RESEARCH PAPER *Asian Journal of Bio Science* (April, 2010) Vol. 5 Issue 1 : 46-48

Irrigational impact of dye factory effluent on tissue metabolities concentration in *Vigna radiata* (L.) R. Wilczek

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(Revised : May, 2009;Accepted : December, 2009)

The impact of dye factory effluent on various tissue metabolites concentration was evaluated in pot culture experiment using *Vigna radiata* (L.) R. Wilczek as a test crop. Accumulation of various chemical constituents *viz.*, chlorophyll, protein, soluble carbohydrate, reducing sugar and tissue nutrients such as N,P,K was promoted by dye factory effluent irrigation with the optimum effluent concentration (25%). Irrigation with treated effluent also gave comparable results.

Key words : Dye factory effluent, *Vigna radiata*, Biochemical constituents, Tissue nutrients

INTRODUCTION

Water is the greatest gift of nature and a necessity of mankind. Nature has its own mechanism to regulate and degrade wastes. But when the quantum of wastes exceeds the regulating capacity, the crisis situation emerges. The rapid industrialization has led to the enormous amount of discharge of wastes from industries. Textile dyeing and printing industries require large amount of water and consequently generate an equally large amount of waste water carrying high concentrations of the dyes resulting in the pollution of surface waters and also ground water upon percolation. Besides that, they also cause major loss to crops, vegetables and stored organic materials. Recently, the use of dye factory effluent for growing crops is considered as one of the viable alternative for its disposal (Chidambaram pillai and Shunmugasundaram (2008) but also had adverse effect on plant growth and tissue metabolism.

MATERIALS AND METHODS

The seeds of *Vigna radiata* (L.) R. Wilczek were obtained from TamilNadu Agricultural University, Coimbatore. Healthy and uniform seeds were selected and surface sterilized with 0.1% $HgCl_2$ and washed thoroughly with distilled water. Earthern pots (30cm and 20cm) filled with field soil served as medium to grow the test plant. Then, they were drenched with different concentrations (20, 50, 75 and 100%) of the effluent and left as such for one week. The dilution of effluent was made in distilled water. Sterilized *V.radiata* seeds at the rate of 10 seeds per pot were sown and watered regularly with effluent concentrations. The plants were uprooted on different age level (20, 40, 60 and 80 days) and the biochemical characters were studied Chlorophyll, Yoshida *et al*. (1976); Protein Lowry *et al*. (1951). Total soluble carbohydrate and N, P, K content of plant samples were analysed by classical Kjeldahl's method.

Hence, the present study was designed to investigate the effects of both forms of effluent treatments on plant biochemical constituents.

RESULTS AND DISCUSSION

In the present study, certain biochemical contents of *V. radiata* were quantified with a view to assess the extent of plant injury as a consequence of dye house effluent irrigation. Generally assimilatory pigments *viz.*, chlorophyll 'a' and 'b' are often related to different levels of host tissue samples (Haspel Horvatovie and Harickove, 1974). In the present investigation, treated dyeing effluent significantly enhanced the chlorophyll content in the leaves of *V. radiata* at all the four age levels studied (Table 1). Raw effluent after suitable dilutions (25% and 50% effluent concentrations) also gave comparable results (Table 1). On the, other hand, treatment of plants with undiluted effluent (100%) and 75% concentration registered pronounced decreases indicating various levels of host tissue injury. In similar line of research using dyeing factory effluent Jain and Khan (1996), Gupta and Nathawat (1991) showed decreasing trend in chlorophyll content in the leaves of the test plants with increasing concentrations of the effluent. In a number of short term studies using various other industrial effluents as irrigation water, dilution seems to neutralize their toxic effects and promote chlorophyll content. (Mamte and Nail, 1992) showed similar trend of increase in pigment content at

10% concentration of fertilizer factory effluent on Cyamopsis.

Besides the assimilatory pigments, the other biochemical contents of *V. radiata* viz., soluble protein, and reducing sugar and soluble carbohydrates also registered significant increases under treated as well as diluted effluent irrigation. On the other hand, the undilluted effluent led to decrease accumulation of the said biochemical constituents in the host tissue (Table 1). Similar observations were made by Misra and Behera (1991) in rice seedlings where the accumulation of protein and carbohydrates showed a decreasing trend with increase in effluent concentration and time. Since, the protein and carbohydrate content of a plant is directly related to its growth, the decrease in their amount is indicative of how seriously plant growth is affected by untreated waste water. The studies carried out by Mane and Shitole (1989) irrigation with treated effluent from paper factory effluent stimulated carbohydrates, protein ascorbic acid and organic acid metabolism of methi (*Trigonellafoenum graecum*) and increased the uptake of N, P, K and Na by the plant. Conversely, (Table 1) the raw effluents tendered to decrease the contents of protein and soluble sugars in *Cyamopsis tetragonoloba* (Jain and Khan, 1976) and *Phaseolus aureus* (Rout, 1990).

The nitrogen, phosphorus and potassium contents of plant tissue had definite correlations. The maximum contents of them were generally observed in 25 and 50% untreated effluent concentrations as well as the different growth periods (Table 2). Under normal conditions, it is logical to expect higher accumulation of tissue N, P and K in plants treated with effluents of higher concentrations due to the availability of NO_3 K^+ and PO_4. Similarly, the tissues N concentration in plant crops was found to increase significantly with increasing levels of palm oil mill effluent (Azizah Chulan, 1997). In the present study also, the raw dye effluent and 75% concentration resulted in decreased accumulation of tissue nutrients in *V. radiata*. Similar decreases in tissue N, P and K were noted in *Pisum sativum* irrigated with rubber factory effluent (Sharma and Habib, 1996).

From the foregoing accounts, it is concluded that the industrial effluents in general releasing from dye houses in particular are injurious to plants. This could be reduced by biochemical contents and tissue nutrients in the related effluent concentrations, such as, factories can either recycle the waster water after treatment or after dillution the treated effluent could be used for irrigation.

Table 1 : Effect of various concentrations of dye house effluent on the chlorophyll, protein, carbohydrate contents (µg g^{-1} fresh leaf weight)* protein and carbohydrate (mg g^{-1} leaf dry weight)* of green gram at different growth stages under pot condition

Effluent conc. %	Plant age (days) Chlorophyll 20	40	60	80	Protein 20	40	60	80	Carbohydrate 20	40	60	80
C	1.92 a	2.40 ab	2.00 ab	0.77 ab	61.8 a	70.0 a	49.2 ab	24.8 ab	99.2 a	77.8 c	62.0 ab	32.0 a
25	1.95 a	2.32 ab	2.17 ac	0.78 ab	60.6ab	70.1 a	57.4 ab	23.0 ab	97.0 a	86.2 d	66.0 b	40.2 b
	(+1.6)	(-3.3)	(+ 8.5)	(+1.3)	(0.14)	(+0.14)	(+4.5)	(-7.3)	(-2.2)	(+10.8)	(+6.5)	(+25.6)
50	1.94 a	2.51 a	1.96 c	0.89 ab	51.4 ba	64.0 b	48.2 a	18.2 c	91.6 c	77.6 c	63.2 c	26.4 c
	(+1.0)	(+4.6)	(-2.0)	(+14.7)	(-16.8)	(-8.6)	(-2.0)	(-28.0)	(-7.7)	(-0.26)	(+1.9)	(-17.5)
75	1.81 a	2.35 ab	1.69 c	0.89 ab	48.0 c	63.8 b	48.2 a	17.2 c	90.0 d	70.6 b	50.6 d	26.0 c
	(-5.7)	(-2.1)	(-2.0)	(+14.7)	(+22.3)	(-8.9)	(-2.0)	(-32.6)	(-9.3)	(-9.3)	(-18.4)	(-18.75)
100	1.77 a	1.88 ab	1.51 d	0.62 a	29.0d	63.0 b	41.8 c	30.0 d	88.0 e	62.2 a	41.8 e	22.0 d
	(-7.8)	(-21.7)	(-24.5)	(+19.9)	(-53.0)	(-10.0)	(-15.0)	(47.6)	(-11.3)	(-20.1)	(-32.6)	(-28.1)
Treated	2.01 a	2.59 b	2.16 bc	0.93 b	60.8 ab	71.6 b	53.8 b	21.8 b	104.0 f	86.8 a	67.2 c	41.0 ab
	(+4.7)	(+7.9)	(+8.0)	(+20.2)	(+1.6)	(+2.3)	(+9.3)	(-12.1)	(+4.8)	(+11.6)	(+88.4)	(+21.9)

* Based on five determinations for each treatment.
Values with same superscript in each sampling day in the columns do not differ significantly from each other ($P<0.05$).
Values in parentheses are per cent changes over the respective controls.

Table 2 : Effect of various concentration of dye house effluent on the nitrogen content cmg g^{-1} dry weight of green gram at different growth stages under pot conditions

Eff. conc. %	Plant age (days)											
	Nitrogen				Phosphorous				Potassium			
	20	40	60	80	20	40	60	80	20	40	60	80
C	26.6^{a}	30.5^{c}	34.5^{d}	28.8^{c}	1.02 a	1.48 c	1.18 a	0.95 d	10.1 d	10.6 d	16.5 d	19.39 d
25	27.5^{b}	35.1^{b}	44.2^{a}	30.5^{b}	1.53^{b}	1.43^{d}	1.40^{c}	1.05^{b}	15.1^{a}	14.7^{b}	18.9^{b}	22.8^{b}
	(+3.4)	(+5.1)	(+28.1)	(+5.9)	(+50.0)	(-3.4)	(+18.6)	(+10.5)	(+49.5)	(+38.7)	(+14.5)	(+18.2)
50	27.7^{b}	34.0^{c}	35.2^{c}	26.7^{a}	1.16^{c}	1.68^{b}	1.54^{b}	1.01^{c}	11.6^{c}	12.5^{c}	17.2^{c}	19.6^{c}
	(-3.4)	(+11.5)	(+2.0)	(-7.3)	(+13.7)	(+13.6)	(+30.5)	(+6.0)	(+14.9)	(+17.9)	(+4.2)	(+1.6)
75	22.3^{c}	31.0^{d}	31.6^{c}	24.7^{c}	1.05^{b}	1.39^{c}	1.02^{c}	0.73^{f}	8.6^{e}	9.8^{e}	13.5^{e}	16.2^{f}
	(-16.2)	(+1.6)	(-8.4)	(-14.2)	(+2.9)	(-6.1)	(-13.6)	(-23.1)	(-14.8)	(-7.5)	(-18.1)	(-16.0)
100	21.1^{f}	27.9^{f}	29.0^{f}	22.5^{f}	0.88^{f}	1.29^{f}	0.86^{f}	0.88^{e}	6.7^{f}	8.9^{f}	11.5^{f}	16.5^{e}
	(-20.7)	(-8.5)	(-15.9)	(-21.9)	(-13.7)	(-12.8)	(-27.1)	(-7.5)	(-33.7)	(-16.0)	(-30.3)	(-14.5)
Treated	28.5^{a}	43.7^{a}	35.5^{b}	32.4^{a}	1.55^{a}	1.87^{a}	1.64^{a}	1.14^{a}	14.2^{b}	14.8^{a}	20.8^{a}	24.5^{a}
	(+7.1)	(+43.3)	(+2.9)	(+12.5)	(+51.9)	(+26.4)	(+38.9)	(+20.0)	(+41.4)	(+39.8)	(+26.1)	(+29.0)

* Based on five determinations for each treatment.
Values with same superscript in each sampling day in the columns do not differ significantly from each other ($P<0.05$).
Values in parentheses are per cent changes over the respective controls.

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