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EFFECT OF TEXTILE EFFLUENT ON DRY MATTER YIELD AND NUTRIENT CONTENT OF JUTE LEAVES (*Corchorus capsularis*)

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Abstract

A pot experiment was conducted at Bangladesh Jute Research Institute (BJRI) to evaluate the effect of textile effluent on dry matter yield and the nutrients content of newly developed BJRI Deshi pat shak-1 (*Corchorus capsularis*). The treatments were T_1: control, T_2: 100% RDF + 0% effluent, T_3: 50% RDF + 25% effluent, T_4: 50% RDF +50% effluent, T_5: 50% RDF + 75% effluent, T_6: 50% RDF + 100% effluent. All the treatments had significant positive effect over control on dry matter yield and nutrient content of jute vegetables on non-contaminated soils. But in contaminated soils effluent irrigation showed negative effect on dry matter yield and nutrient content of jute leaves vegetables over control. The highest yield of dry matter in both contaminated and non-contaminated soils were observed in treatment T_2 (100% RDF + 0% effluent), which were1.81, 1.90, 1.86 and 1.69 t/ha in non-contaminated and contaminated soils of Narayanganj and Gazipur, respectively. Among the textile effluent treated pots T_4 the gave second highest yield of dry matter yield which were 1.55, 1.77, 1.36 and 1.58 t/ha in non- contaminated and contaminated soils, respectively.

***Key words*:** Dry matter; Yield; Jute leaves; Irrigation.

INTRODUCTION

Water scarcity is one of the main constraints for agriculture sector in many countries (Raja *et al.* 2015). In areas where fresh water is scarce, textile effluent allows low-income farmers to produce crops. On the other hand, textile effluent can be a good source of nutrients in addition to meet the crop water requirements in area facing water shortage problem. The irrigation of untreated textile effluent can be hazardous and soil environment due to high concentration of pollutants. The toxic effect of effluent could be reduced by dilution of these pollutants. The average organic matter content of top soils is declined by 20- 46% over the past 20 years due to intensive cultivation (Gani *et al.* 2017). Effluent irrigation may improve the nutrient and organic matter content of soil. Jute leaves are widely used as a leafy vegetable in many Asian, African and European countries (Furumuto *et al.* 2002, Velempini 2003, Oyedele 2006). Jute leaves contain as many as 17 active nutrient compounds including protein, fat, carbohydrate, fiber, ash, calcium, potassium, iron, sodium, phosphorous, beta-carotene, thiamine, riboflavin, niacin, ascorbic acid *etc*. (Islam 2013). Presence of these nutrients in jute leaves creating an opportunity of taking balance nutrition to the poor people cheaply. Moreover, jute leaves can be used to fulfill the demand of leafy vegetables during the early summer in Bangladesh when leafy vegetables are scarce in market (Tareq *et al.* 2019). The jute leaves are used in the treatments of many diseases and have wide antibacterial properties (Ngomuo *et al.* 2017). Indigenous leafy vegetables are fairly easy to cultivate in terms of pest and disease control while producing very stable yields even under difficult climatic condition (Cunninghum *et al.*1992). Keeping all these facts in mind an attempt was made to assess the effect of textile effluents on the dry matter yield and nutrient content of jute leaves vegetables (*Corchorus capsularis).*

METERIAL AND METHODS

A pot experiment was carried out in the premises of Bangladesh Jute Research Institute, Dhaka. Textile effluent and soil samples were collected from Gazipur and Narayanganj districts, located between Latitude $20^0 25^/$ to $23^0 02^/$ N and Longitude $88^0 35^/$ to $92^0 24^/$ E. Most of our textile mills are situated in these locations. The collected soil samples (0-15 cm depth) were air dried, ground and screened to pass through a 2.0 mm sieve and mixed thoroughly. One kg soil sample was kept in the plastic container for chemical analysis. One litter of textile waste water was also kept in a plastic bottle. Physical and chemical characteristics of the soils and water were determined using standard methods. The total nitrogen of plant sample was determined by the alkali distillation of Kjeldahl digest (Jacksion 1973). Total phosphorus, potassium and sulphur were determined by digestion with a mixture of conc. HNO_3 and $HClO_4$. Total phosphorus was determined by yellow color method (Jackson 1973) and S was determined by turbidimetric method (Sakai 1978) using spectrophotometer. Potassium was determined using flame photometer (Huq and Alam 2005). Total Ca and Mg were determined using atomic absorption spectroscopy (Huq and Alam 2005).

Table 1. Some physical and chemical properties of the soil used.

Parameters	Values			
	NCSN	CSN	NCSG	CSG
Particle size analysis [(a)]				
Sand (%)	39	24	18	15
Silt (%)	63	63	61	59
Clay (%)	8	13	21	26
Textural class	Silt Loam	Silt Loam	Silt Loam	Silt Loam
pH	6.8	6.9	5.9	6.6
EC (dS/m)	1.6	1.9	1.5	4.2
Organic matter (OM) % [(b)]	1.77	3.82	1.78	2.69
Total Nitrogen (N) % [(c)]	0.187	0.091	0.12	0.135
Potassium (K) meq/100g soil	0.18	0.10	0.62	0.49
Calcium (Ca) meq/100g soil	4.16	3.12	3.76	5.08
Magnesium (Mg) meq/100g soil	1.22	0.88	0.81	1.45
Available Phosphorus (P) mg kg^{-1}	6.20	17.16	4.24	5.21
Available Sulphur (S) mg kg^{-1}	16.73	11.22	14.03	33.25
Available Copper (Cu) mg kg^{-1}	0.24	0.56	0.82	0.22
Available Iron (Fe) mg kg^{-1}	52.07	234.00	50.12	118.70
Available Manganese (Mg) mg kg^{-1}	12.52	12.79	16.05	13.02
Available Zinc (Zn) mg kg^{-1}	1.46	5.67	0.9	19.38
Available Lead (Pb) mg kg^{-1}	11.67	17.62	10.21	27.02
Available Cadmium (Cd) mg kg^{-1}	0.098	0.123	0.054	0.133
Available Nickel (Ni) mg kg^{-1}	29.67	27.84	25.84	30.00
Available Chromium (Cr) mg kg^{-1}	34.80	33.37	32.42	37.72

NCSN= Non-contaminated soil of Narayanganj, CSN= Contaminated soil of Narayanganj, NCSG= Non-contaminated soil of Gazipur, CSN= Contaminated soil of Gazipur, ([a]) Boyoucos (1962), ([b]) Jackson (1973), ([c]) Walkley and Black (1934)

In the textile effluent of Narayanganj and Gazipur pH were 7.99 and 7.32, EC 2.39 and 2.09 (dS/m), TDS 1191 and 752 (mg kg^{-1}), DO 0.28 and 0.19 (mg kg^{-1}), BOD 2.85 and 1.39 (mg kg^{-1}), total N 0.05 and 0.07(%), K 1.10 and 0.52 (mg kg^{-1}), Ca 1.10 and 0.58 (mg kg^{-1}), Mg 0.33 and 0.20 (mg kg^{-1}), P 58.72 and 64.32 (mg kg^{-1}), S 201.60 and 113.72 (mg kg^{-1}), Co 1.23 and 1.12 (mg kg^{-1}), Fe 1.06 and 1.34(mg kg^{-1}), Mn 0.206 and 0.097(mg kg^{-1}), Zn 0.11 and 0.08 (mg kg^{-1}) were found, respectively.

Two sets of pot experiments for non-contaminated and contaminated soils were carried out with six treatments. Seven kg soil was placed in each pot. The treatments were T_1: (control), T_2: 100% RDF + 0% effluent, T_3: 50% RDF + 25% effluent, T_4: 50% RDF + 50% effluent, T_5: 50% RDF + 75% effluent, T_6: 50% RDF + 100% effluent. The experiment followed completely randomized design (CRD) having three replications. Newly developed BJRI Deshi pat shak-1 was used as test crop in the experiment. Half dose of urea, full dose of TSP, MoP and textile effluent were incorporated to soil one day before sowing according the treatments. Remaining half amount of urea was top dressed after 15 days of sowing. No insect and other pests were observed during jute vegetable cultivation. Jute vegetables plants were allowed to grow for 45 days. After harvest the separated plant parts were kept in an oven for 72 hours at 65°C and oven dry weight was taken.

RESULTS AND DISCUSSION

In the non-contaminated soils both Narayanganj and Gazipur all the treatments significantly enhanced dry matter yield over control (Tables 2, 3, 4 and 5). But, in both Narayanganj and Gazipur contaminated soils all the treatments decreased dry matter yield except T_2 (100% RDF + 0% effluent). At both soils higher rate of dry matter yield production was obtained with the treatment T_2 (100% RDF +0% effluent)

Table 2. Effects of textile effluent on dry matter production of jute leaves in non-contaminated soil of Narayanganj.

Treatments	Green weight of 10 plants /pot (g)			Oven dry weight of 10 plants/pot(g)			Total dry weight (t/ha)
	Leaves	Shoot	Root	Leaves	Shoot	Root	L+S+R
T_1: Control	5.29	6.50	2.48	1.72	2.18	0.63	0.81 f
T_2:100% RDF + 0% Effluent	11.62	15.19	4.08	3.75	5.05	1.03	1.81 a
T_3: 50% RDF + 25% Effluent	4.98	6.67	2.60	1.62	2.23	0.66	0.83 e
T_4:50% RDF + 50% Effluent	10.24	12.58	3.74	3.34	4.21	0.95	1.55 b
T_5:50% RDF + 75% Effluent	9.28	10.99	3.14	3.03	3.68	0.80	1.39 c
T_6:50%RDF + 100% Effluent	4.63	5.48	2.29	2.41	1.83	0.59	0.88 d
LSD at 5% level	1.82	2.68	0.38	0.08	0.06	0.07	0.06

which were1.81, 1.90, 1.86 and 1.69 t/ha in Narayanganj and Gazipur non-contaminated and contaminated soils respectively, which were 123.46, 167.61, 37.78 and 14.19% more as compared to the control. Among the textile effluent treated pots T_4 (50% RDF + 50% effluent) gave the second highest value of total dry matter yield in both non-contaminated and contaminated soils, which were 1.55, 1.77, 1.36 and 1.58 t/ha in Narayanganj and Gazipur non-contaminated and contaminated soils, respectively.

Table 3. Effects of textile effluent on dry matter production of jute leaves in non-contaminated soil of Gazipur.

Treatments	Green weight of 10 plants /pot (gm)			Oven dry weight of 10 plants/pot (gm)			Total dry weight (t/ha)
	Leaves	Shoot	Root	Leaves	Shoot	Root	L+S+R
T_1: Control	5.36	4.86	1.89	1.74	1.62	0.48	0.71 e
T_2:100% RDF + 0% Effluent	13.16	14.86	3.73	4.28	4.94	0.95	1.90 a
T_3: 50% RDF + 25% Effluent	6.55	7.56	2.5	2.11	2.51	0.63	0.97 d
T_4:50% RDF + 50% Effluent	10.41	16.08	3.04	3.36	5.35	0.78	1.77 b
T_5:50% RDF + 75% Effluent	10.48	15.7	2.35	3.38	5.22	0.6	1.71 c
T_6:50% RDF + 100% Effluent	4.54	4.6	2.24	1.46	1.53	0.57	0.66 f
LSD at 5% level	2.33	1.36	0.46	0.75	0.83	0.13	011

In non-contaminated soils of Narayanganj and Gazipur dry matter yield in T_4 were 91.36 and 149.30% more as compared to the control. In both non-contaminated soils the lowest dry matter yield was obtained for the treatment T_1 (control), which were 0.81 and 0.71 t/ha in Narayanganj and Gazipur agricultural soils, respectively. But in contaminated soils the lowest dry matter production was obtained in the treatment T_6 (50% RDF+ 100% effluent) and T_3 (50% RDF+ 25% effluent) which were 1.05 and 1.29t/ha in Narayanganj and Gazipur contaminated soils, respectively.

Table 4. Effects of textile effluent on dry matter production of jute leaves in the contaminated soil of Narayanganj.

Treatments	Green weight of 10 plants /pot (gm)			Oven dry weight of 10 plants/pot (gm)			Total dry weight (t/ha)
	Leaves	Shoot	Root	Leaves	Shoot	Root	L+S+R
T_1: Control	7.55	11.69	3.62	2.45	3.87	0.92	1.35 b
T_2:100% RDF + 0% Effluent	11.71	15.17	4.34	3.81	5.08	1.09	1.86 a
T_3: 50% RDF + 25% Effluent	9.76	7.14	2.14	3.18	2.36	0.54	1.13 d
T_4:50% RDF + 50% Effluent	8.97	11.17	3.06	2.84	3.71	0.78	1.36 b
T_5:50% RDF + 75% Effluent	8.69	9.04	3.12	2.82	3.03	0.79	1.25 c
T_6:50% RDF + 100% Effluent	7.27	7.73	2.62	2.34	2.58	0.66	1.05 e
LSD at 5% level	2.10	0.92	0.51	0.22	0.49	0.12	0.09

The results were consistent with the findings of Yaseen *et al.* (2017) who reported that the application of 50:50% textile effluent and canal water improved plant root dry weight and shoot dry weight of field mustard 15 and 56%, respectively, over control treatment. Hassan *et al.* (2013) found significant difference in shoot length, fresh weight and dry weight of individual seedling of country bean with textile waste water irrigation whereas the rest of characteristics shown statistically insignificant results.

Table 5. Effects of textile effluent on dry matter production of jute leaves in the contaminated soil of Gazipur.

Treatments	Green weight of 10 plants /pot (gm)			Oven dry weight of 10 plants/pot (gm)			Total dry weight (t/ha)
	Leaves	Shoot	Root	Leaves	Shoot	Root	L+S+R
T_1: Control	10.33	11.04	3.35	3.36	3.7	0.86	1.48 c
T_2: 100% RDF + 0% Effluent	12.31	12.5	3.71	3.97	4.16	0.95	1.69 a
T_3: 50% RDF + 25% Effluent	9.08	9.84	3	2.94	3.3	0.77	1.29 e
T_4: 50% RDF + 50% Effluent	10.18	12.83	3.29	3.31	4.28	0.85	1.58 b
T_5: 50% RDF + 75% Effluent	9.6	11.3	3.2	3.12	3.85	0.82	1.47 c
T_6: 50% RDF + 100% Effluent	9.32	10.16	3.26	3.03	3.41	0.83	1.34 d
LSD at 5% level	0.47	1.31	0.34	0.11	0.32	0.08	0.14

The nutrient contents of jute vegetables due to effluent application are presented in the Tables 6 to 10. The highest value of nitrogen (N) contents was found 3.78, 3.27, 3.97 and 4.35%, in leaves with treatment T_2 (100% RDF + 0% effluent) at both non-contaminated and contaminated soils of Narayanganj and Gazipur, respectively. In non-contaminated soils with effluent application the second highest contents of N were found 3.71 and 2.92% with treatment T_4 (50% RDF + 50% effluent). But in contaminated soils the second highst N contents 3.36 and 3.66% in leaves were found with treatment T_1 (control). It was also found that the irrigation of more than 50% effluent had negative effect on the N content of jute leaves in both the soils. It might be due to higher Cu content in the textile effluent. The present findings agreed well with the findings of Strand *et al.* (1990), Dahiya *et al.* (1990), and Osawa and Tuzuke (1990). They reported that N content decreased with increasing Cu application and opined that N and Cu had antagonistic effect on each other.

Table 6. Nutrient content in jute leaves due to textile effluent application to the non-contaminated soil of Narayanganj.

Treatments	N	P	K	Ca	Mg	S
	(%)					
T_1: Control	1.57	0.18	1.74	0.126	0.143	0.028
T_2:100% RDF + 0% Effluent	3.78	0.23	2.26	0.195	0.159	0.076
T_3: 50% RDF + 25% Effluent	2.10	0.20	2.19	0.151	0.148	0.057
T_4:50% RDF + 50% Effluent	3.71	0.21	2.23	0.174	0.157	0.069
T_5:50% RDF + 75% Effluent	2.85	0.19	2.27	0.178	0.155	0.062
T_6:50% RDF + 100% Effluent	1.53	0.15	2.18	0.163	0.144	0.052
LSD at 5% level	0.09	0.06	0.08	0.29	0.01	0.01

In these studies, the highest P contents were found 0.23 and 0.31% in non-contaminated soils and 0.29 and 0.27% in contaminated soils of Narayanganj and Gazipur, respectively in the treatment T_2(100% RDF +0% effluent). In non-contaminated soils the second highest value of P contents were observed with T_4 (50% RDF + 50% effluent) which were 0.21% and 0.27% in Narayanganj and Gazipur, respectively. But, in the contaminated soils the second highest value of P contents were observed in the control (T_1), which were 0.25 and 0.24% in Narayanganj and Gazipur, respectively. In both soils the irrigation of more than 50% effluents gave negative effect on the P content of jute leaves. The present findings agreed well with the findings of Sahar *et al.* (2017) who found that the application of 100% textile wastewater reduced nitrogen and phosphorous contents in grains by 27 and 18%, respectively.

Table 7. Nutrient content in jute leaves due to textile effluent application to the non-contaminated soil of Gazipur.

Treatments	N	P	K	Ca	Mg	S
	(%)					
T_1: Control	1.65	0.11	2.99	0.187	0.152	0.032
T_2:100% RDF + 0% Effluent	3.28	0.31	3.12	0.334	0.172	0.082
T_3: 50% RDF + 25% Effluent	2.52	0.19	3.18	0.231	0.166	0.035
T_4:50% RDF + 50% Effluent	2.92	0.27	3.74	0.313	0.170	0.091
T_5:50% RDF + 75% Effluent	2.54	0.21	3.86	0.286	0.164	0.058
T_6:50% RDF + 100% Effluent	1.93	0.18	3.06	0.225	0.162	0.044
LSD at 5% level	0.11	0.05	0.07	0.26	0.02	0.01

Table 8. Nutrient content in jute leaves due to textile effluent application to the contaminated soil of Narayanganj.

Treatments	N	P	K	Ca	Mg	S
	(%)					
T_1: Control	3.36	0.25	2.27	0.156	0.155	0.057
T_2:100% RDF + 0% Effluent	3.97	0.29	2.38	0.251	0.163	0.062
T_3: 50% RDF + 25% Effluent	2.55	0.22	2.02	0.105	0.147	0.051
T_4:50% RDF + 50% Effluent	3.32	0.24	2.10	0.146	0.151	0.057
T_5:50% RDF + 75% Effluent	3.22	0.23	2.16	0.133	0.150	0.050
T_6:50% RDF + 100% Effluent	3.05	0.21	1.92	0.114	0.144	0.046
LSD at 5% level	0.08	0.09	0.07	0.31	0.02	0.01

In the non-contaminated soils of Narayanganj and Gazipur, the highest K contents were found 2.27 and 3.86%, respectively in T_5 , and in the contaminated soils of Narayanganj and Gazipur the highest K contents 2.38% and 3.48% were found in the treatments T_2 and T_4, respectively. In both the soils more than 75% effluent irrigation decreased P content in jute vegetable leaves. It might be due to higher Pb content in the textile effluent. The results agreed with Khan and Khan (1983) who reported that the increasing Pb concentration had an adverse impact on P and K uptake by rice plant. Yaseen *et al.* (2017) suggested that application 50:50 of textile wastewater and canal water improved nitrogen, phosphorus and potassium concentration in grain and straw up to 20, 44 and 42%, respectively over the control treatment.

Table 9. Nutrient content in jute leaves due to textile effluent application to the contaminated soil of Gazipur.

Treatments	N	P	K	Ca	Mg	S
	(%)					
T_1: Control	3.66	0.24	3.42	0.223	0.153	0.052
T_2:100% RDF + 0% Effluent	4.35	0.27	3.45	0.239	0.159	0.061
T_3: 50% RDF + 25% Effluent	1.96	0.15	2.77	0.217	0.148	0.046
T_4:50% RDF + 50% Effluent	2.73	0.19	3.48	0.222	0.151	0.055
T_5:50% RDF + 75% Effluent	2.09	0.17	3.02	0.219	0.150	0.054
T_6:50% RDF + 100% Effluent	2.02	0.16	2.53	0.218	0.149	0.051
LSD at 5% level	0.12	0.05	0.07	0.24	0.01	0.01

Sulphur, Ca and Mg contents in jute vegetable leaves also affected by the irrigation of higher concentration of textile effluent. In Narayanganj non-contaminated soil S, Ca and Mg contents were highest with the treatment T_2 in jute leaves which were 0.076, 0.195 and 0.159%, respectively. The second highest S and Mg contents were observed in T_4 and second highest Ca content were observed in T_5 (Table 6). In Gazipur non-contaminated soil S content was the highest with the treatment T_4 and the highest Ca and Mg were found with the T_2 in jute leaves which were 0.082, 0.334 and 0.172%, respectively. The second highest value of S was achieved with T_2, and second highest values of Ca and Mg were found with T_4 (Table 7). In the contaminated soil of Narayanganj the highest value of S, Ca and Mg contents were found in T_2, which were 0.062, 0.251 and 0.163% respectively (Table 8). Similarly, in the Gazipur contaminated soil the highest values of S, Ca and Mg content in jute leaves were 0.61, 0.239 and 0.159%, respectively which were found in T_2 (Table 9). But, in both the contaminated soils the second highest values of N, P, K, S, Ca and Mg were found in the treatment T_1 (control). The lowest values of N, P, K, S, Ca and Mg were observed with the control in both non-contaminated soils. But, in both contaminated soil the lowest values of all nutrient were found in the T_6 treatment. These might be due to fresh water has optimum nutrient from which plant can uptake higher amount of nutrients. These results are in agreement with the findings of Begum *et al.* (2011) who found that the N, P, K, and S contents were higher in uncontaminated field **+** fresh water irrigation which gave the highest grain yield of rice.

Results revealed that the different concentrations of effluent on dry matter yield and nutrient content of jute vegetables showed positive impact on non-contaminated soils over control. But textile effluent irrigation water on contaminated soils showed negative effect on dry matter yield and nutrient content in jute vegetables. So, it may be suggested that fresh water or 50% textile effluent could be used to cultivate the new vegetable variety of Deshi pat shak-1 in non-contaminated soil.

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