RECOVERY IN GROWTH OF *SOLANUM MELONGENA*. L FROM ADVERSE EFFECTS OF WASTEWATER EFFLUENTS

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خلاصہ

تاثرہ پودوں میں آلودہ پانی کے خطرناک اثرات کو کم کرنے کے لئے، ٹرمینلیا بلیپ پتیوں کا استعمال کرتے ہوئے ایک حیاتیاتی اصلاحاتی حکمت عملی تیار کی جاتی ہے. فصلوں کی صحت کی بحالی کے ل ئے سولانم melongena کی حیاتیاتی ہتھیار کے طور پر یہ اثرات کا معائنہ کرنا ہے. T 2 نمونے میں تناسب 50٪ اور 100٪ نمونے یعنی 100٪ انکرن میں تیزی سے تھا، جبکہ 2T (100٪) کا تازہ ترین وزن یعنی 0.049 ± 0.002 گرام اور T 2 (75٪) کا خشک وزن زیادہ تر یعنی 0.034 ± 0.001 گرام تھا. T 1 اور T 2 نمونے دونوں کے اوسط اضافہ سے 6 ہفتوں تک ظاہر ہوتا ہے جب ان کے متعلقہ فضلہ کے پانی کا علاج کیا جاتا ہے. خالی کی درخواست کے بعد، پودوں کی ترقی کو برقرار رکھا گیا تھا اور T 1 اور 2T میں 100 فیصد نمونے میں اوسطا اقدار سے اوپر حاصل کی گئی. علاج کے پودوں کی مجموعی ترقی میں بہتری مختلف تھی اور اس سے قبل علاج کی بحالی کی درخواست کے بعد آئی ٹی نے علاج کے بعد انتہائی اہم ترقی (پی ایس 0.001) کو ظاہر کیا اور ٹی 2 نے علاج کے بعد تھوڑی اہم ترقی (پی> 0.1) کو ظاہر کیا. اس تجربے سے پتہ چلتا ہے کہ مٹی میں حیاتیاتی کھاد کا استعمال پودوں کی کیفیت کو بہتر بنانے اور پودوں پر فضلہ کے پانی کے خراب اثرات کو کم کر سکتا ہے.

Abstract

To lower down the hazardous effects of polluted water in effected plants, a biological remedial strategy is developed by using *Terminalia catappa* leaves. This is to inspect the effects on growth of *Solanum melongena* as a biological weapon for the crop's health recovery. Germination in T2 samples was rapid in 50% and 100% samples i.e. 100% germination, while fresh weight of T2 (100%) was highest i.e. 0.049±0.002gm and dry weight of T2 (75%) was highest i.e. 0.034±0.001gm. Both T1 and T2 samples showed below average growth uptill 6 weeks when treated with their respective waste water. After application of manure, growth of plants was sustained and attained above average values in 100% samples in T1 and T2. The overall growth of treated plants was significantly different before and after remedy manure application i.e. TI showed highly significant growth ($p>0.001$) after remedy and T2 showed slightly significant growth ($p>0.1$) after remedy. This experiment showed that using a biological fertilizer in soil can improve the quality of plants and lower the adverse effects of waste water on plants.

Introduction

Different industries freely release their waste water on land that contain a number of pollutants. This water should be treated with inherent safety mechanisms that should be safe for consumers and sustainable for agro ecosystem. Distillery waste water used in soil contains low pH, high percentage of organic and inorganic substances (Chhonkar *et al.* 2000). Waste water from industries contains toxic pollutants. When it is discharged on land it is collected in ground water and ultimately cause health hazard when used as drinking water, agriculture and live stock (Malik and Bharti, 2010). Without any adequate treatment a large number of industries release their heavy metals containing effluents into fresh water (Canter, 1987).As a result of these practices our land has become polluted, living terrestrial life has been greatly disturbed and plants are top of the list in it. Industrial waste water cause indirect effects on plants or agriculture which ultimately effects on humans. The textile industries containing high concentration of heavy metals and many toxic substances that cause diseases in human being and live stock by accumulation in different levels of ecosystem (Malik *et al.* 2004). In addition these toxic substances may affect the water, soil and plants (Bhart and Singh, 2013).

Generally most part of our food requirement is fulfilled by plants including vegetables, pulses, cereals etc. There is no information about diseases caused by agricultural mechanisms in developing countries such as wheat and rice treated with waste water that contain heavy metals which effects the consumer. Worldwide vegetables play important role for food requirement because vegetable contain various essential components i.e. vitamins ,minerals and dietary fibers (Olge *et al.* 2001 ; Mukerji, 2004). The textile industries containing high concentration of heavy metals and many toxic substances that cause diseases in human being and live stock by accumulation in different levels of ecosystem (Malik *et al.* 2004).

Pollution is a consequence of increasing population and human activities that gradually lowers our living standards. Irrigation with sewage material would change the physical and chemical attributes of soil and this could cause the change in quality of soil. Sewage sludge might contain many minerals in various hazardous forms as well as it contain heavy metals and toxic substances which show negative effect on plants and soil. Sometimes sewage produces salinity in soil and this would change soil structure, usage of sewage is an urgent way but environment and public health must be preserved (Jesmanitafti *et al.* 2014).

Due to drought or shortage of water, farmers directly use untreated industrial waste water for irrigation (Hoek *et al.* 2002). *Solanum melongena* is one of the most commonly used vegetable worldwide and an important vegetable in Pakistan, generally it is called egg plant. Waste water contain toxic elements which accumulate in plants and these plants are injurious for edible purpose by means of causing disease such as dihorrea, kidney problems, liver problems. Toxic substances present and their exudates cause genetic mutation and chromosome aberration proved by experiments on plants and insects such as Drosophila (Singh *et al.* 2012). The practices of industrial waste water if treated, could be more effective for undeveloped countries in future which exclusively depend on plants for food requirements. Therefore biologist fertilizer is used to recovered plant growth and health, for a vegetable plant irrigated by industrial waste water.

Materials and Methods

Petri plate technique was adopted to conduct germination studies by sowing the seeds of (Brinjal) *Solanum melongena* L. using waste water which was collected from pharmaceutical and food industrial local drainage systems in Karachi Korangi industrial area.

Pot experiment was also designed using treatments from pharmaceutical waste water (T1) in 25%, 50%, 75% and 100% and food industrial waste water (T2) as 25%, 50%, 75% and 100%. Data was recorded in three phases, i) germination period ii) growth of plants under treatment of waste iii) *Terminlia catappa* dried leaves were used as green manure to recover the treated plants in different quantities i.e. 5gm manure added in 25% treatment of waste water, 10gm in 50%, 15gm in 75% and 20gm in 100% of each replicate and observed results. The third phase was consisted of plants maturity or maximum recovery from the stress after receiving the remedial manure.

Carbohydrate content was determined by performing Anthrone method (Hedge and Hofreiter, 1962). Protein content was examined by microjheldal method (Allen, 1931). Soil analysis was also done by using TDS multimeter to identify different parameters of soil i.e dissolved oxygen, pH, salinity, conductivity, ORP, TDS.

Results

The observations showed that the increased level of contamination in water brought retardation in growth of plants. At lower concentration of pharmaceutical (T1) samples and higher concentrations of food industry (T2) samples, the germination and growth occurred in profoundly better form as compared to control samples. The pattern of growth of plants is in various dimensions that are represented in following results. Their growth and maturity was triggered or altered in response to the treatment levels. Table 1 showed germination, mean length, fresh and dry weight of seedlings under treatments provided. T2 (100% and 50%) attained highest germination while T2 (100% and 75%) samples attained highest fresh and dry weight respectively. In Fig1(a and b) growth of treated plants after 3, 6 and 9 (after manure application) weeks is presented respectively. Results (Fig.2) showed a significant increase in growth of plants after manure application, T2 (100%) plants grew best when remedy provided. Fig3(a and b) showed protein and carbohydrate content in plants before and after manure application so as to determine the effectiveness of green manure as a remedy to effected crops. Table 2 presented the physiological characteristics of soil in treated pots to understand soil condition in presence of such effluents. Fig4 presented ANOVA between before and after remedy application on T1 and T2 samples to analyze growth variance in both types of treated plants. Growth in T1 samples was observed to be highly significant ($p>0.001$) while T2 samples were slightly significant ($p>0.1$) after remedy.

Mean length of plants were higher in T2 samples as compared to T1 samples while control samples attained highest elongation i.e. 7.86cm. Germination was 100% (highest) recorded in T2 (50% and 100%) plants while the mean fresh weight was > 0.04(gm) in T1 (25% and 50%) and T2 (75% and 100%) which was predominantly greater than control samples. This showed a positive response of waste water treated plants at lower concentrations in T1 and higher concentrations in T2. Similar condition seen in case of dry weight observed values.

Table. 1: Effects of waste water of pharmaceutical industry (T1), Food industry (T2) and fresh water (Control) on seed germination of *Solanum melongena* L.

Source	Treatment	Mean Length	Germination	Mean F. wt	Mean D. wt
	(%)	(cm)	(%)	(gm)	(gm)
T1	25	4.23	80	0.042±0.002	0.016±0.001
	50	2.82	66	0.043±0.002	0.021±0.001
	75	3.43	60.6	0.028±0.001	0.009±0.0001
	100	3.17	60	0.027±0.001	0.007±0.00011
T2	25	5.14	86.6	0.037±0.001	0.02±0.001
	50	5.31	100	0.038±0.001	0.022±0.001
	75	5.69	93.3	0.047±0.002	0.034±0.001
	100	7.47	100	0.049±0.002	0.028±0.001
Control	-	7.86	93.3	0.023±0.001	0.009±0.0001

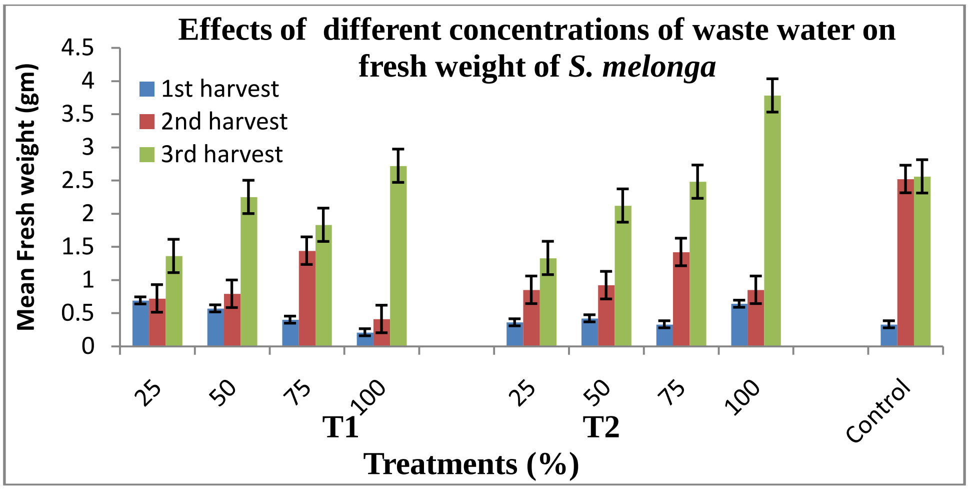

Fig.1(a): Effects of waste water of pharmaceutical industry (T1), Food industry (T2) and fresh water (Control) on mean fresh weight of *Solanum melonga* L. in [3 weeks (1st harvest), 6 weeks (2nd harvest) before remedy] and 9 weeks [(3rd harvest) after remedy]

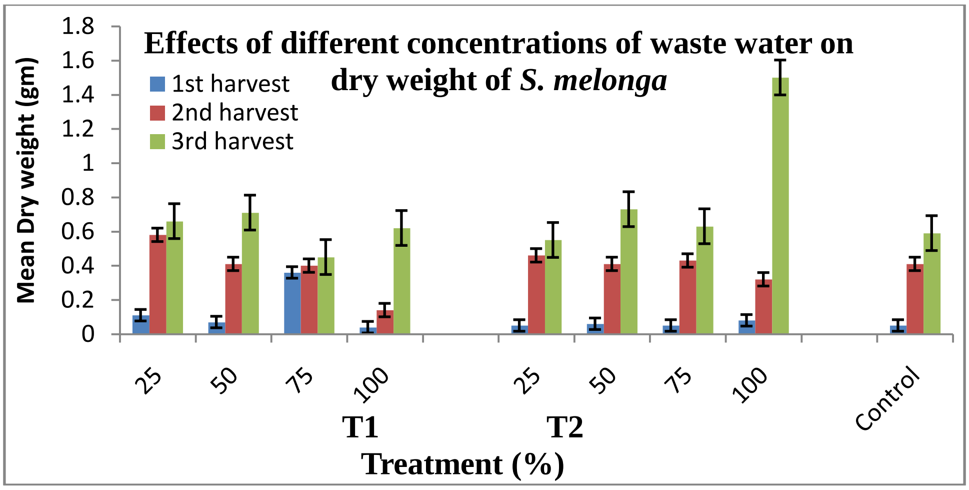

Fig.1(b): Effects of waste water of pharmaceutical industry (T1), Food industry (T2) and fresh water (Control) on mean dry weight of *Solanum melonga* L. in [3 wees (1st harvest), 6 weeks (2nd harvest) before remedy] and 9 weeks [(3rd harvest) after remedy]

Fig1(a and b) presented clear difference in fresh and dry weight on 1st and 2nd harvested phase in all treatments while control samples attained lower weight at 1st harvest that has eventually increased at 2nd harvest. The observed values on 3rd harvest showed a remarkable increase in fresh and dry weight of the treated plants that signifies the remedial effect of manure on growth of plants. Fig 2 showed paling of leaves after 6th week on treated plant that has increased on daily basis before the application of manure. Fig. 3(a) presented the nutritional values (protein) of treated plants that were in between the range of 2-3.8% in T1 samples and 0.58-0.77% in T2 samples, values decreased with the increase in concentration. Fig.3(b) presented carbohydrate content in treated samples which was in between the range of 0.42-1.8 in T1 samples and 0.55-0.65mg/gm in T2 samples before treating with manure. After manure application the nutritional content has increased in both the samples. Fig.4 show variance in growth of T1 and T2 samples before and after remedy.

Fig 2: Symptoms after 6th week show larger circumference of leaves found in T1 plants while T2 plant's leaves contain dense arrangement of leaves while their circumference is lower than T1.

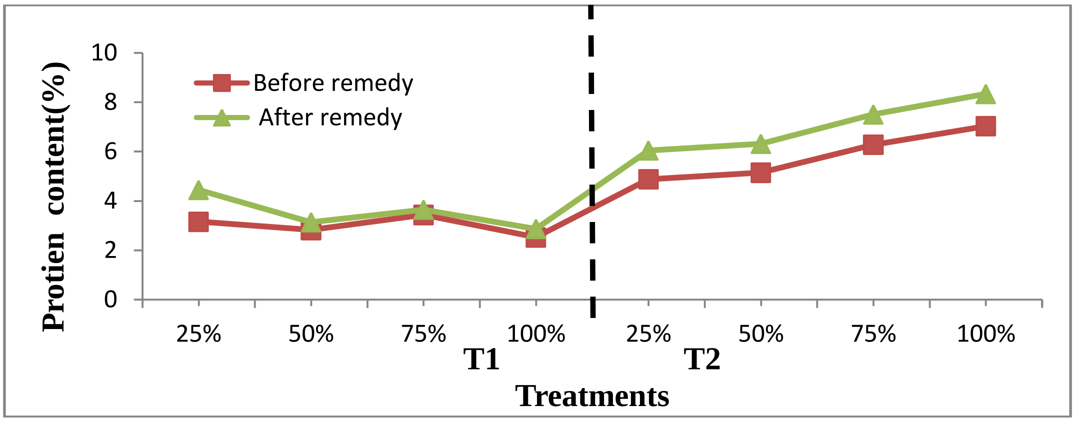

Fig. 3(a): Effect of manure on T1 & T2 in protein content of *S.melongena*

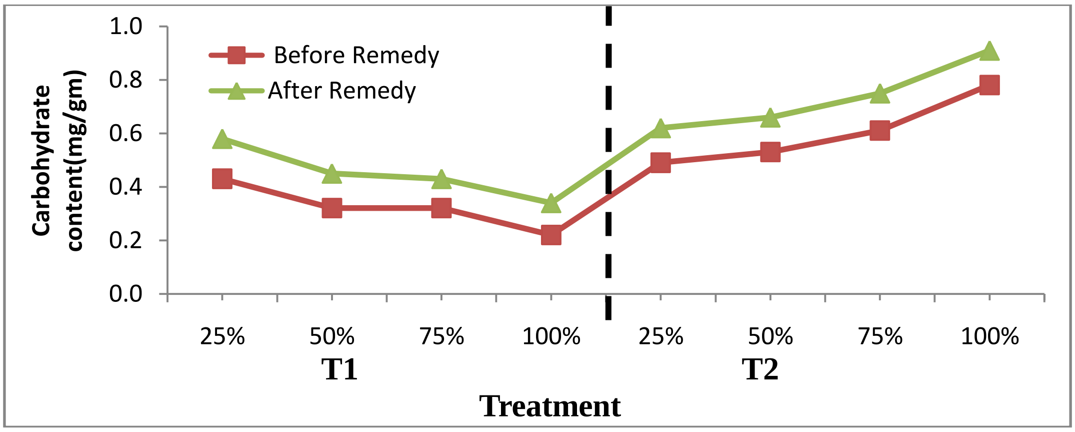

Fig. 3(b): Effect of mannure on T1 & T2 in carbohydrates content of *S.melongena*

Table. 2: Physio-chemical properties of soil

Source	Treatment	DO mg/l	pH	Temp C	Con µs/cm	TDS ppm	Salinity ‰	ORP
T1		**0**	**6.9**	**30**	**122**	**56.8**	**0.2**	**31.4**
	25%	0.77	7.7	31	500	250	0.24	56.3
	50%	0	7.98	32	121	61	0.06	47
	75%	0	7.71	31.8	169	85	0.08	58.8
	100%	0	7.37	31.7	364	182	0.17	68.6
T2		1.2	9.2	31.6	524	390	0.31	48.7
	25%	0	8.02	30.19	382	174	0.16	51.6
	50%	0	7.74	30.95	845	380	0.37	64.1
	75%	0.35	7.8	31.25	499	147	0.13	52
	100%	0	8.02	30.86	466	210	0.2	45.9
Control	-	0	7.5	31.11	428	189	0.18	41.4

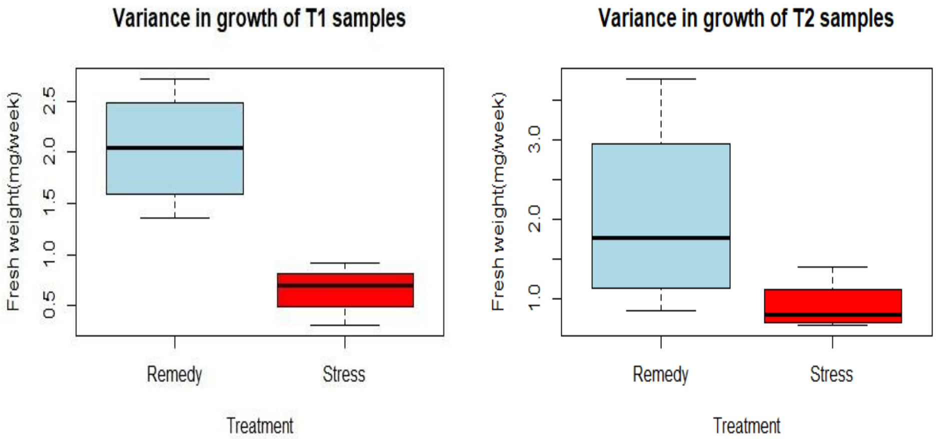

Fig.4: shows variance in growth of T1 and T2 samples before and after remedy.

Discussion

Increased population has become a global problem. The use of chemicals in industries and its discharge as effluents of factories had adverse effects on the environment including marine life and agriculture. Natural resources are also effected due to over exploitation that results in damaging the environment.

Due to the high price of chemical fertilizer, farmers sometime prefer waste water to reuse large amount of valuable nutrients present in industrial waste water such as nitrogen, potassium and phosphorous (Ghafoor *et al.* 1994). Therefore they consider applying waste water to agricultural lands is a more economical alternative than using canal or tube well water. However if heavy metals are present in the waste water, they could cause health hazards to human. According to (Hari *et al.* 1994) waste water act as both a resource and a problem; since waste water irrigation plant get nutrients, they look more fresh. Reuse of waste water is a cheaper way to to obtain necessary nutrients which can produce benefits for farming community (Hari *et al.* 1994). However, care should be taken before using distillery water effluents for irrigation of pre-sowing seeds, distillery effluent is crop specific (Ramana *et al.* 2002). Rising concentration of effluents showed decrease in germination %. Higher concentration of effluent showed adverse effect on germination while, low concentration showed increased rate of germination (Sharma *et al*. 2002).Spent wash diluted at higher level has increased germination percentage (Soundarrajan and Pitchai, 2007). According to Yadav and Meenakshi, 2007 the germination percentage decreased with raising the effluent concentration (Yadav and Meenakshi, 2007).

The industrial waste water effects on agriculture and it ultimately effect on our economy. We irrigated *Solanum melongena* L.(Brinjal) with pharmaceutical and food industry waste water and observed that shoot length increase in pharmaceutical industry waste water as per decrease their effluent concentration (25%>50%> 75%>100%) as compare to control (irrigated with tap water) while, food industrial waste water result showed that shoot length showed minor increase with the decrease in concentration of waste water.

Vegetable like lady finger, bitter gourd, chilli, brinjal, tomato was better grow along with germination %, root & shoot length in treated waste water than untreated waste water (Malathi, 2001). From waste water irrigation leaching of salts, heavy metals and nitrates contaminate ground water. (Hussain *et al.* 2002).As we observed that plants showed higher growth in Pharmaceutical (T1) as compare to food (T2) and control. The circumference of pants in T2 is greater whereas in case of T1 and control the condition of plants more or less similar with each other. Large size of leaves present in T2 than T1 and control.

Industrial waste water may contain toxic metals which could play the role of injurious contents that have been accumulated in plants, the effluent of textile industries contain toxic colour, heavy metals and organic pollutants which may affect the water surface, soil and also plant tissues (Bharti and Singh, 2013). Quality of crop and vegetables deteriorate by the use of polluted water for irrigation (Keraita *et al.* 2003). Against these toxic materials that have been accumulated in plants, we used *Terminalia catappa* leaves manure for cure and treatment of *Solanum melongena* L. (Brinjal) from Pharmaceutical and food industrial waste water. *Terminalia catappa* leaves manure prepared because the plant has reported for many significant uses for human health and its beneficial contents found beneficial against the toxic accumulation of industrial waste water in plants. *T.catappa* acts as chemical barrier due to its allelopathic and bacterial properties. Studies carried out on effects of *Terminalia catappa* leaves extract on invasion and mortality of tumor cells. These results indicates that *T. catappa* leaves extract could be a potential antimetastatic agents (Chu *et al.* 2007). Increasing cases of kidney problems and cancer caused by irrigated waste water of chemical and food industries in agriculture and live stock that contain heavy metals and toxicological interest (Singh *et al.* 2012). The growth of plants after using *Terminalia catappa* showed that the plant height of pharmaceutical (T1) is increased as increased of mannure concentration (25% <50% <75% <100%). While, food (T2) plant height is also increased as per increased their effluent concentration (25% <50% <75% <100%). But T1 plant height is more increase than T2 and control (T1> T2 & control). Therefore, it has been concluded that the industrial waste water is not both injurious and beneficial for plants but it must have to be maintained and tested before using in the agricultural fields as described by Srivastava (1991)

It has also been concluded that there are several biological ways to save a plant from different fatal agents in our environment whether they are pathogenic, biological or external factors. The use of chemicals to protect our crops should be minimized for recovery processes by developing bioremedial strategies.

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