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EFFECT OF INDUSTRIAL EFFLUENT ON THE MORPHOLOGICAL PARAMETERS AND CHLOROPHYLL CONTENT OF *ARACHIS HYPOGAEA* L.

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ABSTRACT

A pot culture experiment was conducted to study the effect of sugar industry effluent on seed germination, seedling growth and chlorophyll content of *Arachis hypogaea* L. (Variety. Narayani) have been estimated at different effluent concentrations (25%, 50%, 75% and 100%) and day's intervals (10^{th}, 20th and 30^{th} Day). The germination percentage of seed, seedling growth and chlorophyll content showed a gradual decline with increase in effluent concentration. It has been observed that at 25% and 50% effluent concentration, there is growth in the root length, an increase in shoot length and total chlorophyll content up to 20 days. After 20^{th} day there is decline in all the parameters observed. However, at higher concentrations of the effluent, toxic effects were observed from 20th day. This suggests that the effluent can be used safely for *Arachis hypogaea* cultivation, only after proper treatment and dilution.

KEYWORDS: Chlorophyll, Sugar industry, Effluent, Seed germination, Seedling growth, *Arachis hypogeae* L.

INTRODUCTION

Water and soil pollution due to industrialization is a cosmopolitan problem, creating acute insanitation and adverse effects on soil and crops when waste waters are used for irrigation. In recent years, however, there is a revival of activity in direct burning of biomass power products. Sugar industry is one of the most important agro-based industries in India and has significantly contributed to countries economy (Doke et al., 2011, Siva and Suja., 2012; Siddiqui and Waseem., 2012). As India is the largest producer of sugarcane in the world with 550 Sugar mills and 220 million tons cane per year and total Sugar production 13.5 million tons per year. Sugar production processing requires huge water for a number of steps and released almost equal quantity of effluent which contains toxic material (Kaur et al., 2010).

The water resources are most often affected by anthropogenic activities and also from industries. With the exponential increase in the number of industries, there has been a substantial increase in generation of industrial wastewater, which is discharged either into open land or nearby aquatic ecosystems. This activity promotes varying degree of pollution load in water, soil and air (Banupriya and Gowrie. 2012). Most of the waste water discharged into the surrounding water bodies, disturbs the ecological balance and deteriorates the water quality. However, anthropogenic inputs associated with agricultural practices, mineral exploration, industrial processes and solid waste management are important contributors to heavy metal contamination of natural ecosystems (Alumaa et al., 2002; Pandey, 2006). The utility of municipal and industrial waste water for irrigation of crops is well documented (Aziz et al., 1999; Javid et al., 2006; Singh et al., 2006; Nath et al., 2007). Use of industrial effluent and sewage sludge on agricultural lands has become a common practice in India as a result of which these toxic metals can be transferred and get accumulated into plant tissues from soil. Farmers using effluents water for irrigation to reduce water demand have found that plant growth and crop yield were reduced and soil contaminated (Doke KM et al.,2011).

Adnan et al., (2010) reported that the untreated sugar mill effluent is toxic to plants when used for irrigation. In higher concentrations of sugar mill effluent contains high amount of organic and inorganic compounds, it becomes toxic to plants. Similar observations were obtained by several workers (Sundaramoothy et al., 2007; Pandey et al., 2008; Rajendra et al., 2010; Doke et al., 2011). Therefore the present work has been attempted to study the impact of sugar industry effluent on *Arachis hypogeae* L. at different effluent concentrations and duration of exposure to seed germination and seedling growth.

MATERIALS AND METHODS

An effluent sample was collected during March, 2015 (peak hours) from outlets of (sugar industry) from from S.N.J. Sugars And Products Limited, Nelavoy, Chittoor district, Andhra Pradesh. Effluent sample was collected in well cleaned polythene bottle. Before collection each bottle was washed with fresh water. Finally bottle was tightly closed. After filtering, pH, electrical conductivity (EC) of the sample was immediately measured in the laboratory and afterwards the samples were stored at 4^{o}C for physico-chemical analysis of (APHA, 2005). Sandy clay loam soil near industry was collected and used for pot culture. The seeds of green gram were obtained from agriculture college, Tirupati and treated with 0.2 N mercuric chloride for 2 min and washed with running water to remove contamination of seed coat, prior to germination studies (Singh et al., 2006). This experiment carried out with green gram as a test crop using different concentrations of effluent 25, 50, 75, 100% and distilled water which served as control. Each treatment including control, was performed in triplicate and in every pot 20 seeds were used. The number of seeds germinated in each treatment was recorded at 10, 20 and 30 days of the experiment and the germination percentage was calculated. Growth of the root and shoot length were measured with the help of meter scale and chlorophyll content estimated following the method of Arnon (1949) using UVUIS spectrophotometer 117 model. Statistical analysis: Data were expressed as mean ± standard error of mean (SEM).Results were statistically analyzed by student's t-test (Pillai and Sinha, 1968).

RESULTS AND DISCUSSION

The physico-chemical characteristics of effluent are presented in Table 1. The present study sugar industry effluent consist EC, Cr, Pb and Zn values are compared to ISI standards recommended for disposal of effluent on land for not suitable irrigation. The higher EC alter the chelating properties of receiving water systems, which create conditions for free metal availability to flora and fauna (Nanda et al., 1999). The percentage of seed germination on exposure of different concentrations and duration (72 and 96 hr) was recorded in Table 2. The maximum seed germination was recorded at 50% and minimum at 100% of effluent concentrations, as compared to control. At 50% of effluent concentration, increase in root and shoot length is high at 30th day as compared to control, whereas at 100% of effluent concentration decrease in length of root and shoot was recorded at 10, 20 and 30 days. Inhibition of seed germination may be due to high level of dissolved solids, which enrich the salinity and conductivity of the absorbed solute by seed before germination (Gautam et al., 1992; Singh et al., 2006), Murkumar and Chavan (1987) have reported that the higher concentration of effluent decrease enzyme dehydrogenase activity that is considered as one of the biochemical change which may have disrupt germination and seedling growth. Similarly the activities of enzyme acid phosphatase was inhibited by effluent at every stage of seed germination and exhibit a broad range of activity (De Leo and Sacher, 1970) and involved in mobilization of nutrient reserves, may be due to presence of optimum level of nutrients in this effluent concentration. Similar observation was recorded in many researchers (Rajesh et al., 2013; Shalu Malik et al., 2014; vaithiyanathan et al., 2014).

Data of chlorophyll content at different duration of exposure and concentration of effluent represented in Table. At 50% of effluent concentration chlorophyll a,b and total chlorophyll contents increased up to 20th day and decreased from 25th day onwards in green gram. At 100% effluent concentration overall decrease in chlorophyll content was recorded at all intervals as compared to control. Changes in total chlorophyll concentration indicate that the chlorophyll synthesizing capacity of the crop has diminished affecting the overall photosynthetic process. Similar trends and observations have been reported in earlier investigations (Krupa et al., 1993; Gouia et al., 2003). The exposure of lower concentration of effluent to the seedling shows growth promotion, over all development of the seedling and chlorophyll content. Reduction in seed germination percentage at higher concentration of effluent may be due to the higher amount of solids present in the effluent, which causes changes in the osmotic relationship of the seed and water. Thus reduction in the amount of water absorption takes place, which results into retardation of seed germination due to enhance salinity. The salt concentration, out side the seeds known to act as limiting factor and it might be responsible for delay in germination (Adriano et al., 1973).

The other possibility of reduction in germination percentage at higher concentration of effluent may be due to presence of excess amount of ammonia in effluent, causing depletion of the Tricarboxylic acid cycle, which reduces the respiration rate and subsequently germination (Kirkby, 1968). According to Saxena et al. (1986) the low amount of oxygen in dissolved form due to the presence of higher concentration of solid in the effluent reduce the energy supply through anaerobic respiration resulting in restriction of the growth and development of the seedling. The higher concentration of effluent treatment, germinating seeds would get low of oxygen which restricts the energy supply and retards the growth and development of seedling (Hadas, 1976).Subramani et al. (1998) reported a progressive decrease in seedling growth with the increasing concentration of fertilizer factory effluent. Similar finding have been reported by Mishra and Bera (1996) the lower concentration of tannery effluent had a marked growth promoting effect while higher concentration of effluent showed reduction in seed germination, seedling growth and chlorophyll content in some crops.

The inhibition of chlorophyll synthesis probably results from the Cu-induced inhibition of ALA-dehydrates reported by Scarponi and Perucci (1984). Izawa (1997) suggested that the inhibition of chlorophyll may be due to the induced inhibition of electron transport system in PS - II. The significant fall in the chlorophyll content under the higher percentage of effluent concentration might have been due to inhibitory effect of toxicants of effluent on chlorophyll synthesis in exposed plant.

Table 1: Physico-chemical characteristics of sugar industry effluent.

Parameters	Observed Values	Potable and values irrigation water ISI (1983)
Color	Colourless	- -
Odor	Odorless	- -
pH	5.5 ± 0.23	6.5 -8. 5
EC (µ mhoS cm^{-1})	11.5 ± 0.1	1 2.25
Dissolved solids (mg l^{-1})	611 ± 11.79	- -
Suspended solids (mg l^{-1})	651.33 ± 3.28	- -
Biological oxygen demand (mg l^{-1})	53.6 ± 0.28	- -
Chemical oxygen demand (mg l^{-1})	128.66 ± 0.25	- -
Chromium (mg l^{-1})	0.071 ± 0.003	0.05
Copper (mg l^{-1})	0.014 ± 0.002	0.05
Manganese (mg l^{-1})	0.036 ± 0.002	0.1
Lead (mg l^{-1})	0.108 ± 0.002	0.10
Zinc (mg l^{-1})	6.73 ± 0.120	5.0

Values are arithmetic mean ± SEM of three replicates

Table 2: Germination percentage of green gram in control and sugar industry effluent at different time intervals.

Effluent concentration (%)	Exposure periods		
	72 hr	96 hr	Total hr
Control	16.4± 0.927	1.6± 0.927	18.4± 0.244
25	17.4 ± 0.748ns	1.8± 0.509ns	
50	14.2± 0.663ns	1.8± 0.583ns 1	6.0± 0.316***
75	12.4± 0.244**	1.4± 0.509ns	13.8± 0.489**
100	9.6± 0.927***	1.2± 0.374ns	10.8±0.916***

Values are arithmetic mean ± SEM of three replicates, *p<0.01, **p<0.001, ***p<0.0001, ns = non significant

Table 3: Change in chlorophyll a content (mg g-1 f.wt.) of green gram at different time intervals exposed to sugar industry effluent.

Treatment (%)	10 Day	20 Day	30 Day
Control	1.191±0.022	2.59±0.018	1.011±0.014
25	1.275±0.035 ns	2.993±0.033*	0.913±0.023*
50	1.407±0.011**	3.327±0.018**	0.868±0.038**
75	0.924±0.03*	2.196±0.027***	0.567±0.003**
100	0.881±0.024***	2.122±0.036***	0.474±0.006***

Values are arithmetic mean ± SEM of three replicates, *p<0.01, **p<0.001, ***p<0.0001, ns = Non significant.

Table - 3.1: Change in chlorophyll b content (mg g^{-1} f.wt.) of green gram at different time intervals exposed to sugar industry effluent

Treatment (%)	10 Day	20 Day	30 Day
Control	0.758±0.055	0.996±0.051	0.581±0.09
25	0.963±0.051	1.474±0.078**	0.669 ±0.031 ns
50	1.524±0.054ns	2.831±0.022ns	0.225±0.029*
75	0.054±0.022*	0.468±0.034**	0.113±0.003***
100	0.351±0.028**	0.369±0.032*	0.032±0.004**

Values are arithmetic mean ± SEM of three replicates, *p<0.01, **p<0.001, ***p<0.0001, ns = Non significant

Table - 3.2: Change in total chlorophyll content (mg $^{g-1}$ f.wt.) of green gram at different time intervals exposed to sugar industry effluent.

Treatment %	10 days	20 Days	30 days
Control	1.815±0.067	3.567±0.069	1.479±0.054
25	2.239±0.081**	4.467±0.109**	1.882±0.071*
50	2.533±0.039*	5.157±0.031ns	1.095±0.056**
75	1.472=0.03*	2.667±0.061ns	0.681±0.003***
100	1.235=0.053*	2.493±0.066ns	0.503±0.010***

Values are arithmetic mean ± SEM of three replicates, *p<0.01, **p<0.001, ***p<0.0001, ns = Non significant.

CONCLUSION

From the findings of the present analysis, it is evident that the effluent is normally highly toxic to growth of *Arachis hypogeae* L., and has high amount of organic and inorganic compounds which harmful affects to the plant. Higher concentration of effluent have may be toxic elements presented but the lower concentration of effluent have may be required amount of plant nutrients. However, the lower concentration of effluent can be utilized for agricultural irrigation after suitable treatment with appropriate dilution.

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