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Influence of Dairy Effluent on Physiochemical and Biological Characteristics of Soil and Early Growth of Paddy (*Oryza sativa* L.)

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The purpose of the current study was to analyze the influence of dairy effluent at various concentrations (viz. 0%, 25%, 50%, 75%, and 100%) on cultivation of Oryza sativa L. (paddy). The results revealed that the effluent has a significant amount of nutrients and can alter the characteristics of the soil and Oryza sativa L. The soil was treated with different dilutions of dairy effluent for 30 days. There was observed a significant effect on the porosity, moisture, water holding capacity (WHC), organic carbon, humus content, bulk density, N, P, K, Ca, Cl and minor effect on the temperature, salinity, pH and conductivity. The characteristics like seed germination percentage, root length, shoot length, total plant growth, fresh and dry weight of seedlings were also upgraded at lower concentrations of dairy effluent in comparison to control. Moreover, paddy seedlings treated with lower concentrations of dairy effluent had an improved nitrogen content and chlorophyll amount. An effluent dilution of 50% showed best results of plant growth during early seedling growth phase as compared to other dilutions. The results propose that an effluent at concentration of 50% can be used effectively to cultivate paddy.

Keywords: *Crop Growth, Dairy Effluent, Seedling Growth, Seed germination*

Introduction

Freshwater is one of the precious and indispensable natural resources. This is a prime need for different purposes like domestic, industries, irrigation and power generation. Around 96.5% of the planet's water is found in seas with a great amount of salts, 1.7% in glaciers, 1.7% in groundwater, 0.001% in the air as water vapors and around 1% is available in the fresh form for use (Gleick, 1993). There are two issues as far as the water concerns:

Firstly, India supports more than sixteen percentage of the world's total population with only four percentage of the world's freshwater sources (Singh, 2003). Of the total fresh water, around 3% is used for industries, 6% for domestic and about 90% for irrigation purposes (Amjal and Khan, 1985). Hence, with increasing agriculture, the gap between the demand and supply for fresh water has increased and reached an alarming level in a few parts of the country. Therefore, the water allotted to irrigation is expected to be reduced by 10-15% in the next two decades (CWC, 2002). This increasing scarcity of water is compelling the scientists to explore the superior water management options.

Secondly, the dairy sector of state Punjab has shown a notable growth in milk production over the last few years. There are twelve major milk plants running under Milkfed (milk product exporter of Punjab) in Punjab. As we know, the dairy industry falls under most polluting industries with regard of the amount of effluent generated and its characteristics. The volume and composition of the effluent generated in a dairy industry depends

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on the type of products, production methods and design of the industrial plant. Generally, it generates about 2.5 liters of dairy effluent per 1 liter of milk. The undiluted effluent being rich in organic matter is 60 to 80 times more contaminating than domestic sewage. An inappropriate discharge of the dairy industry effluent is a key source for pollution of the land, water, air and biodiversity. Moreover, the effluent disposal is one of the major problems faced by dairy factories, due to the production of effluent in high quantity and with restricted space for its disposal. Hence, dairy industries need some kind of effluent management system. Hence, it is a peak time to focus on one of the methods to recycle fresh water through the reuse of effluent for irrigation purpose. Therefore, the present study has been presented to analyze the influence of various dilutions (0%, 25%, 50%, 75% and 100%) of dairy industry effluent on the physiochemical and biological characteristics of soil and growth of *Oryza sativa* L.

Materials and Methods

The laboratory and pilot plant studies were carried out by obtaining samples of the soil and effluents from Verka Milk Plant, Patiala during the period June, 2014 and July-August, 2015 in order to analyze the influence of dairy industry effluents on soil and growth of paddy (*Oryza sativa* L.). The effluent samples were stores at 25^0C and then analysed for the physiochemical and biological parameters as per standard methods. Various dilutions of dairy effluent (viz. control, 25, 50, 75 and 100%) were prepared. Twenty seeds of paddy were treated with five ml of dairy effluent dilutions on filter paper in each petri plate. The germination of seeds was observed at regular interval of twenty four hours for seven days. The developing seeds were cleaned with water for seven day in order to remove any contaminants and then treated with all the dilutions of effluent. The number of sprouted seeds was counted manually and calculated germination percentage. Five earthen pots of same size and diameter having same quantity of soil (1 Kg) were used for growth of paddy (*Oryza sativa* L.) and replicated 3 times. Similarly, a pilot scale trial was also maintained in five different plots of identical dimensions in three replications. An equal and appropriate distance was kept between seedling (3 cm) and among treatments (30 cm) for the better performance of the plants. The agronomical characteristics like leaf length, root length, root length, fresh weight, dry weight, total growth of the plant, nitrogen and chlorophyll content were measured in plants for 0 to 30 days. The soil was also analysed for the physicochemical and biological parameters as per standard procedures after thirty days of treatment. All the recordings were collected in three replicates and the data was compiled as mean of the three replications. The quantitative analysis of data was done using, Microsoft excel and graphical representations. The average values, standard deviations and percentage increase or decrease in comparison to control were recorded.

Results and Discussion

The results of various physiochemical and biological parameters of the dairy industry effluent are presented in table 1. Results revealed that the effluent was neutral (pH 7.2), clear, colourless and odourless with SAR value 23.9. The average values of the quality parameters such as total solids (TS), total dissolved solids (TDS), total suspended solids (TSS), alkalinity, choride, sulphate, COD, BOD, DO, calcium, hardness and nitrate were found under the approved limits of BIS Indian standards. The effluent had a significant amount of plant nutrients for example nitrogen (N), phosphorous (P), potassium (K), organic carbon, chloride, sulphate, nitrate and sodium.

Table 1 Physical, cchemical and biological characteristics of dairy effluent

Parameter	Unit	Observation	BIS for irrigation water
Temperature	^{0}C	28.2	
EC	S m^{-1}	1140	
Salinity		0.1	
pH		7.2	6.5-9.0*
TS	mg L^{-1}	310.44	2700*
TDS	mg L^{-1}	289	2100*
TSS	mg L^{-1}	21.44	600*
Colour		Colourless	Colourless**
Appearance		Clear	
Odour		Odourless	Odourless**
Total hardness	mg L^{-1}	414	600**
Total alkalinity	mg L^{-1}	52.7	600**
DO	mg L^{-1}	3.1	4-6*
BOD	mg L^{-1}	19.8	50*

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COD	mg L^{-1}	57.4	250*
Nitrogen	mg L^{-1}	27	
Phosphorous	mg L^{-1}	12	
Potassium	mg L^{-1}	178	
Calcium	mg L^{-1}	77	200**
Sodium	mg L^{-1}	309	
Chloride	mg L^{-1}	27	600*
Sulphate	mg L^{-1}	321	1000*
Phosphate	mg L^{-1}	Nil	
Nitrate	mg L^{-1}	12	100*
SAR		23.9	
Total bacterial count	cfu/mL	12036	
Total Fungal count	cfu/mL	1500	
Azotobactor Count	cfu/mL	Nil	

Bureau of Indian standards (BIS) Reference**(Kumar & Chopra, 2010), *(Siddiqui & Waseem, 2012)

Moreover, the effluent had nophosphate content. The content of plant nutrients is already in compliance with previous studies (Deshpande et al., 2012, Nawaz et al., 2006, Kumar and Gopal, 2001). The effluent was recorded with a significant count of bacterial and fungal load of 12036 cfu/ml and 1500 cfu/ml, respectively. Such microbial load in the dairy effluent could be as a result of more organic content, total dissolved solids (TDS), nitrogen and phosphorous hence could improve their breakdown and absorption by plants (Chhonkar et al., 2000).

As evident from table 2, dairy industry effluent imparted very less effect on soil temperature. The pH value of the soil (6.3-6.6, r= -0.48) was negatively correlated with effluent concentrations and will not be able to cause any negative effect on soil quality, since it is not sufficient to provide a negative charge on soil particles, hence the breakdown of soil structure (Rehman et al., 2009). A slight variation in the pH value of the soil irrigated with various dilutions of effluent could be attributed to phosphoric acid of cleansing agents (Thiruvaruldev, 2006). The soil treated with effluent appeared to be fit for crop growth since it contains a significant pH range required for nutrient uptake by plants (Singh, 2003). The conductivity and salinity of the soil were positively correlated (r = +0.94, r = +0.65), respectively with effluent concentration. This was interesting to note that the effluent concentration at 25% showed more deviation in conductivity (0.27 mg l^{-1}) and salinity (0.27 mg l^{-1}) as compared to control. Electrical conductivity values can be due to the presence of detergent, sanitizer, salts, organic matter and other ions (Singh, 2003). Salinity could be attributed to the trends of conductivity change, TDS and TS. The total moisture content of the soil samples (r = +0.71) increased with the increase in dairy effluent concentrations. Total moisture was positively correlated to the organic matter of various dilutions. On the other hand, the bulk density (r = -0.77) of soil samples was negatively linked with the increase in effluent concentrations. It effect could be caused by higher amount of organic matter and microbial activity (Guo & Sims, 2003). The porosity (r = +0.53) of soil samples almost improved with increase in the effluent concentrations. The trends in the porosity change were in an inverse relation with the trends of the bulk density. Higher amount of organic matter and its degradation could have caused a rise in the porosity of the soil (Tabriz, 2011). The WHC of the soil samples (r = +0.74) almost increased with the increase in effluent concentrations. The significant values could be directly related to the salt content, soil moisture content, soil pores distribution and organic carbon in the soil (Kumar and Chopra, 2010). Chloride content varied from 30±5.02 mg/100g to 32.3±5.28 mg/100g and sulphate content varied from 246±5.33 mg/100g to 335±5.98 mg/100g. Negative correlation of sulphate could be due to more microbial community that decompose sulphate. Alkalinity of soil (r = +0.62) was positively interrelated with increase in effluent concentrations. It may be attributed to carbonates and bicarbonates present in effluent. Low alkalinity of the soil treated with 50% dilution could be due to buffering materials (acidic content in the ingredients) that help neutralize bases. Organic carbon of soil (r = +0.54) was positively correlated with the increase in effluent concentrations. An increase in the humus content (r = +0.25) of the soil samples may be attributed to the organic carbon. An increase in nitrogen content (r = +0.81) could be as a result of an application of the effluent already containing such nutrients (Kannan and Ubreti, 2008). This also affected C/N (r = -0.78) in various effluent concentration. The availability of P (r = +0.55) depends upon the combined result of factors like soil pH and organic matter. An improved status of phosphorous, potassium (r = +0.74) and calcium (r = +0.05) in soil treated with an effluent could be attributed to

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balanced chemicals (Siddiqui and Waseem, 2012). Sodium content (r = -0.85) almost decreased with an increase in effluent concentration due to more calcium that results in sodium leaching. The frequent distribution of microflora in dairy effluent could be *Pseudomonas sp* (58%) which is dominant followed by *Escheritia coli* (40%) and *Aerococcus* (2%) among the bacterial isolates. *Aspergillus niger* (45%) dominated the fungal isolates followed by *Mucor sp* (25%) and other species of *Aspergillus* (30%) (Ale et al., 2008).

Table 2 Effect of dairy factory effluent on physiochemical characteristics of the soil (Paddy season)

Parameters	Units	Control	DILUTION 25%	50%	75%	100%	r-value
Temperature	^{0}C	28.0±0.15	27.6±0.20 (-1.42)	27.5±0.15 (-1.78)	28.0±0.40 (0)	28.0±0.40 (0)	+0.25
pH		6.5±0.10	6.6±0.10 (+1.53)	6.6±0.10 (+1.53)	6.6±0.10 (+1.53)	6.3±0.00 (-3.07)	-0.48
Conductivity	dS/m	0.26±0.01	0.27±0.01 (+3.84)	0.27±0.01 (+3.84)	0.28±0.01 (+7.69)	0.28±0.01 (+7.69)	+0.94
Salinity	ppt	0.25±0.09	0.45±0.09 (+80.00)	0.27±0.08 (+8.00)	0.48±0.08 (+92.0)	0.47±0.10 (+87.99)	+0.65
TMC	%	29.3±4.56	35.2±3.89 (+20.13)	34.2±4.68 (16.72)	33.4±±5.67 (33.99)	36.2±6.02 (+23.54)	+0.71
Bulk Density		1.76±0.07	1.53±0.07 (-13.06)	1.52±0.09 (-13.63)	1.53±0.10 (-13.06)	1.49±0.10 (-15.34)	-0.77
Porosity	%	12.4±2.01	11.1±1.49 (-10.48)	13.4±2.25 (+8.06)	12.2±2.75 (-1.61)	13.5±3.01 (+8.87)	+0.53
WHC	%	44.2±4.45	43.2±5.02 (-2.26)	43.3±3.45 (-2.03)	46.8±4.39 (+5.88)	46.3±4.20 (+4.75)	+0.73
Chloride	mg/100g	30±5.02	32.2±3.45 (+7.33)	32.3±5.28 (+7.66)	31.8±4.29 (+6.00)	31.9±3.60 (+6.33)	+0.51
Sulphate	mg/100g	334±7.75	275±8.37 (-17.66)	335±5.98 (+0.29)	331±6.38 (-0.89)	246±5.33 (-26.34)	-0.46
Alkalinity	mg/100 g	22.5±3.01	23.5±2.51 (+4.44)	21.8±2.58 (-3.11)	24.3±2.25 (+8.00)	24.3±3.22 (+8.00)	+0.62
Organic Carbon	mg/100g	1.30±0.02	1.25±0.25 (-1.25)	1.65±0.01 (+26.9)	1.50±0.02 (+15.38)	1.45±0.01 (+11.53)	+0.54
Humus	mg/100g	12.5±1.75	14.2±2.58 (+13.59)	13.5±2.58 (+8.00)	13.2±2.59 (+5.59)	13.5±1.33 (+8.00)	+0.25
Total Nitrogen	mg/100g	0.21±0.01	0.51±0.01 (+142.8)	0.53±0.02 (+152.3)	0.57±0.01 (+171.4)	0.57±0.02 (+171.4)	+0.81
C/N ratio		2.9±1.27	2.2±1.26 (-24.13)	2.4±1.25 (-17.24)	2.2±1.00 (-24.13)	2.3±1.28 (-20.68)	-0.65
Phosphorous	mg/100g	8.2±1.38	9.5±1.58 (+15.85)	9.6±2.00 (+17.07)	9.6±1.46 (+17.07)	9.2±1.58 (+12.19)	+0.55
Potassium	mg/100g	82±7.37	82±5.37 (0)	86±5.98 (+4.87)	87±6.38 (+6.09)	83±6.37 (+1.21)	+0.74
Sodium	mg/100g	212±7.89	215±8.37 (+1.41)	114±8.28 (-46.22)	112±8.28 (-47.16)	115±6.38 (-45.75)	-0.85
Calcium	mg/100g	37.0±5.38	36.6±6.38 (-1.08)	35.1±5.35 (-5.13)	36.9±4.66 (-0.27)	37.0±4.66 (0)	+0.05
Total Bacterial Count	cfu/g	$1.12x10^{4}$	$2.55x10^{4}$	$1.36x10^{4}$	$1.51x10^{4}$	$1.52x10^{4}$	-0.06
Total Fungal Count	cfu/g	$2.11x10^{3}$	$3.68x10^{3}$	$1.29x10^{3}$	$2.71x10^{3}$	$1.25x10^{3}$	-0.51
Azotobacter Count	cfu/g	$2.35x10^{3}$	$2.26x10^{3}$	$1.55x10^{3}$	$1.35x10^{3}$	$2.36x10^{3}$	-0.29

Note: Average values of three replicates ± standard deviations, % increase or decrease as compared to control given in parentheses, r-value: coefficient correlation

The results of this study showed in table 3 and figures 1 to 8 presented that seed germination percentage (r = +0.22) increased with a rise in the effluent concentration. The low seed germination could be related to higher osmotic pressure of dairy effluent (Dixit et. al., 1986; Ramana et. al., 2002; Nagada et. al., 2006). Moreover, the effluent stress conditions can cause the distortion of carbohydrates and protein metabolites of the cell membrane, hence decline in water absorption by seeds (Kannan & Upreti, 2008). Average values exhibited that the growth characteristics of the seedlings were also affected, on treatment with different dilutions of dairy effluent. The shoot length of seedlings almost improved with increase in concentration of effluent after 7 days (r = +0.33) and 15 days (r = +0.57) of treatment. Similarly, the leaf length (r = +0.40), shoot length (r = +0.32) and total plant growth (r = +0.19) also showed positive correlation with various effluent dilutions. The studies are in accord with previous studies (Yousaf et al., 2010; Orhue et al., 2005; Akbar et al., 2007; Dhanam, 2009). Effluent stress results in a decline of oxygen supply and hence development of seedlings. The total growth of the plant was found to be maximum (101.1 cm) in plants treated with 50% effluent concentration. An appropriate amount of nutrients like N, P, Ca and sulphate could have stimulated the chlorophyll amount, cell division and protein production required for plants (Jaja and Odomena, 2005), hence growth. The findings are in accord with the studies where higher concentrations were found injurious (Avasn and Rao, 2001, Kaushik, P., et Al., 2005, Arora and Saxena, 2005]. The fresh and dry weight (r = +0.19, r = +0.05) were positively correlated with an increase in the effluent concentration. This could be due to healthy growth of the shoot, leaves and roots (Pandey et al., 2008, Rani and Alikhan, 2007). The addition of dairy industry effluent also increased the chlorophyll and nitrogen content as compared to higher concentration. Similar trends of gradual decrease in chlorophyll at a high amount of effluent were also recorded in previous studies (Nath et al., 2007).

Table 3 Growth Factors of the Paddy Crop Exposed to Effluent Dilutions at Lab Scale

Days	Parameters	Units	Dilutions					r-value
			0%	25%	50%	75%	100%	
After 7 Days of Germination	Germination Percentage	%	57.5±3.50	67.5±5.38 (+17.39)	90±5.69 (+56.52)	70±3.50 (+21.74)	65±3.18 (+13.04)	+0.22
	Shoot Length	cm	1.0±0.50 a=1.0-1.5	12.0±1.10 (+1100) a=2.2-12.5	17.0±3.20 (+1600) a=2.5-19.6	8.5±2.50 (+750) a=2.0-8.5	9.0±3.10 (+800) a=1.8-10.2	+0.33
After 15 Days of Germination	Leaf Length	cm	14.2±5.45 a=2.7-14.5	19.2±4.50 (+35.21) a=3.2-23.6	23.4±3.70 (+64.79) a=2.7-29.5	23.1±5.20 (+62.68) a=3.2-24.9	19.1±5.10 (+34.51) a=3.6-24.6	+0.57
	Shoot Length	cm	42.2±6.70 a=5.5-14.8	47.4±6.10 (+12.32) a=4.6-47.9	48.8±6.80 (+15.64) a=5.2-57.9	46.8±7.45 (+10.90) a=4.5-53.5	43.8±6.50 (+3.79) a=3.2-49.6	+0.57
After One Month of Germination	Leaf Length	cm	23.1±7.90 a=4.5-28.9	41.1±7.49 (+77.92) a=7.5-43.5	44.6±5.10 (+93.07) a=4.5-48.6	41.5±4.85 (+79.65) a=5.8-46.2	33.9±6.48 (+46.75) a=4.5-37.8	+0.40
	Shoot Length	cm	62.6±8.46 a=7.6-69.0	58.1±7.39 (-7.19) a=7.2-60.3	80.2±6.39 (+28.12) a=7.3-84.9	63.2±7.20 (+0.96) a=5.6-67.4	68.9±5.17 (+10.06) a=4.5-72.2	+0.32
	Root Length	cm	18.9±5.35 a=4.1-20.2	16.2±6.32 (-14.29) a=4.2-21.5	20.9±6.38 (+10.58) a=3.1-21.5	20.2±5.10 (+6.88) a=2.5-24.2	14.1±4.29 (-25.40) a=2.2-16.3	-0.31
	Total Growth of Plants	cm	81.5±8.38 a=12.7-89.5	74.3±7.18 (-8.83.0) a=10.0-75.0	101.1±7.15 (+24.05) a=9.0-102.5	83.4±8.17 (+2.33) a=7.0-85.7	83±7.90 (+1.84) a=6.4-84.9	+0.19
	Fresh Weight	g	3±0.50	6.6±0.15 (+120.0)	9.2±2.11 (+206.67)	5.48±2.15 (+82.67)	5±2.00 (+66.67)	+0.19
	Dry Weight	g	1.10±0.10	2.09±0.50 (+90.00)	5.10±0.50 (+363.64)	1.80±0.60 (+63.64)	1.50±0.10 (+36.36)	+0.05
	Chlorophyll	mg/g	0.52±0.10	0.62±0.10 (+19.23)	0.70±0.10 (+34.62)	0.52±0.10 (0)	0.53±0.05 (+1.92)	-0.15
	Nitrogen	%	4.40±0.50	5.20±0.50 (+18.18)	5.60±0.60 (27.27)	5.52±0.60 (+25.45)	5.42±0.60 (+23.18)	+0.76

Note: Average values of three replicates ± standard deviations, % increase or decrease as compared to control given in parentheses, r-value: coefficient correlation

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Fig.1 Effect of dairy effluent on seed germination

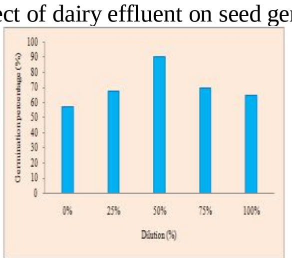


Fig.2 Effect of dairy effluent on shoot length after 7 days of germination

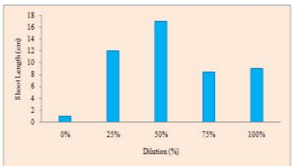


Fig.3 Effect of dairy effluent on leaf length after 7 days of germination at

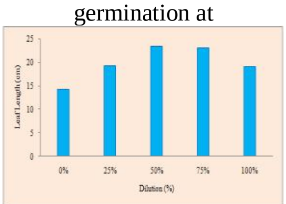


Fig.4 Effect of dairy effluent on shoot length after fifteen days of seed germination

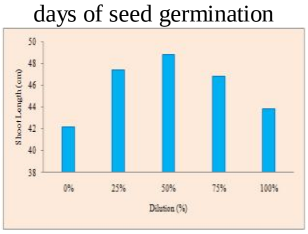


Fig.5 Effect of dairy effluent on growth factors after 30 days of germination

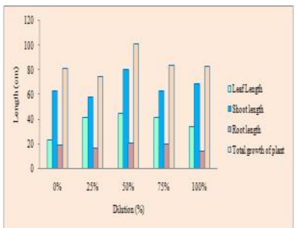


Fig.6 Effect of dairy effluent on fresh and dry weight

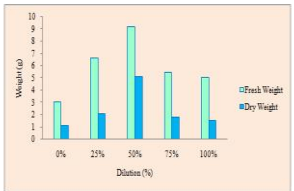


Fig.7 Effect of dairy effluent on chlorophyll content

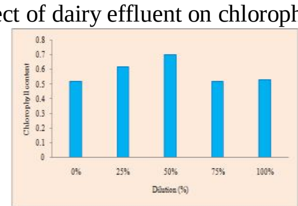
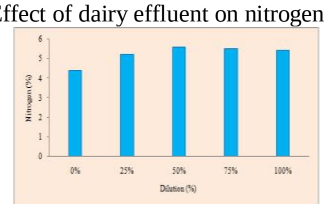


Fig.8 Effect of dairy effluent on nitrogen content



As shown in table 4 and figures 9 to 12, germination percentage (r = +0.22) was positively related with an increase in effluent concentration at pilot scale. A decline in the seed germination percentage at high concentrations of dairy effluent could be related to water absorption that is essential for germination process, failing to that, the growth of seedlings gets affected severely (Debeaujan et. al., 2000). Absorption of the higher amount of dissolved total solids by the seeds could also have impacted the germination rate (Singh et. al., 2007). Shoot length (r = +0.85) and leaf length (r = +0.55) were positively correlated with effluent concentration after fifteen and seven days of treatment, respectively. Similar to laboratory scale studies, the leaf length and root length (r = +0.11, r = +0.03) almost increased with an increase in the effluent concentration. The leaf length, root length, shoot length and total plant growth (r = +0.05, r = +0.11, r = +0.03, r = +0.11) were positively correlated with an increase in the effluent concentrations. The fresh and dry weight (r = -0.57, r = -0.23) decreased with a rise in the effluent concentration. It could be due to a decline in growth of the leaves, shoots and roots at higher concentration of effluents. The effluent diluted with normal water at 1:1 ratio is could be fully composed with required nutrients and chemicals and fit for irrigation purpose (Siddiqui & Waseem, 2012). Overall improvement in the chlorophyll content as compared to control is also seen.

Table 4 Growth Factors of the Paddy Crop Exposed to Different Effluent Dilutions at Pilot Scale

Days	Parameters	Units	Dilutions					r-value
			0%	25%	50%	75%	100%	
After 15 Days of Germination	Leaf Length	cm	16.30±3.28 a=3.0-18.5	20.10±2.56 (+23.31) a=2.4-24.3	22.25±3.27 (+36.50) a=2.1-25.5	22.35±3.15 (+37.12) a=4.5-24.7	20.15±3.96 (+23.62) a=4.9-24.8	+0.64

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	Shoot Length	cm	40.6±5.27 a=5.2-44.5	45.25±4.00 (+11.45) a=4.9-47.6	45.9±4.25 (+13.05) a=5.9-47.9	45.95±3.96 (+13.18) a=7.5-47.5	44.6±5.03 (+9.85) a=4.5-46.8	+0.62
	Leaf Length	cm	25.25±4.17 a=4.5-27.6	40.25±3.90 (+59.41) a=4.5-43.1	43.2±5.01 (+71.09) a=4.3-45.8	40.2±4.20 (+59.21) a=7.6-43.6	33.85±4.10 (+34.06) a=7.9-35.8	+0.38
After One Month of Germination	Shoot Length	cm	61.6±6.26 a=7.8-63.5	60.1±5.20 (-2.44) a=6.4-63.4	70.35±5.28 (+14.20) a=7.4-74.8	61.1±6.18 (-0.81) a=9.8-64.9	69.2±4.10 (+12.34) a=5.7-72.6	+0.52
	Root Length	cm	9.20±1.40 a=3.5-10.2	8.9±1.02 (-3.26) a=3.6-10.3	10.22±1.00 (+11.09) a=4.1-13.1	10.05±2.11 (+9.24) a=4.7-13.2	9.90±2.00 (+7.61) a=3.2-10.7	+0.70
	Total Growth of Plant	cm	70.80±5.28 a=10.3-73.5	69.00±4.90 (-2.54) a=9.5-73.1	80.57±5.00 (+13.80) a=11.7-84.6	71.15±6.18 (+0.49) a=12.6-74.3	79.10±7.10 (+11.72) a=7.9-81.5	+0.56
	Fresh Weight	g	4.25±1.00	6.95±1.50 (+63.53)	8.2±1.40 (+92.94)	7.30±2.00 (+71.76)	4.75±1.00 (+11.76)	+0.13
	Dry Weight	g	1.95±0.55	2.85±0.65 (+46.15)	6.25±0.50 (+220.51)	2.75±0.50 (+41.03)	2.8±0.50 (+43.59)	+0.15

Fig.9 Effect of Dairy Effluent on Leaf Length (Pilot Scale)

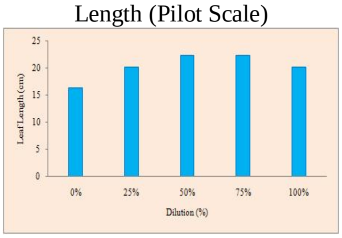


Fig.10 Effect of Dairy Effluent on Shoot Length (Pilot Scale)

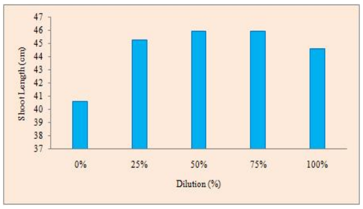


Fig.11 Effect of Dairy Effluent on the Fresh and Dry Weight of Plants (Pilot Scale)

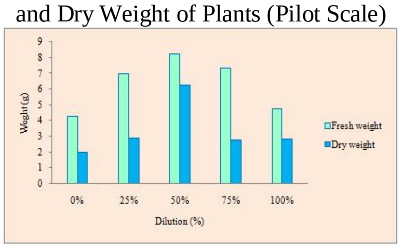
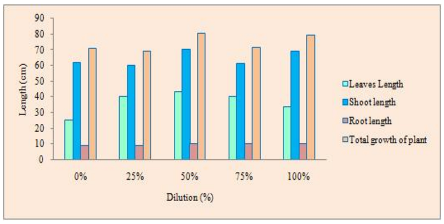


Fig.12 Effect of Dairy Effluent Dilutions on Growth Parameters of Plants after 30 Days of Germination (Pilot Scale)



Conclusion

From the present study, it is concluded that treatment of soil with low concentration of dairy effluent shown a beneficial effect on the development and growth of the paddy crop as compared to a control. The secondary clarified dairy industry effluent is suitable for an improvement in growth parameters significantly at 50% dilution. Therefore, reuse of low dilutions of the effluent from dairy industry could be suggested in the paddy cultivation, with a view of taking advantage of its essential nutrients.

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