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EFFECTS OF QUETTA CITY WASTEWATER ON GROWTH AND DEVELOPMENT OF SPINACH (*SPINACEA OLERACEA* L.)

A. K. K. Achakzai and Z. A. Bazai

Department of Botany, University of Balochistan, Quetta-Pakistan; e-mail:profakk@yahoo.com

ABSTRACT

This study was conducted to assess the effect of 5 concentrations of polluted water of three different localities of Quetta city (viz., Chiltan Ghee Mill, Chiltan Town and Zarghoon Town) on the growth and development of spinach (*Spinacea oleracea* L.). Results showed that number of leaves and biomass contents are significantly ($P < 0.05$) influenced both by source and concentration of applied effluents whereas leaf length and moisture content did not exhibit any significant response. Results also revealed that number of leaves and biomass contents are significantly reduced when provided with the effluents from Chiltan ghee mill and Zarghoon town, respectively. Results also indicated that highest concentration of wastewater (T_5) significantly reduced the number of leaves, whereas reverse was found in case of biomass contents.

Key words: Wastewater, Spinach, Quetta, Growth, Development

INTRODUCTION

The practice of irrigating agriculture land with wastewater for growing vegetables is a common practice. It contains many plant nutrients. The kind and concentration of nutrients depend upon the source. Direct use of untreated waste water is common in most cities which are due to the lack of alternative water sources. About 26% of the domestic vegetables are cultivated with wastewater in Pakistan (Ensink *et al.,* 2004). Quetta is the capital of Balochistan province and one of the largest trade centers in Pakistan. The population explosion, urbanization, persistent drought, the influx of Afghan refugees and industrialization are the factors, which have changed the fresh water channels into the carriers of domestic sewage and the industrial waste. Such changed situation, however, could not influence the local farmers indulged in conventional practice of growing vegetables earlier by fresh water and now by wastewater. Like many other cities of the country, wastewater in Quetta is also directly used for irrigation to raise vegetables, which are considered as a source of organic matter and plant nutrients as well (Ahmad *et al.,* 1994). Wastewater consists of multi-elemental organic wastes that are also used commonly as manures (Otobbang *et al.,* 1997). The use of wastewater not only greatly enhance the microbial populations, wastewater contains trace elements in larger proportions in comparison to tap water. Trace elements entering plant tissue are active in metabolic processes, but also can be stored as inactive compounds in cells and on the membrane. In each case, however, they may interfere with and upset the chemical composition and growth of the plants without causing at times any visible injury to them (Kabata and Pendias, 1984). In view of the fact that sources of pollution are increasing, the challenges for adequate knowledge about elemental toxicities are greatly intensified. Research has revealed that growth of plants is generally reduced at higher concentration of sewage, although it may be promoted at low concentrations. There are examples that chlorophyll concentration decreases at higher concentration of sewage (Chaman, 1991). The present study has mainly aimed to conduct an experiment for determining effects of wastewater on growth and development of *Spinacea oleracea* (L.), a common vegetable grown with wastewater in Quetta.

MATERIALS AND METHODS

The work presented here deals with the effect of 5 different concentrations (treatments) of wastewater collected from three different localities of Quetta (viz., Chiltan town, Chiltan Ghee Mill and Zarghoon town) on growth and development of spinach (*Spinacea oleracea* L.). The treatments (T) were made by dissolving calculated amount of wastewater in tap water i.e., control (background), 25, 50, 75, and 100%. These treatments were then designated by T_1, T_2, T_3, T_4 and T_5, respectively.

Spinach was grown in 45 pots contained well-mixed garden soil. Each treatment was replicated thrice for each locality. Ten (10) healthy, uniform and pretreated seeds of spinach were sown in each pot at 1cm depth at an equal distance with the help of clean policeman. Then the pots were shifted to an open field by arranging them in a Completely Randomized Design (CRD). They were also kept in North-South direction at proper distance so as to avoid any possible external contamination along with the provision of possible uniform light condition. They were

then equally irrigated with respective treatments (T) of wastewater. All recommended cultural practices were followed to maintain a healthy crop growth and development. Finally the plants of each treatment were separately harvested before the initiation of their flowers. The number of leaves on each plant was counted and measured (cm). The biomass of plant material weighed by simple oven dried method. The fresh weight (w_1) of plant noted, and then allowed for their oven dried weight (w_2) after keeping them in an oven at 70 ^{0}C for 24 hours. The plant materials were cooled in desiccator prior to note their oven dry weight. Thereafter, the moisture contents were calculated with the help of formula given below.

$$\text{Moisture content, (\%)} = \text{Fresh } \frac{\text{Weight } (w_1) - \text{Oven Dry Weight } (w_2) \times 100}{\text{Oven Dry Weight } (w_2)}$$

Data obtained were statistically analyzed, following the procedure described by Steel and Torrie (1980). MSTAT-C computer software package was used for the said purpose.

RESULTS AND DISCUSSION

Data presented in Table 1 showed that wastewater collected from different localities (A) and their 5 different concentrations (B) highly-significantly ($P< 0.05$) influenced the leaflet numbers and their biomass contents. The interactions between A x B was also found to be highly-significant only in case of biomass productivity.

There was significant linear decrease in number of leaves with increase in concentration of effluents (Table 2). This is also supported by Chaman (1991), who reported that the growth of a species decreases at higher concentration of sewage but is promoted at low concentrations. However, such an increase is somewhere not regular, which might be due to the nature of effluents (heterogeneous mixture), time of exposure and temperature. Statistically and numerically average number of leaves was the maximum (7.2) in T_2. By comparing the result of localities from where the effluents were collected the number of leaves showed significant difference with respect to the localities - Zarghoon town effluents being less toxic than Chiltan Ghee and Chiltan Town effluents which were more or less equally toxic.

Data regarding mean value of leaf length deciphered that neither localities nor treatments exhibited any significant effect (Table 3). However, numerically the maximum leaf length was recorded for Zarghoon town (10.00 cm) and treatment T_4 (10.50 cm).

Table 1. Analysis of variance (ANOVA) for growth and development of spinach (*Spinacea oleracea* L.) subjected to various level of wastewater collected from different localities of Quetta.

Variables	Sum of square			Mean square			F-value of variables at an error of 28			CV (%)
	Localities (A)	Wastewater levels (B)	A x B	Localities (A)	Sewagewater levels (B)	A x B	(A)	(B)	A x B	
Leaves numbers.	44.764	41.214	12.910	22.382	10.304	1.616	11.510 **	5.298 **	. 0.8299 ns	23
Leaf length, cm.	3.93	16.68	49.872	1.965	4.170	6.234	0.672 ns	1.427 ns	2.1338 ns	18
Moisture contents,	43.942	47.125	128.524	21.971	11.781	16.066	0.678 ns	0.363 ns	0.4959 ns	7
%. Biomass, g.	62.299	92.373	73.791	31.150	23.093	9.224	17.501 **			13

** Highly significant at 5% level of probability, ns = non-significant and CV = coefficient of variation.

Table 2. Effect of five different level of wastewater of Quetta city on the number of leaves of spinach (*Spinacea oleracea* L.).

Wastewater Localities	Wastewater Treatments (T)					Mean
	T_1	T_2	T_3	T_4	T_5	
1) Chiltan Ghee Mill	6.48	5.32	5.23	4.67	4.23	**5.19 B**
2) Chiltan Town	6.28	7.29	6.09	4.50	3.22	**5.48 B**
3) Zarghoon Town	7.12	8.98	8.09	6.70	6.27	**7.44 A**
Mean	**6.63 AB**	**7.20 A**	**6.47 AB**	**5.30 AB**	**4.58 B**	6.031

LSD at $P< 0.05$ and $P < 0.01$ are 2.333 and 2.330, respectively.

Values followed by the same letter(s) within right column (source of waste water) and bottom row (treatments) are not significantly differ with each other at 5% level of probability using LSD test.

Data obtained for moisture contents also revealed that neither localities nor different concentration of effluents reflected any significant effect (Table 4). Similar results are also obtained by Bazai *et al.* (2005). Data regarding the biomass of spinach plant enumerated that both localities and treatments showed significantly positive effects (Table-5). Statistically, maximum biomass content is obtained with Chiltan town effluents (11.60 g) and in T_5 level (12.38 g). Interaction between localities and sewage water treatments are also found to be significant. Similar results are also obtained by Bazai *et al.* (2005).

Table 3. Effect of five different level of wastewater of Quetta city on the leaf length (cm) of spinach (*Spinacea oleracea* L.).

Wastewater Localities	Wastewater Treatments (T)					Mean
	T_1	T_2	T_3	T_4	T_5	
1) Chiltan Ghee Mill	10.86	10.82	9.43	9.21	7.45	**9.554**
2) Chiltan Town	9.81	7.10	8.98	10.13	10.40	**9.284**
3) Zarghoon Town	9.77	8.76	9.04	12.15	10.28	**10.00**
Mean	**10.15**	**8.90**	**9.15**	**10.50**	**9.38**	9.61

LSD at P<0.05 and P < 0.01 are 2.858 and 3.856 respectively.

Table 4. Effect of five different level of wastewater of Quetta city on the moisture contents (%) of spinach (*Spinacea oleracea* L.).

Wastewater Localities	Wastewater Treatments (T)					Mean
	T_1	T_2	T_3	T_4	T_5	
1) Chiltan Ghee Mill	86.54	85.03	84.00	85.00	82.66	**84.65**
2) Chiltan Town	83.52	82.00	81.00	84.33	86.98	**83.57**
3) Zarghoon Town	80.22	86.47	79.66	82.83	81.97	**82.23**
Mean	**83.43**	**84.50**	**81.55**	**84.05**	**83.87**	83.48

LSD at P<0.05 and P < 0.01 are 9.518 and 12.841 respectively.

Table 5. Effect of five different level of wastewater of Quetta city on the biomass (g) of spinach (*Spinacea oleracea* L.)

Wastewater Localities	Wastewater Treatments (T)					Mean
	T_1	T_2	T_3	T_4	T_5	
1) Chiltan Ghee Mill	9.62 CDE	8.72 DE	8.87 DE	10.89 BCD	10.69 BCD	**9.758 AB**
2) Chiltan Town	8.82 DE	7.87 E	12.75 B	11.79 BC	16.74 A	**11.594 A**
3) Zarghoon Town	8.85 DE	7.74 E	8.75 DE	8.72 DE	9.70 CDE	**8.752 B**
Mean	**9.10 BC**	**8.11 C**	**10.12 BC**	**10.47 AB**	**12.38 A**	10.04

LSD at P < 0.05 and P< 0.01, are 2.231 and 3.010 respectively.

Values followed by the same letter(s) within right hand side column (localities) and bottom row (treatments) are not significantly differ with each other at 5% level of probability using LSD test. Similarly values followed by the same letter (s) within column and rows (A x B) in the center of the Table are also not significantly differ with each other at 5% level of probability.

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