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Toxic Effect of Textile Industry Effluent on Germination, Growth, Yield and Plant Metabolism in Wheat (*Triticum aestivum L.*) Plants

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ABSTRACT

This study was carried out to investigate the effect of textile industry effluent in relation to growth and metabolism of wheat plants. It was observed in the present study the germination percentage, plant growth, yield, photosynthetic pigments, sugar and protein concentrations and total amylase was significantly decreased at increasing concentrations of effluent. While two important iron enzymes such as catalase and peroxidase was found to be significantly increase with increasing concentrations of effluent. pH and organic carbon % was significantly increased while calcium carbonate % showed variable results by increasing the concentrations of effluent as compared to control.

Keywords : Textile Industry Effluent, Wheat, Germination, Growth, Pigments, Sugar , Protein, Catalase, Peroxidase, Amylase and Soil chemical changes

I. INTRODUCTION

Pollution is one of the major issue we are facing. Due to the rapid growth in pollution the ecosystem is getting affected at a major rate, thus harming the life of all living beings. Due to the increasing development resulting in rapid change in climate , the nature is facing an adverse effect. The pollution rate is increasing in such a way that it will completely ruin the existence of the mankind slowly. As the population is increasing day by day, the demand curve is also increasing which is leading to rapid urbanization and enormous development of industries. To foster development, rapid industrialization is really good as it provides employment, digitization but in order to build so many industries, we are forgetting the harmful effects of industrialization.

The continuous disposal of the harmful effluents from the industries leads to severe environmental issues like triggering harmful diseases and deforestation, soil erosion. These further affects mortality rate, also reduces area covered under forests and agricultural land, thus causing imbalance in the flora and fauna of the area. This is a serious issue as it will adversely affect sustainability of life in the long run.

This paper aims to find out the effect of various concentrations of textile industry effluent on growth, yield and metabolism of wheat plant. This paper also aims to spread awareness in public about effect of

toxicity of this effluent and also give impetus for future studies.

II. MATERIALS AND METHODS

The experiments were carried out in earthen clay pots under controlled glass house conditions. The soil samples were collected from Chinhat area of Lucknow (U.P.). The tap water washed soil was filled in medium size earthen pots provided with a central drainage hole. The soil pH was maintained by repeatedly flushing with distilled water. The soil sample were collected after harvest. The dried soil samples were powdered in agate mortar/ grinder and then they sieved through a 1 mm sieve and analyzed for different chemical characteristics of soil.

The glass distilled water was used for preparation of nutrient stocks and used for all metabolic and analytical work. When plants were raised basal nutrition solution / respective solution were supplied. The plants were treated with different concentrations (25, 50, 75 and 100%) of effluent on alternate days. Growth of plants subjected to different doses of textile industry effluents were measured in terms of germination (%), shoot and root lengths (in cms), total fresh and dry weights (in gms). The basal nutrient solution was prepared by method given by Hewitt (1966). Chlorophyll content was measured by the method of Petering et al.(1940). Protein was estimated by the method of Lowry et al.(1951). Total sugar concentrations was estimated by the methods of Dubias et al.(1956). Activity of enzyme catalase was assayed by the method of Bisht (1972), a modified method of Eular and Josephson (1927). Activity of enzyme peroxidase was measured by the modified method of Luck (1963). Amylase activity in plant tissue was assayed by the method of Katsuni and Frekuhara (1969). Soil pH was determined in 1:2 soil water ratio (Jackson, 1973).The Calcium carbonate in the soil was determined by the rapid titration method of Piper (1942). The organic carbon in the soil was determined by Walkley and Black's (1934) rapid titration method.

III. RESULTS AND DISCUSSION

(a) Germination percentage: Germination percentage was found to be decreased at increasing concentration of effluent (25, 50, 75 and 100%). It was 11.60, 14.49, 20.29 and 23.19% decrease at 25, 50, 75 and 100% concentration respectively than the control (Table-1). It was noticed that effluent of textile industry have inhibitory effect on germination in a wheat plant. According to Murkumar and Chavan (1987) higher concentration of effluent decrease enzyme dehydrogenase activity , which may have disrupt germination and seedling growth.

(b) Plants Growth: Shoot and root lengths was found to be significantly decreased at increasing concentration of effluent. Reduction in shoot length is of 12.82, 22.05, 27.18 and 42.57 and that of root length is of 19.05, 32.14, 53.57 and 63.10 at 25, 50, 75 and 100% concentration respectively than the control. Fresh weight and dry weight was also found to be significantly decreased at increasing concentration of effluent (Table-1). According to Singh et al. (2005), different kinds of pollutants mainly affect the respiration of roots which along with soil organism tends to reduce the oxygen and increase the CO_2 concentration and that causes soil harder and closed , and the closed pores of the soil causes less aeration which causes retardation in the growth of plant. The inhibition of growth with increase in the effluent concentrations was already reported (Om et al., 1994; Balashouri and Prameeladevi, 1994; Mishra and Bera, 1995, 1996; Sundaramoorthy, 1995; Solaimalai and Saravankumar, 2004; Chandra et al., 2004).

(C) Metabolic activities

(i) Chlorophyll: Supply of different concentrations of effluent significantly reduced the level of

photosynthetic pigments (Chlorophyll a, chlorophyll b, total chlorophyll and carotenoids). The results indicate that chlorophyll b was found to be more effected at higher concentration of effluent. It was 15.06, 26.45 , 63.70 and 71.79% decrease at 25, 50, 75 and 100% concentration respectively than the control (Table-2). Prasad and Strzalka (1999) stated that heavy metal usually decreases pigment contents and this reduction in pigments can be the result of the volume reduction of chloroplasts and their number per unit surface of leaf. According to Bamniya et al. (2010), reduction in pigment content may be due to the breakdown of chlorophyll during stress or due to inhibition of chlorophyll biosynthesis. Decrease in chlorophyll b could be due to the destabilization and degradation of the protein of the peripheral part (Verney et al . 2007).

(ii) Sugar: Sugar concentration was significantly decreased at increasing concentration of effluent. It was 3.99, 12.77, 28.81 and 48.01% decrease at 25, 50 , 75 and 100% concentration respectively than the control (Table-3).According to Vijayaragavan et al. (2011), reduction in sugar content may be due to the increase in the concentration of various cations and anions present in the effluent.

(iii) Protein: This parameter was also found to be significantly decreased at increasing concentration of effluent. It was 10.72, 28.50, 47.86 and 55.34% decrease at 25, 50, 75 and 100% concentration respectively than the control (Table-3). It was noticed that higher concentratios of effluent gave negative effects. This is conformity with the study of Muthusamy and Jayabalan (2001), Ayyasamy et al. (2008).

(iv) Enzymes activity: The Catalase activity was significantly increased at increasing concentration of effluent. It was 22.81, 28.04, 37.97 and 56.17% increase at 25, 50, 75 and 100% concentration respectively than the control (Table-4). The Peroxidase activity was found to be significantly increased. It was found to be 15.26, 53.57, 124.74 and 186.83% increase at 25, 50, 75 and 100% concentration respectively than the control (Table-4). Results indicated that activity of amylase was significantly decreased at increasing concentration of effluent. It was of 27.52, 32.51, 50.02 and 57.52 % decrease at 25, 50, 75 and 100% concentration respectively than the control.(Table-4). The antioxidant enzyme, catalase which is largely found in peroxisomes is thought to convert the hydrogen peroxide evolving in photorespiration. (Halliwell,1977). Both antioxidant enzymes catalase and peroxidase can be used as indicator of metabolic functions and are known to be induced by many stress factors, including heavy metals (Van Assche et al., 1988, Subhadra et al., 1991). It was observed in this study amylase activity was found to be decreased with increasing concentrations of effluent. Heavy metals can also cause a reduction in the hydrolysis products expressly amylase, Phosphatase, RNAs and proteins (Agarwal,1999).

(v) Soil chemical changes: Values of pH varied at different concentrations of effluent was significantly increased (Table-5). The pH of soil increased gradually with increase in the effluents concentration, it might be due to the continuous irrigation with the effluent which was alkaline in nature and that increased the salt accumulation in the soil (Dhevagi and Oblisami,2006). Increase in pH due to industrial effluents was reported by many workers Ajmal and Khan (1983), Orhue et al. (2005b) using brewery effluent, Saravanmoorthy and Ranjitha Kumari (2007), Malarkodi et al. (2007), Srinivaschari et al .(2000) using textile effluent, Singh and Mishra (1986) using Fertilizer waste water. Calcium carbonate % showed variable results with increasing concentration of effluent. Calcium carbonate % showed non- significant increase at 50, 75 and 100% concentration of effluent while similar decrease was observed at 25% concentration of effluent (Table-5).

Similar results of increased soil calcium carbonate content was reported by Ajmal and Khan (1983). Organic carbon % showed significant increase at increasing concentration of effluent (Table-5). The organic carbon in the soil irrigated with effluent was found to be higher than the soil irrigated with unpolluted water. It may be due to the high organic nature of the effluent (Ale et al.,2008). Similar increases in organic carbon has been reported by Ajmal and Khan (1983), Valdes et al. (1996), Saravanamoorthy and Ranjitha Kumari (2007), Acharya (2001), Dhevagi and Oblisami (2006).

Table 1. Effect of different concentrations of Textile industry effluent on germination percentage, growth and biomass yield of Wheat (*Triticum aestivum* L.) plants.

S. No.	Effluent Concentration (%)	Germination (%)	Shoot Length(cm)	Root Length(cm)	Total fresh weight (g)	Total dry weight(g)
1.	Control	92.000a ±2.309	65.000a ±0.577	28.000a ±1.155	9.653a ±0.154	3.672a ±0.048
2.	25	81.333a ±1.333 (-11.60%)	56.667ab ±4.807 (-12.82%)	22.667ab ±1.202 (-19.05%)	4.102a ±0.138 (-57.51%)	1.742a ±0.374 (-52.60%)
3.	50	78.667a ±1.333 (-14.49%)	50.667ac ±2.186 (-22.05%)	19.000ab ±1.528 (-32.14%)	3.883a ±0.409 (-59.77%)	1.668a ±0.193 (-54.60%)
4.	75	73.333a ±4.807 (-20.29%)	47.333ad ±1.202 (-27.18%)	13.000abc ±0.577 (-53.57%)	3.800ab ±0.259 (-60.63%)	1.520a ±0.160 (-58.61%)
5.	100	70.667a ±1.333 (-23.19%)	37.333abcd ±0.333 (-42.57%)	10.333abc ±0.333 (-63.10%)	2.756ab ±0.503 (-71.45%)	0.928a ±0.124 (-74.73%)

All values are means of triplicates ±S.E. Identical superscripts on values denote significant difference ($p<0.05$) between means of different treatments according to Duncan's multiple range test. The values given in the bracket shows percent increase or decrease as compared to control.

Table 2. Effect of different concentrations of Textile industry effluent on pigment contents of Wheat (*Triticum aestivum* L.) plants.

S.No.	Effluent concentration (%)	Chlorophyll a (mg/g FW)	Chlorophyll b (mg/g FW)	Total chlorophyll (mg/g FW)	Carotenoid (mg/g FW)
1.	Control	2.086^{a} ±0.010	1.361^{a} ±0.074	3.447^{a} ±0.067	1.549^{a} ±0.030

2.	25	2.082[b] ±0.004 (-0.19%)	1.156[ab] ±0.017 (-15.06%)	3.253[ab] ±0.029 (-5.63%)	1.447[ab] ±0.000 (-6.59%)
3.	50	2.033[bc] ±0.029 (-2.54%)	1.001[abc] ±0.004 (-26.45%)	3.033[abc] ±0.032 (-12.01%)	1.303[abc] ±0.012 (-15.88%)
4.	75	2.016[abd] ±0.061 (-3.36%)	0.494[abcd] ±0.001 (-63.70%)	2.514[abcd] ±0.015 (-27.07%)	1.184[abcd] ±0.002 (-23.56%)
5.	100	1.926[abcd] ±0.005 (-7.67%)	0.384[abcd] ±0.005 (-71.79%)	2.310[abcd] ±0.010 (-32.99%)	1.016[abcd] ±0.003 (-34.41%)

All values are means of triplicates ±S.E. Identical superscripts on values denote significant difference ($p<0.05$) between means of different treatments according to Duncan's multiple range test. The values given in the bracket shows the percent increase or decrease as compared to control.

Table 3. Effect of different concentrations of Textile industry effluent on the concentrations of sugar and protein of Wheat (*Triticum aestivum* L.) plants.

S.No.	Effluent concentration (%)	Sugar Concentration (mg/g FW)	Protein Concentration(%FW)
1.	Control	2.083[a] ±0.017	2.221[a] ±0.210
2.	25	2.000[b] ±0.100 (-3.99%)	1.983[b] ±0.079 (-10.72%)
3.	50	1.817[abc] ±0.017 (-12.77%)	1.588[abc] ±0.080 (-28.50%)
4.	75	1.483[abcd] ±0.017 (-28.81%)	1.158[abc] ±0.032 (-47.86%)
5.	100	1.083[abcd] ±0.017 (-48.01%)	0.992[abc] ±0.040 (-55.34%)

All values are means of triplicates ±S.E. Identical superscripts on values denote significant difference ($p<0.05$) between means of different treatments according to Duncan's multiple range test. The values given in the bracket shows percent increase or decrease as compared to control.

Table 4. Effect of different concentrations of Textile industry effluent on the activity of different enzymes in wheat (*Triticum aestivum* L.) plants.

S.No.	Effluent concentration (%)	Catalase activity (μ moles H_2O_2 decomposed/min/mg Protein)	Peroxidase activity(ΔOD/mg protein)	Amylase activity(starch hydrolyzed in mg/gm FW)
1.	Control	100.27^{abcd} ±9.238	1.245^{abcd} ±0.128	2.667^{a} ±0.176
2.	25	123.137^{ad} ±7.171 (+22.81%)	1.435^{abcd} ±0.044 (+15.26%)	1.933^{a} ±0.133 (-27.52%)
3.	50	128.383^{ac} ±5.696 (+28.04%)	1.912^{abc} ±0.130 (+53.57%)	1.800^{ac} ±0.115 (-32.51%)
4.	75	138.343^{b} ±4.584 (+37.97%)	2.798^{ab} ±0.184 (+124.74%)	1.333^{ab} ±0.176 (-50.02%)
5.	100	156.590^{a} ±3.907 (+56.17%)	3.571^{a} ±0.144 (+186.83%)	1.133^{abc} ±0.133 (-57.52%)

All values are means of triplicates ±S.E. Identical superscripts on values denote significant difference ($p<0.05$) between means of different treatments according to Duncan's multiple range test. The values given in the bracket shows percent increase or decrease as compared to control.

Table 5. Chemical properties of Textile industry effluent irrigated soils after harvesting of wheat (*Triticum aestivum* L.) plants.

S.No.	Effluent concentration(%)	pH (1:2 soil water)	Calcium carbonate(%)	Organic carbon(%)
1.	Control	7.100^{abcd} ±0.058	3.083 ±0.083	0.412^{abcd} ±0.008
2.	25	7.400^{abd} ±0.058 (+4.23%)	3.000^{NS} ±0.144 (-2.69%)	0.568^{abd} ±0.038 (+37.86%)
3.	50	7.467^{abc} ±0.033 (+5.17%)	3.417^{NS} ±0.083 (+10.83%)	0.617^{abc} ±0.043 (+49.76%)
4.	75	7.700^{b}	3.500^{NS}	0.749^{b}

		±0.058 (+8.45%)	±0.250 (+13.53%)	±0.022 (+81.80%)
5.	100	7.833^{a} ±0.088 (+10.32%)	3.333^{NS} ±0.083 (+8.11%)	0.766^{a} ±0.038 (+85.92%)

All values are means of triplicates ±S.E. Identical superscripts on values denote significant difference ($p<0.05$) between means of different treatments according to Duncan's multiple range test. NS=non significant. The values given in the bracket shows percent increase or decrease as compared to control.

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