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Impact of Fertilizer Industry Effluent on Germination, Growth and Metabolism of Maize (*Zea mays L.*) Plants

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ABSTRACT

The effect of different concentrations (25, 50, 75 and 100 %) of fertilizer effluent was observed on seed germination, plant growth and metabolism of maize plants. Based on the outcomes of the current study, it can be concluded that germination, growth, yield, chlorophyll pigments, sugar and protein concentrations was decreased with increasing concentrations of effluent. Catalase enzyme showed variable results while activity of other enzyme peroxidase showed enhancement . A significant stimulation in amylase activity was observed at lower concentration of effluent, Chemical properties of soil analysis showed increase in pH and organic carbon while calcium carbonate % showed variable results with increasing concentrations of effluent as compared to control.

Keywords : Fertilizer Industry Effluent, Maize, Growth, Pigments, Sugar, Protein, Catalase, Peroxidase, Amylase and soil chemical changes

I. INTRODUCTION

Since many years it has been observed that the industrial wastes are being discharged to various places like on land, water bodies. And the affect has lead to degradation of the environment as with the growing population and development, the waste disposal has increased that has led to disastrous consequences. It has also been observed that during a period of time due to the discharge of such harmful effluents, it is leading to toxicity and is harming the water resources even if the discharge contains some harmless nutrients but the content also has some dangerous organic and inorganic compounds that are leading to various issues. This fact in view this study was carried out to investigate the harmful effects of this effluent on the growth and metabolism of maize plants.

II. MATERIALS AND METHODS

Experiment was carried out in soil as pot culture under controlled glass house conditions. 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 glass distilled water was used for all metabolic and analytical work. The basal nutrient solution was prepared by method given by Hewitt (1966).When plants were raised basal nutrition solution were supplied. The plants were treated with different concentrations (25, 50, 75 and 100%) of effluent on alternate days. Growth of Maize plants subjected to different doses of fertilizer industry effluents were measured in terms of germination (%), shoot and root lengths (in cms), total fresh and dry weights (in gms).Activities of enzymes catalase and peroxidase was assayed by the modified methods of Bisht (1972) and Luck (1963) respectively. Chlorophyll, total sugars, proteins were measured by the methods of Petering et al.(1940), Dubias et al.(1956) and Lowry et al.(1951) respectively. Amylase activity was assayed by the method of Katsuni and Frekuhara (1969). Soil pH was determined in 1:2 soil water ratio (Jackson,1973). 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

Germination Percentage: The results indicate that the increasing concentration of effluent decreased the germination percentage of maize. Germination in control was 94.67 and it was decreased to 89.33, 80.00, 77.33 and 72.00% respectively (Table-1). Reduction in germination percentage may be due to the high osmotic pressure caused by effluent that apprehended high amount of salt content. Adriano et al., (1973) reported that, the salt content outside the seed is known to act as limiting factor and it might be responsible for delay in germination. The other possible reason is may be due to the inhibition of enzyme activity (Agarwal et al.1996).

Plants Growth: Plants growth in terms of shoot and root length was found to be decreased with increasing concentration of effluent in plants. Shoot length percentage was reduced to 13.55,24.10,31.33 and 41.57% and a percentage decrease in root length were at the rate of 11.11,17.59,19.44 and 23.15 at 25,50,75 and 100% concentration respectively than the control. The acquisition of plants biomass characteristics was detected and the results indicate a non significant loss in total fresh and dry weights was there (Table-1). Higher concentrations of effluent decreases enzyme dehydrogenase activity that is reasoned as one of the biochemical change which may have interrupted germination and seedling growth (Ahmed et al. 2006).

Metabolic activities

Chlorophyll: Chlorophyll a, chlorophyll b, total chlorophyll and carotenoids was found to be gradually decreased at increasing concentration of effluent (Table-2). Reduction in pigments causes deficiency in light harvesting capacity and accordingly decreased photosynthetic activity of the cells (Ouzounidou,1996; Srivastava et al.,2005). According to Nagajyoti et al. (2008) various abiotic stresses decrease the chlorophyll content in plants.

Sugar : Sugar concentration was significantly decreased at increasing concentration of effluent. It was 22.73, 36.36, 39.40 and 42.94% decrease at 25, 50, 75, and 100% concentration respectively than the control (Table-3). Manonmani et al.(1992) reported that it may be due to the deranged sugar metabolism

and poor translocation of starch and other metabolites to the growing axis and other possibility of reduction may be due to the heavy metal toxicity that may restrain the membrane transport system mechanism, which transport sugar to the phloem (Rauser, 1978).

Protein: Protein concentration was found to be significantly decreased at increasing concentration of effluent. It was 3.90, 34.61, 40.38 and 50.02 % decrease at 25, 50, 75 and 100% concentration respectively than the control (Table-3). Palma et al.(2002) reported that decrease in protein concentration may be caused by enhanced protein degradation process and therefore increased protease activity under stress conditions. According to Ericson and Alfinito (1984) abiotic stress may inhibit synthesis of some proteins.

Enzymes activity

Catalase: At lower concentration catalase activity was found to be non significantly decreased while there was an increase at 50, 75 and 100% concentration of effluent (Table-4). The antioxidant enzyme, catalase play an important role in the defence mechanism of plants (Khan and Patra,2007).The results indicated that enhanced activity of catalase as detoxifying enzyme and the induction of mechanism of tolerance (Sims and Bowel, 1980).

Peroxidase : The peroxidase activity was found to be significantly increased. It was 7.68, 87.90, 129.07 and 162.37% increase at 25, 50, 75 and 100% concentration respectively than the control. The maximum increase was observed at higher concentration i.e. 162.37% as compared to control (Table -4). Gabara et al.(2003) reported that peroxidases are the most important part of the multiple plant defence system and are mostly synthesized in the chloroplasts. In a stress conditions, enhanced peroxidase activity in the intercellular spaces can possibly lead to reduction of cell growth, stimulating cell wall stiffening (Aki et al .2009). According to Sinha et al. (2008) peroxidase induction is a general response of higher plants to the uptaking of toxic metals in roots and leaves of various species.

Amylase: Activity of amylase in maize plants was stimulated at lower concentration of effluent and inhibited at its higher concentration, the result showed that enzyme activity was significantly increased at 25% concentration and significantly decreased at 50,75 and 100% concentration of effluent . The maximum increase was observed at 25% concentration of effluent and it was increased at 3.81% as compared to control (Table-4) the results coincide with Divyapriya et al. (2014), Sang Wans et al. (1997). According to Sheoran (1980) increased amylase activity is due to increased chloride concentration.

Soil Chemical Changes: Soil analysis showed that values of pH was found to be significantly increased. Calcium carbonate % showed variable results with increasing concentrations of effluent . It was found to be non- significantly increased while maximum increase was observed at 50% concentration of effluent. Organic carbon % showed non-significant increase at increasing concentrations of effluent (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). Calcium carbonate % showed variable results with increasing concentration of effluent as compared to control. Similar results of increased soil CaC03 was reported by Ajmal and Khan,1983. The organic carbon in the soil irrigated with effluent was found to be higher than the soil irrigated with unpolluted water. It might be due to the high organic nature of the effluent (Ale et al.2008). The increased organic carbon was also a result of high total solid present in the effluent (Osaigbvoo and Orhue,2006)

Table 1. Effect of different concentrations of Fertilizer industry effluent on germination percentage, growth and biomass yield of maize (*Zea mays* L.) plants.

S. No.	Effluent Concentration (%)	Germination (%)	Shoot Length(cm)	Root Length(cm)	Total fresh weight (g)	Total dry weight(g)
1.	Control	94.667^{a} ±1.333	110.667^{a} ±3.844	36.000^{a} ±3.055	49.180 ±8.421	14.187 ±2.163
2.	25	89.333^{ab} ±2.667 (-5.64%)	95.667^{ab} ±0.667 (-13.55%)	34.333^{b} ±0.882 (-11.11%)	47.222^{NS} ±2.958 (-3.98%)	13.660^{NS} ±0.912 (-3.72%)
3.	50	80.000^{abc} ±0.000 (-15.49%)	84.000^{abc} ±1.155 (-24.10%)	29.667^{ab} ±0.333 (-17.59%)	40.782^{NS} ±5.045 (-17.08%)	11.517^{NS} ±1.663 (-18.82%)
4.	75	77.333^{abd} ±1.333 (-18.31%)	76.000^{abcd} ±0.577 (-31.33%)	29.000^{a} ±0.577 (-19.44%)	37.821^{NS} ±7.782 (-23.10%)	11.839^{NS}± 1.789 (-16.55%)
5.	100	72.000^{abcd} ±0.000 (-23.94%)	64.667^{abcd} ±2.603 (-41.57%)	27.667^{ab} ±0.333 (-23.15%)	32.920^{NS} ±2.000 (-33.06%)	8.638^{NS} ±0.502 (-39.11%)

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 Fertilizer industry effluent on pigment contents of maize (*Zea mays* 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	2.158^{a} ±0.030	1.167^{a} ±0.010	3.325^{a} ±0.040	1.060^{a} ±0.009
2.	25	2.082^{ab} ±0.024 (-5.24%)	1.096^{ac} ±0.009 (-6.08%)	3.178^{ab} ±0.025 (-4.42%)	1.000^{ab} ±0.007 (-5.66%)
3.	50	1.962^{abc} ±0.017 (-9.08%)	1.126^{b} ±0.017 (-3.51%)	3.087^{ac} ±0.024 (-7.16%)	0.972^{ac} ±0.004 (-8.30%)
4.	75	1.771^{abcd} ±0.026	1.013^{abcd} ±0.002	2.784^{abcd} ±0.024	0.916^{abcd} ±0.004

		(-17.93%)	(-13.20%)	(-16.27%)	(-13.59%)
5.	100	1.520^{abcd} ±0.013 (-29.56%	0.877^{abcd} ±0.025 (-24.85%)	2.397^{abcd} ±0.038 (-27.91%)	0.845^{abcd} ±0.017 (-20.28%)

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 Fertilizer industry effluent on the concentrations of sugar and protein of maize (Zea mays L.)plants.

S.No.	Effluent concentration (%)	Sugar Concentration (mg/g FW)	Protein Concentration(%FW)
1.	Control	3.300^{a} ±0.029	2.063^{a} ±0.079
2.	25	2.550^{ab} ±0.104 (-22.73%)	1.983^{b} ±0.079 (-3.90%)
3.	50	2.100^{ab} ±0.058 (-36.36%)	1.349^{abc} ±0.079 (-34.61%)
4.	75	2.000^{ab} ±0.076 (-39.40%)	1.230^{ab} ±0.040 (-40.38%)
5.	100	1.883^{ab} ±0.044 (-42.94%)	1.031^{abc} ±0.079 (-50.02%)

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 Fertilizer industry effluent on the activity of different enzymes in maize (*Zea mays* 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	30.733 ±1.403	2.057^{abc} ±0.075	1.667^{b} ±0.067
2.	25	29.060^{NS}	2.215^{abc}	1.733^{a}

		±2.544 (-5.44%)	±0.101 (+7.68%)	±0.067 (+3.81%)
3.	50	32.210^{NS} ±0.700 (+4.81%)	3.865^{ac} ±0.207 (+87.90%)	1.000^{abc} ±0.000 (-40.01%)
4.	75	34.663^{NS} ±1.053 (+12.79%)	4.284^{ab} ±0.065 (+129.07%)	0.800^{abc} ±0.000 (-52.01%)
5.	100	36.067^{NS} ±3.657 (+17.36%)	5.397^{a} ±0.480 (+162.37%)	0.733^{abc} ±0.067 (-56.03%)

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 5. Chemical properties of Fertilizer industry effluent irrigated soils after harvesting of maize (*Zea mays* L.) Plants.

S.No.	Effluent concentration(%)	pH (1:2 soil water)	Calcium carbonate(%)	Organic carbon(%)
1.	Control	7.133^{abc} ±0.033	0.833 ±0.083	1.342 ±0.051
2.	25	7.267^{ab} ±0.033 (+1.88%)	0.917^{NS} ±0.167 (+10.08%)	1.350^{NS} ±0.052 (+0.60%)
3.	50	7.367^{c} ±0.033 (+3.28%)	1.333^{NS} ±0.083 (+60.02%)	1.375^{NS} ±0.052 (+2.46%)
4.	75	7.500^{b} ±0.058 (+5.15%)	1.167^{NS} ±0.220 (+40.10%)	1.400^{NS} ±0.029 (+4.32%)
5.	100	7.533^{a} ±0.067 (+5.61%)	1.083^{NS} ±0.083 (+30.01%)	1.425^{NS} ±0.038 (+6.19%)

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.

IV. REFERENCES

[1]. Adraino, D.C., Chang,A.C. Pratt, P.E. and Sharpless, R. 1973. Effect of soil application of dairy manure on germination and emergence of some selected crops. J. Environ. Qual., 3: 396-399.

[2]. Agarwal, S.K,,T.Swarnlata and P.S.Dubey (1996).Sources of water pollution in biodiversity and Environment APH-Publishing Corporation, New Delhi,Vol:3(7)PP No:180-182.

[3]. Ahmad, P.,Sharma, S.,Srivastava, P.S. (2006).Differential physio-bio-chemical responses of high yielding varieties of Mulberry (*Morus alba*) under alkalinity (Na_2CO3) stress in vitro. Physiol.Mol.Biol.Plants.12:59-66.

[4]. Ajmal,M and Khan,A.U.(1983).Effects of Sugar Factory Effluent on soil and crop plants.Environ.Pollu.Sev.A.30;135-141.

[5]. Aki,C.,Guneysu,E., and Acar,O. (2009).Effect of industrial wastewater on total protein and the peroxidase activity in plants. Afr.J.Biotechnol,Vol. 8(20),PP.5445-5448.

[6]. Ale,R.,Jha,P.K.and Belbase, N.(2008).Effects of distillery effluent on some agricultural crops: A case of environmental injustice to local farmers in khajura VDC, Banke- Scientific World 6:6.

[7]. Bisht,S.S.(1972). Effects of heavy metals on the plant metabolism. Ph.D.Thesis, University of Lucknow, Lucknow India.

[8]. Dhevagi,P.and Oblisami,G.(2006).Effect of paper mill effluent on soil microflora of maize.Indian Journal of Environmental Science (In Press).

[9]. Divyapriya, S.,Dimi, Divakaran., Deepthi, K.P.(2014) Biochemical effect of industrial effluence on germinating seeds of cicer arientum. Int J Pharm Pharma sciences. Vol:6(2) PP NO :538-542.

[10]. Dubias, M.K.A.,Hamilton, J.K.,Rebos, P.A. and Smith,F.(1956). Colorimetric Dubias method for determination of sugar and related substances. Anal.Chem.28:350-356.

[11]. Ericson,M.C.and Alfinito, A.E.(1984).Proteins produced during salt stress in tobacco cell cultures. Plant Physiol.74:506-9 cross ref.

[12]. Gabra B, Sklodowska M, Wyrwicka A, Glinska S, Gapinska M (2003). Changes in the ultrastructure of chloroplasts and mitochondria and antioxidant enzyme activity in *Lycopersicon esculentum* Mill, leaves sprayed with acid rain, Plant Sci:164(4):507-516.

[13]. Hewitt,E.J.(1966).Sand and water culture method used in the study plant nutrition (2nd ed).Tech.Communication No.22 Common wealth bureau of horticulture and plantation crops.The Eastern Press

[14]. Jackson,M.L.(1973).Soil chemical analysis. Prentice-Hall of India Pvt. Ltd., New Delhi.

[15]. Katsuni and Frekuhara,M.(1969).The activity of amylase in shoot and its relation to Gb induced elongation.Physiol.Plant.22:68-75.

[16]. Khan,M.H.and H.K. Patra.(2007).Sodium chloride and cadmium induced oxidative stress and antioxidant reponses in *calamus tenuis* leaves.Ind.J.Plant Physiol.12:34-40.

[17]. Lowry,O.H.Rosenbrough,N.J.Farr,A.L.and Randal,R.J. (1951).Protein measurement with folin phenol reagent.J.Biol .Chem.193:265.

[18]. Luck,H.(1963).Peroxidase.In:Methhod for enzymatic analysis.Hv Bergmayer (ed).Academic Press Inc., New York,pp 895-897.

[19]. Manonmani,K.,Muerugeswaran,P.and Swaminathan,K.J.(1992).J.Ecobiol.4:99.

[20]. Nagajyoti,P.S Dinakar;N.Prasad,T.N.V.K.V,Suresh.C and Damodharan, (2008).Heavy metal toxicity: Industrial effluent on groundnut (*arachis hypogea*)seedling. Journal of applied sciences research Vol:4(1)pp No:110-121.

[21]. Osaigbavo,A.U.and Orhue,E.R.(2006).Influence of Pharmaceutical effluent on some soil chemical properties and early growth of maize (*Zea mays* L.)African J.Biotechnol.5(12):1612-1617.

[22]. Ouzounidou,G.(1996). The use of photoaceastic spectroscopy in assessing leaf photosynthesis under Cu stress. Correlation of energy storage to photosystem 11 fluorescence parameters and redox change of P700. Plant Sci.111:229-237.

[23]. Palma,J.M.,Sandalio,L.M., Javier, C.F., Romero,P.M.C., Mccarthy, I., Del Rio, L.A (2002). Plant proteases protein degradation and oxidative stress: role of peroxisomes, Plant Physiol. Biochem.40:521-30 crossref

[24]. Piper,C.S.(1942).Soil and plant analysis Waite Agric.Res.Inst.The Uni.Adelaide,Australia.

[25]. Petering,H.H.,Wolman,K.and Hibbard,R.P.(1940).Determination of chlorophyll and carotene in plant tissue.Ind.Eng.Chem.Annal.12:148-151.

[26]. Rauser,W.E. (1978). Early effects of phytotoxic burdens of cadmium,cobalt,nickel and zinc in white beans. Cana.J.Bot.56:1744-1749.

[27]. Sang Wan .,S, Babbers and Varghere T.M. (1997). Effect of salinity on growth and soluble content. J.Indian .Soc.Soil Science, Vol:3(9) PP.No:402-404. Sheron, F.(1980). Effect of industrial effluents on enzyme activity, J.Environ Qual,Vol:9(3) PP No:512-518.

[28]. Sims J.T. and Bowel F.C.(1980). The influence of organic waste water and inorganic nitrogen source on soil yield and elemental composition of ion, J.Environ.Qual.Vol:9(3) PP No:512-518.

[29]. Sinha, S., Singh,S., Mallick, S.(2008).Comparative growth response of two varieties of (*Vigna radiata* L.)(var.PDM54 and var. NM_1) grown on different tannery sludge applications: effects of treated wastewater and ground water used for irrigation . Environ Geochem. Health, 30:407-422.

[30]. Srivastava,S.,Mishra,S.,Dwivedi,S.,Baghel,V.S.,Verma,S.,Tandon,P.K.,Rai,U.N.,Tripathi,R.D.(2005). Nickel phytoremediation potential of broad bean (*Vicia faba* L.).and its biochemical responses. Bull.Environ.Contam.Toxicol.74:715-724.

[31]. Walkley,A and Black,C.A.(1934). An examination of the Degtejareff method for determining soil organic matter and proposed modification of the chromic acid titration method. Soil Sci.37:29-38.