13.90	±1.18
100%	5.00	3.68	465.00	80.50	4.10
	±0.39	±0.49	±29.00	±10.41	±1.22

Table 4: Effect of Steel Factory Effluent on the Growth of Phaseolus Mungo cv.T-9

Parameters	Day after germination											
	15th day				30th day				45th day			
	Concentration of effluent				Concentration of effluent				Concentration of effluent			
	Control	25%	50%	100%	Control	25%	50%	100%	Control	25%	50%	100%
Height of Plant (cm)	33.60	36.10	24.80	26.10	36.40	39.50	30.70	28.90	55.20	74.00	45.50	31.10
± SD	±3.33	±2.22	±2.45	±3.17	±7.32	±8.32	±6.40	±5.05	±6.95	±6.92	±3.55	±4.31
FW of Plant (mg)	2290.00	3090.00	1600.00	1075.00	5375.00	7085.00	3925.00	3845.00	10660.00	18200.00	8970.00	4855.00
± SD	±69.39	±80.81	±55.37	±37.38	±150.00	±254.34	±317.18	±340.00	±348.54	±540.15	±449.00	±390.00
DW of Plant (mg)	393.00	522.00	332.00	231.00	981.00	1234.00	750.00	720.00	1838.00	3380.00	1058.00	755.00
± SD	±34.40	±35.00	±31.29	±29.22	±36.90	±40.17	±32.04	±31.32	±317.20	±310.20	±290.24	±100.25
Root Length (cm)	11.00	12.80	5.60	5.20	11.80	14.50	6.20	5.50	14.50	16.80	8.30	6.80
± SD	±0.79	±1.23	±0.99	±0.85	±1.96	±1.33	±1.21	±1.17	2.10	±2.17	±3.41	±4.01
Shoot Length (cm)	22.60	23.30	20.90	19.20	24.60	25.00	24.50	23.40	40.70	57.20	37.20	24.30
± SD	±3.99	±4.60	±3.17	±2.41	±3.32	±4.00	±4.11	±3.47	±3.17	±4.96	±3.95	±4.05
No. of leaf per plant	3.00	3.00	2.00	2.00	5.00	6.00	4.00	4.00	9.00	14.00	7.00	6.00
(excluding 1st leaf pair)±SD	±0.40	±0.33	±0.12	±0.39	±0.25	±0.54	±0.66	±0.24	±0.63	±1.11	±0.85	±0.39
FW per leaf (mg)	442.50	740.00	360.00	162.00	866.60	1008.00	751.60	581.60	1100.00	1615.00	960.00	.590.00
± SD	±46.20	±51.23	±23.40	±21.09	±32.04	±40.00	39.00	±23.32	±750.55	±180.90	±110.10	±106.40
DW per leaf (mg)	76.50	131.50	73.40	49.50	148.10	172.50	148.00	112.00	234.00	300.00	207.00	170.00
± SD	±7.22	±5.33	±6.40	±4.97	±7.95	±8.66	±7.56	±8.00	±23.30	±24.00	±25.50	±11.66
Leaf area per leaf (cm^2)	25.18	22.98	18.60	11.71	43.67	59.89	41.03	33.48	58.45	77.88	54.44	38.66
(Trifoliage) ± SD	±2.96	±4.33	±2.54	±3.21	±4.96	±4.85	±3.85	±4.01	±3.96	±4.66	±3.54	±4.39
Leaf area per plant (cm^2)	75.54	40.73	18.48	23.42	218.35	259.34	164.12	±133.92	526.05	1099.32	381.08	231.96
± SD	±8.31	±3.33	±4.91	±3.33	±8.99	±9.99	±5.46	±8.01	±7.85	±11.39	±12.36	±9.40
Leaf area of 1st leaf	19.17	122.19	36.96	14.77								
pair (simple leaf) ±SD	±3.21	±8.88	±3.56	±1.47								

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