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Influence of Textile Industry Effluent on Seed Germination, Growth and Metabolism of Barley (*Hordeum vulgare* L.) Plants

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Abstract: The current study was conducted to determine the response of textile industry effluent on growth and metabolism of barley (*Hordeum vulgare* L.) plants. It was observed that germination percentage was found to be decreased at increasing concentrations of textile industry effluent. Plant growth, yield , photosynthetic pigments, sugar and protein concentrations and amylase activity were negatively affected with increase in effluent concentrations. Result showed that chlorophyll a was significantly stimulated at lower concentration of effluent in barley plants. Catalase and peroxidase enzymes showed significant stimulatory effects at increasing concentrations of effluent.

Keywords: Textile Industry Effluent, Barley (*Hordeum vulgare* L.), Growth, Pigments, Sugar, Protein, Peroxidase (POD), Catalase(CAT), and Amylase.

Introduction

With the rapid industrial development taking place around us, we have bagun to pose a greater threat to nature with every coming day. The process is in practice since decades but we are constantly forgetting that these years of environment degradation have inflicted a great amount of damage to our nature. With the industrial effluents being directly discharged in to the water bodies and the dangerous toxic wastes being dumped in to land pits, without keeping in view the safety standards that one shall follow, the pollution level, both in land and in water, has increased significantly. This pollution is growing at such an alarming rate, that not only the land and water bodies around industrial areas are affected but the ones situated at far off places are bearing the hazardous consequences. This includes the decline in the flora and fauna and also the degradation of the quality of soil.

This fact in view this study was carried out to investigate the harmful effects of textile effluent on the growth and metabolism of Barley plants.

Materials and Methods

Short term experiments were carried out by using petridishes culture. All petridishes were properly washed with detergents and then tap water washing followed by hydrochloric acid (HCl) washing and finally washed with deionised and glass distilled water. The various concentrations of treated effluents (25, 50, 75 and 100%) and control (glass distilled water) were taken for the study in triplicate. High quality of whatman filter paper was used in each petridish. Twenty five seeds were placed on filter paper in each petridish and then soaked with controlled solution and solution of various concentrations of effluents in the temperature range of 20 to 30^{o}c. The germinating seeds and seedlings were washed with distilled water every alternate day for the prevention of contaminants and fresh solutions were applied for the maintenance of effluent concentration. Solutions of respective effluents were superimposed on the basal solutions. For germination studies, the number of seeds germinated was noted and accordingly the germination percentage was calculated. Growth of the plants were recorded after two weeks of growth. Plants were harvested for fresh and dry matter yield. The basal nutrient solution was prepared by the method of Hewitt (1966). Chlorophyll, Protein and Sugar concentration were measured by the method of Petering et al (1940), Lowry et al, (1951) and Dubias et al (1956) respectively. Activities of enzymes catalase and peroxidase were measured by the modified method of Bisht (1972) and modified method of Luck (1963) respectively. Amylase activity was assayed by the method of Katsuni and Frekuhara (1969).

Results and Discussion

Germination Percentage: Germination percentage was found to be decreased at increasing concentration of effluent. Germination in control was 96.00 and it decreased to 82.67, 74.67, 73.33 and 69.33% respectively (Table-1).

Plants Growth: The effect of different concentration of textile industry effluent was observed on growth and yield of barley plants. The result showed that the shoot and root length was significantly decreased at increasing concentration of effluent. Reduction of shoot length were of 10.17,13.56,18.65 and 28.81% while that of root length were of 5.00,8.33,13.33 and 21.67% at 25,50,75 and 100% concentration respectively than the control. Total fresh weight was significantly decreased at increasing concentration of effluent and total dry weight was found to non significantly increased at 25% concentration of effluent while a decrease was observed at 50, 75 and 100% concentration of effluent (Table-1).According to Dhanan (2009), reduction in seed germination and seedling growth may also be due to osmotic pressure caused due to high concentration of nutrients . Kannan and Upreti (2008) reported that under a condition of environmental stress, an adverse effect can be observed on the energy forming molecules and later on the carbohydrate and protein metabolites of the membrane get adversely disturbed; which may lead to reduction in absorption of water by the seeds and seedlings. Vizayakumari (2003) reported that reduction in various growth parameters of soyabean in various concentrations of textile dying effluents.

Metabolic activities

Chlorophyll: Chlorophyll a was found to be stimulated at 25% concentration of effluent. It was 2.25% increase as compared to control while 50 to 100% concentration of effluent progressively caused a significant decrease . Different concentration of effluent significantly reduced the level of photosynthetic pigments (chlorophyll b,

total chlorophyll and carotenoids (Table-2).Reduction in pigments causes deficiency in light harvesting capacity and eventually reduces the photosynthetic activity of the cells (Ouzounidou,1996; Srivastava et al;2005). There are also stimulatory effect on photosynthetic pigments at lower concentration of industrial effluent. Similar findings have been reported (Karunyal et al.,1993; Orhue et al.,2005b; Osaigbovo and Orhue,2006.,Oladele et al .2011). Enhancement of pigment could be due to high nutrient uptake synthesis and translocation possibly facilitated by optimum availability of iron and magnesium (Nagda et al.2006).

Sugar: Sugar concentration was significantly decreased at increasing concentration of effluent . It was 10.13, 17.39, 19.57 and 55.09% decrease at 25,50, 75 and 100% effluent treatment respectively than the control (Table-3). According to Rauser, (1978), reduction may be due to the heavy metal toxicity that may inhibit the membrane transport system mechanism which transports sugar to the phloem.

Protein: Protein concentration was found to be significantly decreased at increasing doses of effluent. It was 12.08, 35.40, 37.92 and 47.48% decrease at 25, 50, 75 and 100% concentration respectively than the control (Table-3). A decrease in protein content may be due to the breakdown of soluble protein or due to the increased activity of protease or other catabolic enzymes which might have activated and destroyed the protein (Singh et al.,2005).

Enzyme activity

Catalase: The catalase activity was significantly increased at increasing concentration of effluent. It was 10.00, 40.69, 30.09 and 6.30% increase at 25, 50, 75 and 100% concentration respectively than the control. The maximum increase was observed at 50% concentration of effluent which was 40.69% as compared to control (Table-4). Enhanced activity of catalase at higher concentrations seeing that detoxifying enzyme and mechanism of tolerance (Sims and Bowel,1980).

Peroxidase: The peroxidase activity was found to be significantly increased. It was of 1.73, 44.43, 62.01 and 95.02% increase at 25, 50, 75 and 100% concentration respectively than the control. The maximum increase was observed at higher concentration of effluent (Table-4). Enhancement of peroxidase may be due to the effluents having large amounts of various cations and anions (Behera and Mishra,1982).

Amylase: Results indicated that the activity of amylase was significantly decreased at increasing concentration of effluent. It was of 38.11, 47.61, 66.68 and 76.18% decrease at 25, 50, 75 and 100% concentration respectively than the control (Table-4). Heavy metals can also cause a reduction in the hydrolysis products expressly -amylase and protein and these heavy metals can also interfere in the enzyme action by replacing metal ions from the metaloenzymes and inhibit different physiological processes of plants (Agarwal,1999)

Table 1. Effect of different concentrations of Textile industry effluent on germination percentage, growth and biomass yield of barley (*Hordeum vulgare* L.) plants

S.No.	Effluent Concentration(%)	Germination (%)	Shoot Length(cm)	Root Length(cm)	Total Fresh Weight (g)	Total Dry Weight(g)
1.	Control	96.000^{a} ±2.309	19.667^{a} ±0.882	10.00^{a} ±0.577	0.208^{a} ±0.026	0.013 ±0.002
2.	25	82.667^{ab} ±2.667 (-13.89%)	17.667^{ab} ±0.333 (-10.17%)	9.500^{b} ±0.289 (-5.00%)	0.202^{b} ±0.024 (-2.89%)	0.015^{NS} ±0.005 (+12.78%)
3.	50	74.667^{ab} ±1.333 (-22.22%)	17.000^{ac} ±0.577 (-13.56%)	9.167^{c} ±0.167 (-8.33%)	0.177^{c} ±0.021 (-14.90%)	0.008^{NS} ±0.002 (-37.37%)
4.	75	73.333^{ab} ±1.333 (-23.61%)	16.000^{ad} ±0.577 (-18.65%)	8.667 ±0.167 (-13.33%)	0.118^{ab} ±0.012 (-43.27%)	0.008^{NS} ±0.002 (-37.37%)
5.	100	69.333^{ab} ±3.528 (-27.78%)	14.000^{abcd} ±0.577 (-28.81%)	7.833^{abc} ±0.167 (-21.67%)	0.092^{abc} ±0.008 (-55.91%)	0.008^{NS} ±0.002 (-37.37%)

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 the percent increase or decrease as compared to control.

Table 2. Effect of different concentrations of Textile industry effluent on pigment contents of barley (*Hordeum vulgare* 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	0.490^{b} ±0.008	0.226^{a} ±0.006	0.716^{a} ±0.013	0.558^{a} ±0.006
2.	25	0.501^{a} ±0.010 (+2.25%)	0.182^{ab} ±0.008 (-19.47%)	0.683^{b} ±0.018 (-4.61%)	0.439^{ab} ±0.011 (-21.33%)
3.	50	0.411^{abc} ±0.015 (-16.12%)	0.175^{ac} ±0.007 (-22.57%)	0.590^{abc} ±0.014 (-17.60%)	0.380^{abc} ±0.003 (-31.90%)
4.	75	0.285^{abcd} ±0.008	0.121^{abc} ±0.011	0.407^{abcd} ±0.009 (-43.16%)	0.297^{abcd} ±0.004 (-46.77%)

		(-41.84%)	(-46.46%)		
5.	100	0.233^{abcd} ±0.006 (-52.45%	0.112^{abc} ±0.019 (-50.44%)	0.345^{abcd} ±0.024 (-51.82%)	0.244^{abcd} ±0.010 (-56.27%)

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 barley (*Hordeum vulgare* L.)plants.

S.No.	Effluent concentration (%)	Sugar Concentration (mg/g FW)	Protein Concentration(%FW)
1.	Control	2.300^{a} ±0.076	1.904^{a} ±0.000
2.	25	2.067^{ab} ±0.088 (-10.13%)	1.674^{ab} ±0.008 (-12.08%)
3.	50	1.900^{ac} ±0.058 (-17.39%)	1.230^{abc} ±0.079 (-35.40%)
4.	75	1.850^{ad} ±0.029 (-19.57%)	1.182^{abd} ±0.062 (-37.92%)
5.	100	1.033^{abcd} ±0.017 (-55.09%)	1.000^{abcd} ±0.036 (-47.48%)

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 4. Effect of different concentrations of Textile industry effluent on the activity of different enzymes in barley (*Hordeum vulgare* 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	53.397^{ab}	1.445^{abc}	2.800^{a}

		±0.877	±0.009	±0.231
2.	25	58.737^{ab} ±0.893 (+10.00%)	1.470^{abc} ±0.018 (+1.73%)	1.733^{a} ±0.133 (-38.11%)
3.	50	75.123^{a} ±4.588 (+40.69%)	2.087^{ac} ±0.161 (+44.43%)	1.467^{ac} ±0.267 (-47.61%)
4.	75	69.463^{b} ±3.723 (+30.09%)	2.341^{ab} ±0.134 (+62.01%)	0.933^{ab} ±0.133 (-66.68%)
5.	100	56.760^{ab} ±3.426 (+6.30%)	2.818^{a} ±0.098 (+95.02%)	0.667^{abc} ±0.133 (-76.18%)

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.

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