Toxic Effect of Textile Mill Effluent on Cow Pea (*Vigna unguiculata L.*) Walp.

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Abstract— *The aim of the present investigation was to assess the suitability of textile mill effluent (TME) (untreated) at different concentrations (Control, 2.5, 5, 15, 25, 50 75, and 100%) for irrigation purposes. Effect of textile mill effluent on seed germination, shoot and root length, fresh and dry weight, number of leaves, total leaf area, number of root nodules and pigments of chlorophyll 'a', chlorophyll 'b' and total chlorophyll of cow pea was studied at 15th DAS of seedlings. All morphological growth parameters, pigment contents, were found to increase at 5% textile mill effluent concentration and it decreased from 10% effluent concentration onwards. So these results reflect that the textile mill effluent is toxic to crop and it can be used for irrigation purpose after a proper treatment with appropriate dilution.*

Keywords— ***Textile mill effluent, cow pea, germination percentage, plant biomass, pigment content.***

I. INTRODUCTION

Environmental pollution is one of the major evils of the world and it is increasing day by day due to urbanization and industrialization. Over the last few decades huge scale convention of chemicals in an assortment of human activities has grown very fast, mostly in a country like, India which has to go for rapid industrialization in order to sustain over growing large problem of population. The industrial effluents discharged into water bodies include toxic chemicals, oils, greases, dyes, suspended, radioactive wastes and thermal pollutants from the industries. The pollutants differ in their concentrations and it depends up on raw materials used and the amount of water let in. The indiscriminate discarding of wastes let in a large number of industrial units joins the water bodies and has serious concern to aquatic and terrestrial environment (Mustafa *et al.*, 2010).

The textile industry is one of the oldest and biggest sectors in India. At present it is amongst the top foreign exchange earning industries for India. Textile industries have been placed in the category of the majority polluting industries by the Ministry of Environment and Forests, Government of India. Textile industries in India were initially centred on big cities like Ahmedabad, Mumbai, Tamilnadu, Bangalore and Kanpur. In Tamilnadu, almost 80 per cent of India's cotton knitwear exports happen from Tirupur. There are 6,250 units involved in various operations of the textile industry here. It has 4900 knitting and stitching units, around 736 dyeing and bleaching units, 300 printing units, 100 embroidery units and 200 units catering to compacting, raising and calendaring. The textile industry involves processing or converting raw material into finished cloth employing various operations (Jayanth sarathi 2011). Dyeing, desizing and scouring are the major sources of water pollution in textile effluent and it consume large quantities of water and produces polluting waste effluents (Jadhav *et al.*, 2010). The industry is using more than 8000 chemicals in various processes of textile manufacture including dyeing and printing (Kant 2012). The effluent discharges are necessary in the process of industrial developments which lead to the pollution of water and soil. The water bodies and soils are becoming major sinks for industrial pollutants.

These pollutants affect the ecosystems and agricultural lands. The textile mill effluent discharges from various units contain different types of pollutants like colours, solids, traces of heavy metals *etc*., (Karim *et al.*,2006). These released pollutants direct to the pollution of surface water, groundwater and the soils directly or indirectly. Textile processes requires large volumes of fresh water after the cloth processing operations. The wastewater volume varies from mill to mill. The combined wastewater volume from Indian textile mills lies in the range of 86 to 247 litres with an average 172 litre per kg of cloth produced and 16% of this is consumed in dyeing and 8% in printing. This effluent is characterized by high biological oxygen demand (BOD), chemical oxygen demand (COD), sodium and other dissolved solids as well as micronutrients and heavy metals like *viz.*,chromium, copper zinc, lead or nickel (Manzoor *et al.*,2006)

The effluent discharged by these industries not only affects the exterior and groundwater, but also dangerously affect the soil properties. The effluents of industries used for irrigation, gravely damage the seed germination and seedling growth of various crops but effects varies from crops to crops. Various researchers have carried out studies regarding the effects of different industrial effluents on different crop species (Kaushik *et al.*, 2005; Garg & Kaushik 2008; Saravanamoorthy and Ranjitha kumari 2007; Patel and Pandey 2008; Kant 2012).

The experiment seed of Cowpea is of major significance to the livelihoods of millions of reasonably poor people in fewer developed countries of the tropics. From production of this crop, rural families variously derive food, animal feed, and cash, together with spillover benefits to their farmlands through, for example, in situ decay of root residues, use of animal manures, and ground cover from cowpea's spreading and low growth habit. In addition, because the grain is widely traded out of the major production areas, it provides a cheap and nutritious food for relatively poor urban communities.

In fresh form, the young leaves, immature pods, and peas are used as vegetables, while several snacks and main meal dishes are prepared from the grain. All the plant parts that are used for food are nutritious, providing protein, vitamins, and minerals. Cowpea grain contains, on average, 23-25% protein and 50-67% starch. Petty trading of fresh produce and processed foods provides both rural and urban opportunities for earning cash, particularly by women. So the present research work has been carried out the toxic effect of raw textile mill effluent on the growth of Cow pea (*Vigna unguiculata* (L.) Walp.

II. MATERIALS AND METHODS

2.1 Seed material collection

Cow pea (*Vigna unguiculata* (L.) Walp. Co (CP) 7 was obtained from local Agro Service Centre, Dharmapuri, Dharmapuri Dist, Tamil Nadu, and India. The healthy seeds were chosen and used for the peteridishes experiments.

The textile mill effluent samples were collected in plastic containers from the outlet of Textile Industry, Dharmapuri, Tamil Nadu, and India. They were brought to Laboratory, and kept in refrigerator (5°C) to analyses their properties. The analysis of physico-chemical properties were made as per the methods mentioned in American Public Health Association (APHA, 1998).

2.2 Preparation of Textile Mill Effluent Concentrations

The collected effluent sample from the outlet of textile mill effluent was considered as 100% raw effluent. Different concentrations (control, 2.5, 5, 10, 15, 25, 50, 75 and 100%) of textile mill effluent were prepared freshly by using tap water whenever necessary. They were used for all experiments. For 100 mL,

Control	Tap water
2.5	2.5 mL effluent + 97.5 mL of water
5%	5 mL effluent + 95 mL of water
25%	25 mL effluent + 75 mL of water
50%	50 mL effluent + 50 mL of water
75%	75 mL effluent + 25 mL of water
100%	Raw effluent (undiluted)

2.3 Germination studies

For germination tests 50 seeds were surface sterilized with 0.02% mercuric chloride ($HgCl_2$) for two minutes. Washed with running tap water, 50 seeds were placed equidistantly in sterilized peteridishes lined with filter papers. The seeds in the peteridishes were moistered with 10 ml of each effluent concentrations of control set was treated with distilled water. The emergence of radicle was taken as the criterion for germination. Each treatment was maintained as triplicate

2.4 Germination percentage

The number of seeds germinated in each treatment was counted on each and every day up to 15th day after sowing. The total germination percentage was calculated by using the following formula:

$$\text{Germination percentage} = \frac{\text{Total number of seeds germinated}}{\text{Total number of seeds sown}} \times 100$$

2.5 Seedling length (cm/seedling)

Twenty seedlings were randomly selected on 15th day from each treatment to record the seedling growth. The growth of the seven varieties of groundnut seedlings was measured by using a centimetre scale and the values were recorded.

2.6 Fresh weight and dry weight (g/seedling)

Twenty seedlings were taken, air-dried and their fresh weight was taken. The same seedlings were kept in a hot air oven at 80°C for 24 h. Then, the samples were kept in desiccators and their dry weight was taken by using an electrical single pan balance. The average was expressed in g/seedling.

2.7 Vigour index

Vigour index of the seedlings were calculated by using the formula proposed by (Abdul-Baki and Anderson 1973).

$$\text{Vigour index} = \text{Germination percentage} \times \text{seedling length.}$$

2.8 Tolerance index

Tolerance index of the seedlings were calculated by using the formula proposed by Turner and Marshal (1972).

$$\text{Tolerance index} = \frac{\text{Mean length of longest root in treatment}}{\text{Mean length of longest root in control}}$$

2.9 Phytotoxicity

The percentage of phytotoxicity of effluent was calculated by using the formula proposed by (Chou *et al.* 1978).

Percentage of phytotoxicity =

$$\frac{\text{Radicle length of control - Radicle lenght of test}}{\text{Radicle length of control}} \times 100$$

2.10 Pigment content analysis

The chlorophyll and carotenoid contents of seedlings were estimated by (Aron, 1949; Kirk, and Allen, 1965).

III. RESULT AND DISCUSSION

The physicochemical characteristics of raw textile mill effluent are shown in (Table 1). Raw effluent was brownish black in colour, deficit in dissolved oxygen, highly in total solids, total alkalinity, BOD and COD with considerable amounts of total nitrogen, phosphate, chlorides, sulphates, sodium and calcium. The potassium content was negligible.

A considerable amount of nitrogen and phosphorus were also present in the effluent. The variation in physico-chemical properties of textile mill effluent may be due to the chemicals used and process involved, in the textile dyeing industry. The increased COD levels in the effluent could be due to the presence of high amount of suspended solids. Presence of high total dissolved solids in irrigation water is less suitable for irrigation (Balakrishnan *et al.*, 2008 and Ehiagbonare *et al.*, 2009). The presence of high level of total suspended solids and total dissolved solids might be due to the insoluble organic and inorganic matter present in the effluent (Nagarajan *et al.*, 2005). It may also be due to the reduction in level of toxic substances by dilution and may also cause for better germination (Kannan, 2001).

The germination percentage decreased gradually with an increase in effluent concentrations. The seeds showed cent per cent germination at 5 per cent concentration of effluent on 15th days for cow pea plants respectively (Table 2). The higher concentration of textile mill effluent reduced the germination of seeds. The increase in seedling growth at lower concentrations might be due to the decrease in the concentrations of total nitrogen, phosphate, potassium, calcium, chloride and sulphate in the textile mill effluent. It appears that this low concentration of the effluent act as fertilizer (Singh *et al.*, 1985). The seed might have required some nutrients for their normal metabolic activities. The textile mill effluent also contains plant nutrients and trace elements, which are utilized for the better growth of seedlings (Lenin and Thamizhiniyan, 2009). The tolerance index value decreased with increase in the textile mill effluent concentration. The same trend was observed textile dye industry effluent on groundnut (Swaminathan and Vaidheeswaran, 1991). The percentage of phytotoxicity showed a reverse trend. The phytotoxicity of the effluent increased gradually with increase of textile mill effluent concentration. The results are in conformity with the reports of (Sumathi *et al.* 2006).

TABLE 1
PHYSICAL AND CHEMICAL CHARACTERISTICS OF TEXTILE MILL EFFLUENT

Characteristics	Concentration
Color	Dark Brownish black
Ph	8.69
Temperature(^oC)	34.8
EC(dS/m)	6.05
Total solids(mg/l)	1040
Dissolved solids(mg/l)	1016
Suspended solids (mg/l)	234
BOD (mg/l)	7630
COD (mg/l)	1892
Chlorides (mg/l)	420
Potassium (mg/l)	2.54
Sulphate (mg/l)	14.3
Nitrate (mg/l)	13.5
Calcium (mg/l)	1.32
Magnesium (mg/l)	0.7
Zinc (mg/l)	2.5
Copper	1.25
Total chromium (mg/l)	4.5
Phenolic substances (mg/l)	0.16
Oil and grease (mg/l)	3.8

TABLE 2
TOXIC EFFECT OF TEXTILE MILL EFFLUENT ON COW PEA (*Vigna unguiculata* (L.) WALP. ON 15th DAS OF SEEDLINGS.

Effluent Con, %	Germination (%)	Vigour index	Tolerance index	Phytotoxicity	Shoot length (cm/plant)	Root length (cm/plant)	No. of leaves	Leaf area (cm^2/leaves)	Fresh weight (mg/g fr.wt.)	Dry weight (mg/g dr.wt.)
Control	90 ± 4.5	1532± 76.6	-	-	19.6 ± 0.98	9.8 ± 0.49	16.4 ± 0.82	33.1 ± 1.65	11.5 ± 0.57	5.4 ± 0.27
2.5%	95 ± 4.75	1655± 82.7	2.625± 0.13	0.250± 0.01	21.4 ± 1.07	11.2 ± 0.56	18.6 ± 0.93	35.2 ± 1.76	14.8 ± 0.74	6.5 ± 0.32
5%	98 ± 4.9	1783± 89.1	3.96± 0.198	1.990± 0.09	24.6 ± 1.23	15.8 ± 0.79	20.8 ± 1.04	40.2 ± 2.01	17.2 ± 0.86	8.0 ± 0.40
10%	94 ± 4.7	1604± 80.2	1.96± 0.098	2.342± 0.11	21.8 ± 1.09	13.2 ± 0.66	17.5 ± 0.87	34.6 ± 1.73	14.8 ± 0.74	6.2 ± 0.31
15%	86 ± 4.3	1436± 71.8	1.268± 0.06	3.562± 0.17	19.8 ± 0.99	10.4 ± 0.52	15.4 ± 0.77	30.8 ± 1.54	12.4 ± 0.62	5.1 ± 0.25
25%	80 ± 4	1005± 50.2	0.665± 0.03	4.632± 0.23	16.4 ± 0.82	8.0 ± 0.40	13.2 ± 0.66	26.4 ± 1.32	10.5 ± 0.52	4.6 ± 0.23
50%	69 ± 3.45	936± 46.8	0.390± 0.01	5.863± 0.29	13.2 ± 0.66	6.2 ± 0.31	10.6 ± 0.53	23.5 ± 1.17	7.6 ± 0.38	3.8 ± 0.19
75%	32 ± 1.6	565± 28.2	0.112± 0.00	7.320± 0.36	10.6 ± 0.53	6.0 ± 0.30	6.8 ± 0.34	19.2 ± 0.96	6.5 ± 0.32	2.5 ± 0.12
100%	17 ± 0.85	345± 17.2	0.065± 0.00	9.544± 0.47	07.6 ± 0.38	4.2 ± 0.21	3.0 ± 0.15	13.5 ± 0.67	4.8 ± 0.24	2.0 ± 0.10

3.1 Seedling growth

The seedling stage is the most sensitive stage in the life of a plant and more susceptible to physical and chemical adversities. In the present study, the seedlings growth also gradually increased up to 5 per cent concentration of textile mill effluent increasing the seedling length absorbed same findings absorbed (Szymczyk *et al.,* 2007) the low concentration of dye industry effluent increasing the seedling length of sorghum bicolor and *Zea mays.* (Samyuktha *et al.* 2005) reported that distillery effluent and *Oryza sativa* plant low concentration of effluent and increasing the seedling length. The same findings in juice factory effluent (Lenin and Thamizhiniyan, 2009)

The increase in seedling growth at lower concentrations might be due to the decrease in the concentrations of total nitrogen, phosphate, potassium, calcium, chloride and sulphate in the textile mill effluent. It appears that this concentration of the effluent act as fertilizer (Singh *et al.,* 1985). It indicates that the lower concentrations of textile dyeing industry effluent had a marked growth promoting effect on overall growth of seedlings (Goel and Kulkarni, 1994). The seed might have required some nutrients for their normal metabolic activities. The textile mill effluent also contains plant nutrients and trace elements, which are utilized for the better growth of plant (Lenin and Thamizhiniyan, 2009).

3.2 Seedling weight

The seedling weight of cow pea plants were increased upto 5 per cent of textile mill effluent concentration. The same trend was observed early in textile effluent on seedling weight of wheat cultivars (Kaushik *et al.,* 2005). The effluent also contains plant nutrients and trace elements which are essential for plant growth. The presence of optimum level of nutrients in the lower concentrations of textile mill effluent might have increased the growth as well as the dry weight of seedlings. The growth promoting effect of the lower concentrations of the effluent was attributed to the decrease in the concentration of various chemicals present in the effluent (Hariom *et al.,* 1994). The reduction in seedling dry weight at higher concentrations of textile mill effluent may also be due to the presence of higher amount of elements present in the effluent which results in the poor growth of seedlings under effluent irrigation (Kumawat *et al.,* 2001).

3.3 Chlorophyll

The chlorophyll is one of the important biochemical content which is used as an index of production capacity of the plant. The chlorophyll a, b, total chlorophyll and carotenoid content increased at (5%) lower concentration of textile mill effluent (Table 3). It may be due to the decrease in the chemical concentrations to an optimum level on the dilution of the textile mill effluent the increase in carotenoid content might be due to enhanced influence of nitrogen and other organic elements present in the effluent Sivaraman M and Thamizhiniyan P (2005).

TABLE 2
TOXIC EFFECT OF TEXTILE MILL EFFLUENT ON COW PEA (*Vigna unguiculata* (L.) WALP. ON 15th DAS OF SEEDLINGS.

Effluent concentration (%)	No. of root nodules	Chlorophyll'a' (mg/g fr. wt.)	Chlorophyll 'b' (mg/g fr. wt.)	Total Chlorophyll (mg/g fr. wt.)	Carotinoid (mg/g fr. wt.)
Control	28 ± 1.40	2.542 ± 0.12	1.93 ± 0.09	4.474 ± 0.22	2.11 ± 0.10
2.5%	34 ± 1.70	3.62 0± 0.181	2.56 ± 0.128	6.18 ± 0.30	2.86 ± 0.14
5%	38 ± 1.90	4.860 ± 0.24	3.023 ± 0.15	7.883 ± 0.39	3.12 ± 0.15
10%	31 ± 1.55	3.120 ± 0.15	2.24 ± 0.112	5.36 ± 0.26	2.42 ± 0.12
15%	26 ± 1.30	2.062 ± 0.10	1.068 ± 0.05	3.13 ± 0.15	1.832 ± 0.09
25%	21 ± 1.05	1.200 ± 0.06	0.856 ± 0.04	2.056 ± 0.10	0.975 ± 0.04
50%	18 ± 0.90	0.856 ± 0.04	0.564 ± 0.02	1.42 ± 0.071	0.762 ± 0.03
75%	11 ± 0.55	0.632 ± 0.03	0.247 ± 0.01	0.879 ± 0.04	0.365 ± 0.01
100%	3.0 ± 0.15	0.323 ± 0.01	0.146 ± 0.00	0.469 ± 0.02	0.132 ± 0.00

Reduction in chlorophyll content induced by effluent may be associated with mineral ions. Some of the possible reasons for the decrease in chlorophyll content may be the formation of enzyme such as chlorophyllase which is responsible for chlorophyll degradation (Rodriquez *et al.,* 1987; Krishna and Leelavathi, 2002.). Iron, magnesium, potassium, zinc and copper are essential for the synthesis of chlorophyll (Rao, and Kumar, 1983.). The increase in the chlorophyll content at lower concentration of the textile mill effluent might be due to the favourable effect of nitrogen and other elements which are present in their optimum quantities. Presence of nutrients in their optimum quantities in the lower concentration of the textile mill effluent which are required for biosynthesis of pigment. Finally the article concluded that the textile mill effluent inhibit the growth whereas with a proper dilution it promoted germination and seedling growth of cow pea.

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