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Impact of Dairy Industrial Effluent of Punjab (India) on Seed Germination and Early Growth of *Triticum aestivum*

Vimaldeep Kaur[1]* and Gitanjali Sharma[2]

[1]Chemistry Department, Poornima University, Jaipur – 303905, Rajasthan, India; vimaldeep.kaurphd13@poornima.edu.in
[2]Chemistry Department, Baddi University, Baddi – 173205, Himachal Pradesh, India; gitanjali.sharma@baddiuniv.ac.in

Abstract

Objectives: The aim of the present research was to study the impact of dairy industry effluent fertigation on agronomical characteristics of wheat *(Triticum aestivum)*. **Methods/Statistical Analysis:** The treatments of such effluent, namely 0%, 25%, 50%, 75% and 100% were used for the cultivation of wheat. The effluent of such industry had significant amounts of nitrogen (28mg/l), phosphorous (13.10mg/l), potassium (168.2mg/l), copper (0.75mg/l), iron (<1mg/l) and nitrate (11.9mg/l) that may support plant growth. The effluent had no heavy metals like Cd, Co, Ni and Pb. **Findings:** The studies exposed that effluent at dilution of 50% showed the significant effect on seed germination percentage of 94.10 after seven days of irrigation. The shoot length (33.20cm), root length (12.90cm), total growth of plant (46.10cm), dry weight (0.57g), chlorophyll content (0.60) and nitrogen content (2.70%) were increased after one month of treatment with 50% concentration at lab scale. Significantly increased shoot length (48.35cm), root length (9.20cm), total growth of plant (57.55cm) and dry weight (0.71g) were observed maximum at concentration of 50% at pilot scale. The maximum agronomic performance of wheat was noticed with 50% concentration of dairy industry effluent. **Application:** The treated effluent of dairy industry had potential to be used as liquid fertilizer by mixing it with soil after appropriate dilution.

Keywords: Dairy Industry, Dairy Industry Effluent, Irrigation, Macronutrients, Wheat

1. Introduction

Water is one of the valuable and crucial natural sources of the planet. It is a prime need for various purposes like domestic, industrial, power generation and irrigation. Around 97% of the water is available with lots of salts, 2% is locked in glaciers and only less than 1% is available in fresh form for use. It is worthwhile to mention that increasing population, agriculture and industrialization has caused the following problems as far as water is concerned: First, the heavy consumption of water has brought a gap between water supply and demand. It is increasing day by day and posing a threat to human existence. India supports more than 16% of world's population and contains 4% of world's fresh water sources. The state Punjab being an agricultural state covers only 1.5% of India's land and produces nearly 20% of the nation's wheat and 12% of its rice. The rice and wheat are two main crops grown in Punjab. The state Punjab is severely getting affected because of rice growth which is water intensive crop and requires flood irrigation of fields. There was continuous fall in water level at the rate of 18cm per year in Punjab during year 1982-87. That rate of decline increased to 42cm per year from year 1997-2002 and to a surprising rate of 75cm during 2002-06. It is needed to adopt a careful water management system for successful agricultural purpose. The environmentalists all around the world are analyzing to search alternatives to save water as much as

*Author for correspondence

possible. Secondly, the discharge of effluent from various industries is a challenge for scientists. An effluent is an obvious output of industrial processes. It is defined as "wastewater (treated or untreated) that flows out of a treatment plant, sewer or industrial outfall" is called an effluent. The food industries have maximum consumption of water, hence biggest producers of effluents along with a large volume of sludge. The dairy industries among other food industries produce large amount of waste water from processing units like pasteurization, homogenization and production units. Punjab is ranked sixth in terms of registered dairy industries and has a share of 4% in 1,493 registered dairy industries across India. The milk industries generate great amounts of effluent, around 3 times the volume of milk. Modernization and industrialization has brought serious environment hazards also. Increased number of industries has increased the disposal of effluent either on open land or to water bodies. The waste water from different industries are disposed to nearby water bodies in Punjab State. The task leads to pollution of water bodies, hence disturbing natural water ecosystem.

2. Materials and Methods

The dairy effluent samples were collected from industry located in Patiala, Punjab (India) in previously cleaned and labled plastic bottles and then sealed. The collected samples were stored and incubated at normal temperature for further physiochemical and biological studies. The sample of effluent was analysed for various physiochemical and biological parameters as per procedures of IS: 3025. The COD, nickel, cobalt, potassium, SAR, nitrate AND Azotobacter count were analysed as per procedures of APHA. Biological parameters like bacterial count and fungal count were analysed by IS: 5401 and FSSAI standard methods respectively. The soil sample was collected from 2-3 Km away from effluent disposal point in pre cleaned, dried plastic buckets. Immediately the samples were stored at normal room temperature. The soil was dried, mixed thoroughly and sieved to eliminate debris. Five earthen pots of same dimension in replicates of three were washed, dried, labelled and filled with equal amounts of soil. The soil samples were left open for 3 days. The dilutions of effluent (0%, 25%, 50%, 75% and 100%) were prepared by diluting it with control water. The soil samples were treated with diluted effluents on regular basis. The seeds of wheat were sterilized with 0.1% w/v mercuric chloride solution for 5 minutes as per method of Bathla et al.[18]. Twenty healthy wheat seeds were sown in these pots and then added 50 ml of diluted effluent and incubated at room temperature. Five sets of earthen pots in replicates of three were irrigated with dilutions of effluent (25%, 50%, 75%, 100% and control). The seed germination test was carried out for one week with regular observation at an interval of every 24 hours. The 15 seedlings were permitted to grow in each pot under treatment. Tap water was used to run control experiment. The shoot length of plants was also noticed till 7 days of germination. The growth parameters like shoot length, leaf length, root length, total growth of plant, fresh weight, dry weight, chlorophyll and nitrogen content were determined after one month of sowing. A cultivable plot in dimensions of 2'x2' was ploughed and prepared. Similar to lab experiments, the plants were allowed to grow in plots. Each plot was given equal amounts of water throughout the studies. The growth parameters of wheat were observed for one month of transplantation of the seedlings.

3. Results

3.1 The Physiochemical and Biological Studies of Dairy Effluent

As per the results given in Table 1 the average temperature of 18.15^{0}C of the dairy effluent was observed at the site. The treated effluent was clear, colourless and odourless with pH value nearly 7.10 (on an average). The conductivity and salinity of the effluent samples were found to be 1020S/m and 0.14ppt respectively. The effluent sample had TDS and TSS of 174mg/L and 19.44mg/L that fall under permissible limits as per standards for its disposal. It suggested that such effluents could be used for irrigation. Total hardness and total alkalinity of 443mg/L and 51.20mg/L were observed in effluent sample. The samples were found with DO, BOD and COD of 2.95mg/L, 11.90mg/L and 46.30mg/L respectively. The NPK value of 28mg/L, 13.10mg/L and 168mg/L was observed in effluent samples.

As per studies the presence of such nutrients could enhance the fertility of soil along with growth of crops. In[1] authors studied elevated rice growth due to nutrients like NPK of effluent of paper mill. Similarly, in [2,3] authors also noticed that effluent irrigation lead to healthy growth of plants than fresh water due to supply of nutrients

Table 1. Determination of physiochemical and biological parameters of dairy effluent (Wheat season)

	PARAMETER	UNITS	OBSERVATION
PHYSICAL PARAMETERS	Temperature	^0C	18.15
	Electrical conductivity (EC)	S/m	1020.00
	Salinity	ppt	0.14
	pH		7.10
	Total solids (TS)	mg/L	193.44
	Total dissolved solids (TDS)	mg/L	174
	Total suspended solids (TSS)	mg/L	19.44
	Color		Colourless
	Appearance		Clear
	Odour		Odourless
CHEMICAL PARAMETERS	Total hardness	mg/L	443.10
	Total alkalinity	mg/L	51.20
	Chloride	mg/L	16.01
	Sulphate	mg/L	211.00
	Dissolved Ohxygen	mg/L	2.95
	Biological Oxygen Demand	mg/L	11.90
	Chemical Oxygen Demand	mg/L	46.30
	Nitrogen	mg/L	28.00
	Sodium	mg/L	319.00
	Phosphorous	mg/L	13.10
	Calcium	mg/L	76.10
	Potassium	mg/L	168.20
	Organic Carbon	mg/L	10.40
	Cadmium	mg/L	Not detected
	Cobalt	mg/L	Not detected
	Nickel	mg/L	Not detected
	Copper	mg/L	0.75
	Lead	mg/L	Not detected
	Phosphate	mg/L	Not detected
	Nitrate	mg/L	11.90
	Iron	mg/L	<1
	Sodium Absorption Ratio (SAR)		23.80
BIOLOGICAL PARAMETERS	Total bacterial count	CFU/mL	11096.00
	Total Fungal count	CFU/mL	1467.00
	Azotobacter Count	CFU/mL	Nil

(Nitrogen, Phosphorus and Potassium). The sodium and calcium content of effluent samples were observed to be 319mg/L and 76.10mg/L respectively. Organic carbon of 10.40mg/L was found. In[4] authors also noticed the presence of detergent residues, sanitizer residues, salts and organic matter in effluents. In[5,6] authors explored increase in pH, conductivity and organic matter content on application of effluent. Similarly, in[7–9] authors recorded an increase of organic content of soil on application of industrial effluent. The effluent of such industry could be used for irrigation. The copper, nitrate and iron content of the effluent samples were analyzed to be 0.75mg/L, 11.90mg/L and <1mg/L respectively. The effluent sample was with SAR value of 23.80. The total bacterial count, total fungal count and Azotobacter count was 11096CFU/mL, 1467CFU/mL and nil respectively. The results indicated that similar to TDS and TSS; the pH, BOD and COD values of effluents were also within permissible limits to be used as irrigation. In[10] authors also recommended the use of treated effluents for irrigation in agriculture. According to[11] the large amount of effluent of milk industry could fulfil water demands.

3.2 Effect of Effluent of Various Dilutions on Seed Germination and Plant Growth of Wheat on Laboratory Scale

Effect of effluent-soil mixture on growth of wheat plants on laboratory scale is shown in Table 2. The percentage of seed germination of 94% and 67.10% were noticed in seeds treated with 50% and 100% of dilution on 7th day of treatment. In[12] concluded that pure effluent could leads to inhibition of amylase activity, hence low germination percentage. Less percentage germination of plants treated with effluent of 100% concentration may also be due to change in its osmotic pressure. The shoot length of 8.10cm after 7 days of treatment was observed maximum in dilution of 25% and minimum in plants irrigated with dilution of 100%. This may also have attributed to variation in osmotic pressure. Seed germination revealed a healthy growth on irrigated seeds with effluent of 50% of dilution. In[13] authors also concluded the healthy growth of mustard plants after treating of seeds with diluted effluents. As per the studies, in[14] the growth of kharif crops may get affected with effluent of dairy industry at different concentrations due to variation in germination of seeds and growth of seedlings. The length of leaf and shoot of 5.2cm and 12.50cm were healthy in plants treated with effluent of 50% concentration after 15 days of treatment. The leaf length and shoot length of 5.6cm and 13.70cm were attained using effluent of 100% concentration after 15 days of sowing. The leaf length and shoot length of 17.45cm and 33.20cm were observed maximum in plants treated with effluent of 50% concentration. On another hand the root length of 13.30cm was maximum in plants treated with 75% dilution. In[15] authors studied almost same trends in the results in the growth of Pisum Sativum using textile effluents. Overall growth of plants of 46.10cm was maximum in seedlings irrigated with effluent of 50% concentration after a month of sowing. The fresh weight and dry weight of 1.96g and 0.57g indicated an improved growth of plants treated with effluent of 50% dilution. The nitrogen content of plants treated with 50% of dilution and control was 2.70% and 2.38%. The chlorophyll content varied from 0.40 to 0.60 in case of 0% and 50% dilution. The results are in agreement to the

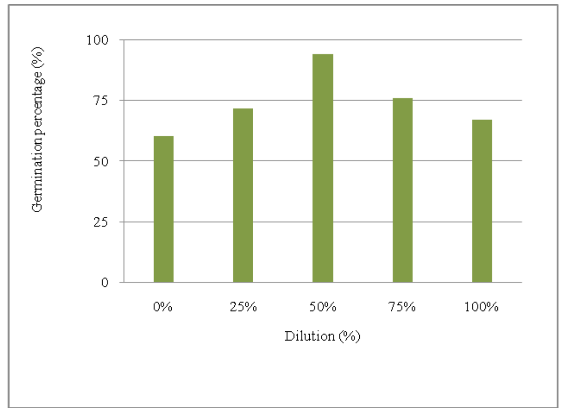

Figure 1. Germination of wheat seeds after seven days of sowing at laboratory scale.

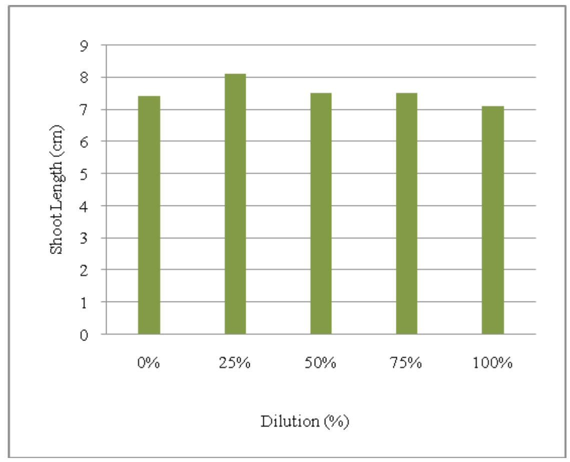

Figure 2. Shoot length of wheat plants after seven days of sowing at laboratory scale.

Table 2. Effect of various soil-effluent mixtures on seed germination of Paddy on laboratory scale

Days	Parameters	Units	Dilutions				
			0%	25%	50%	75%	100%
After 7days of germination	Germination percentage	%	60.40	71.50	94.10	76.00	67.10
	Shoot length	cm	7.40	8.10	7.50	7.51	7.10
After 15 days of germination	Leaf Length	cm	5.30	04.80	5.20	5.20	5.60
	Shoot length	cm	12.40	12.25	12.50	12.80	13.70
After one month of germination	Leaf Length	cm	15.40	15.07	17.45	16.40	14.90
	Shoot length	cm	25.06	28.00	33.20	24.20	28.20
	Root length	cm	10.90	11.20	12.90	13.30	10.00
	Total growth of plant	cm	35.96	39.20	46.10	37.50	38.20
	Fresh weight	g	1.55	2.20	1.96	1.58	1.09
	Dry weight	g	0.58	0.48	0.57	0.52	0.53
	Chlorophyll (Absorbance value)	620nm	0.40	0.52	0.60	0.42	0.45
	Nitrogen	%	2.38	2.40	2.70	2.51	2.60

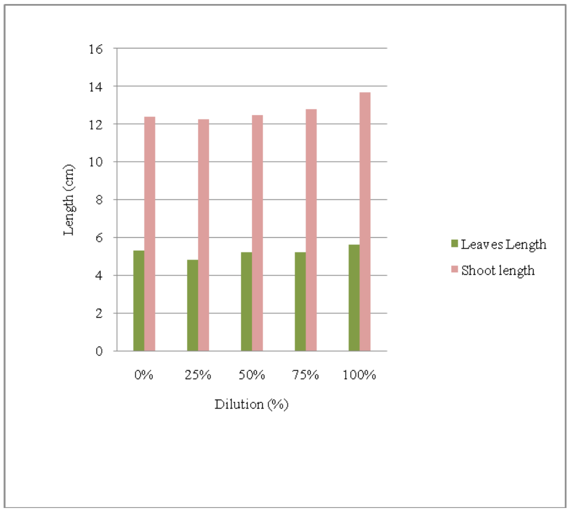

Figure 3. Leave length and shoot length of wheat plants after fifteen days of sowing at laboratory scale.

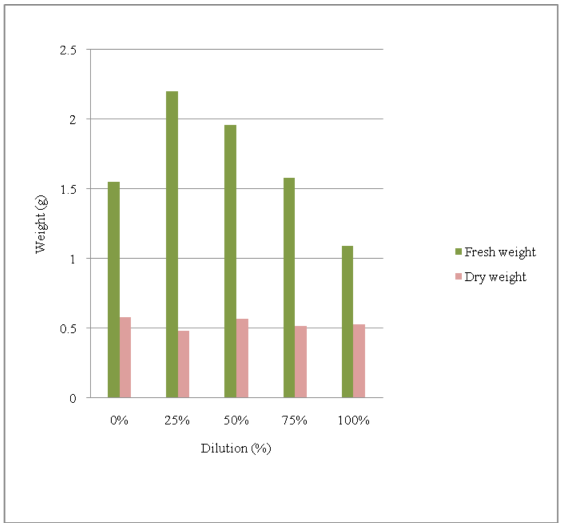

Figure 5. Weight of wheat after thirty days of sowing at laboratory scale.

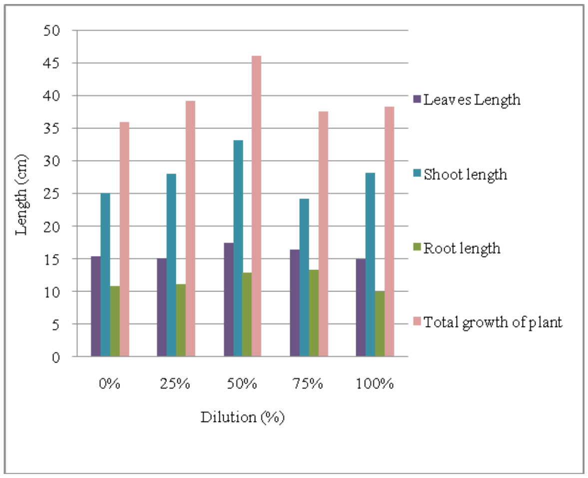

Figure 4. Growth parameters of wheat after thirty days of sowing at laboratory scale.

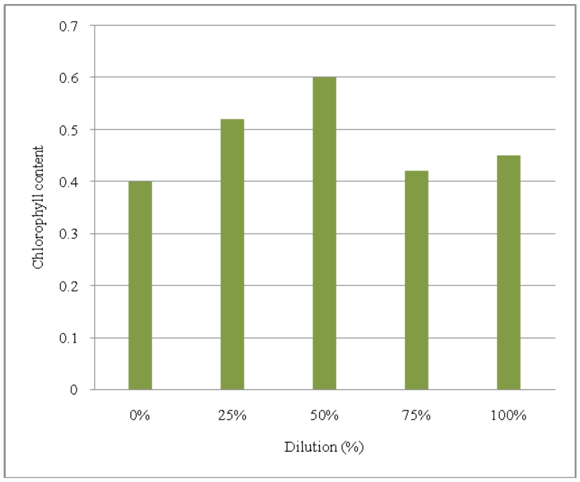

Figure 6. Chlorophyll content of wheat after thirty days of sowing at laboratory scale.

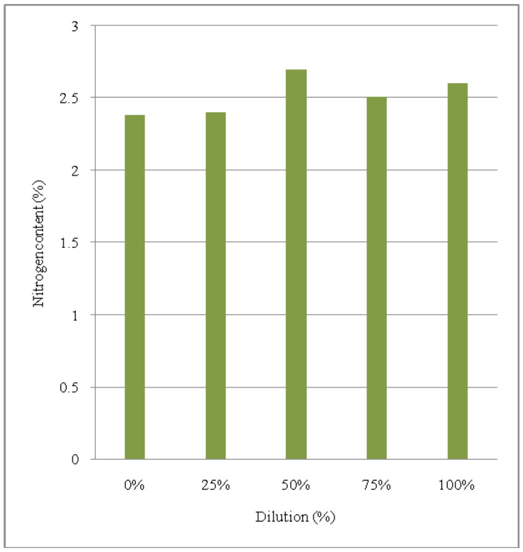

Figure 7. Nitrogen content of wheat after thirty days of sowing at laboratory scale.

Figure 8. The germination of seeds on treatment with effluent of dairy industry after seven days of sowing.

Figure 9. The germination of seeds on treatment with effluent of dairy industry after fifteen days of sowing.

Figure 10. The germination of seeds on treatment with effluent of dairy industry after thirty days of sowing.

findings that the effluents of sugar mill diluted to particular dilution improved the plant growth and chlorophyll content of green grams in the studies[16]. In[17] authors also concluded the same during analyzing effects of fertilizer factory effluents on growth of gram plants. The representations for plant growth are shown in Figures from 1 to 10.

3.3 Effect of Effluent on Seed Germination and Plant Growth of Wheat on Pilot Scale

The effluent treated plants were observed for various parameters after the interval of 24 Hours for one month of transplantation. Effect of various soil-effluent mixtures on seed germination of wheat on pilot scale are shown in Table 3. For instance, maximum leave length and shoot length of 7.35cm and 18.9cm were found in plants treated with effluent of 50% dilution after 15 days of growth. The leave length and shoot length of 6.10cm and 16.60cm were observed minimum in plants treated with effluent of 0% after 15 days of treatment. Leaf Length, shoot length, root length and total growth of plant of 14.9cm, 48.35cm, 9.20cm and 57.55cm were found in plants treated with 50% of dilution. The total growth of 33.50cm was found minimum in plants treated with control. As per studies in[18], similar findings for irrigation of wheat plants using pharmaceutical effluents of 60% dilution were observed. The fresh weight and dry weight of 1.12g and 0.57g was observed minimum in plants grown by control. Based on all the parameters, the dilution of 50% showed healthy growth of plants. It is in agreement with studies[19,20] that the industrial effluents could supply essential nutrients in enough amounts, which may improve growth of plants. The graphical representation of growth parameters is shown in Figures from 11 to 13. Many researchers have studied soil properties and other parameters in local as well as global level[21–28].

4. Conclusion

The compatibility of the effluents of dairy industry located in Punjab (India) for wheat growth was investigated during wheat season. The results showed the presence of macronutrients (Nitrogen, Posphorous and potassium) and micronutrients like copper, iron and nitrate that helped to boost up the growth of wheat. The effluent was found free of toxic components like lead. The growth parameters like percentage germination of seeds, leaf length, shoot length, root length, total growth of plant

Table 3. Effect of various soil-effluent mixtures on crop growth on pilot scale

Days	Parameters	Units	Dilutions				
			0%	25%	50%	75%	100%
After 15 days of germination	Leaf Length	cm	06.10	07.10	07.35	06.75	06.20
	Shoot length	cm	16.60	18.00	18.90	18.10	17.60
After one month of germination	Leaf Length	cm	15.35	15.95	14.90	14.20	14.55
	Shoot length	cm	26.60	39.10	48.35	37.10	46.20
	Root length	cm	6.90	7.20	09.20	09.00	8.90
	Total growth of plant	cm	33.50	46.30	57.55	46.10	55.10
	Fresh weight	g	1.12	1.55	1.60	1.70	1.35
	Dry weight	g	0.57	0.65	0.71	0.70	0.59

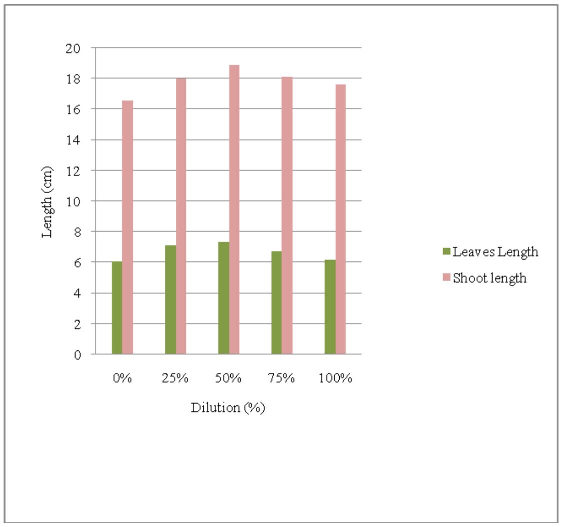

Figure 11. Growth of wheat after fifteen days of sowing at pilot scale.

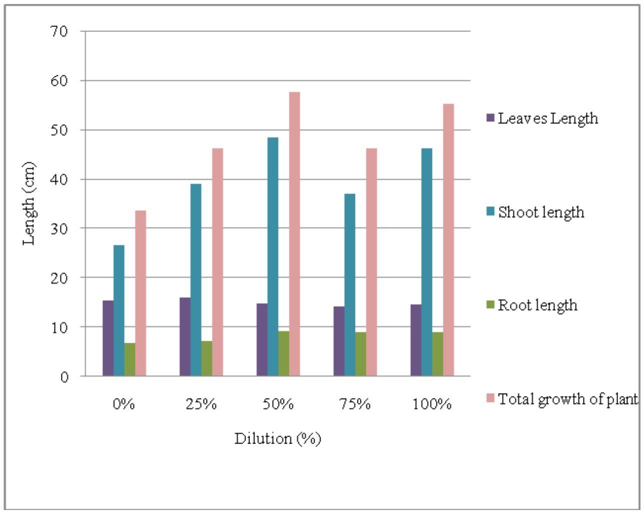

Figure 12. Growth of wheat after thirty days of sowing at pilot scale.

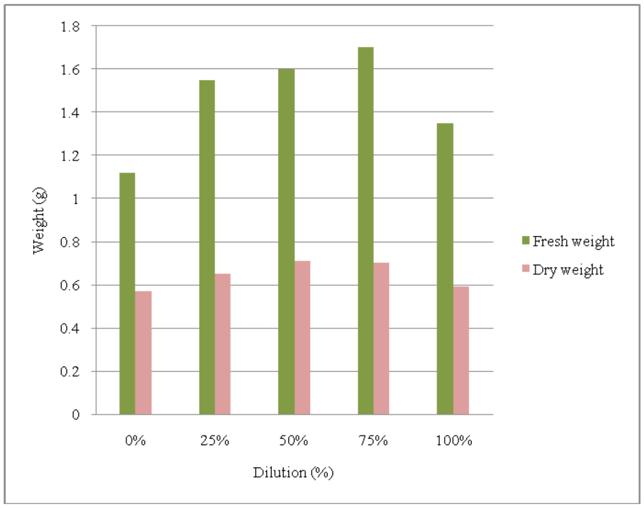

Figure 13. Weight of wheat plant after thirty days of sowing at pilot scale.

and weight showed that dairy industry effluents led to healthy growth of wheat at 50% of dilution. The effluents had potential to be utilized as liquid fertilizer at dilution of 50%.

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6. References

1. Dutta SK, Boissya CI. Effect of paper mill effluent on growth yield and NPK content of transplanted rice. Journal Environmental Biology. 1990; 20(29–32):29–32.
2. Da Fonseca AF, Melfi AJ, Montes CR. Maize growth and changes in soil fertility after irrigation with treated sewage effluent I Plant dry matter yield and soil nitrogen and phosphorus availability. Communications in Soil Science and Plant Analysis. 2005; 36(13–14):1965–81. Crossref
3. Dheri GS, Brar MS, Malhi SS. Heavy-metal concentration of sewage-contaminated water and its impact on underground water soil and crop plants in Alluvial soils of Northwestern India. Communication in Soil Science & Plant Anal. 2007; 38(9–10):1353–70. Crossref
4. Belyea RL, Williams JE, Gieseka L, Clevenger TE, Brown JR. Evaluation of Dairy waste water solids as a feed Ingredient. Journal of Dairy Science. 1990; 73(7):1864–71. Crossref
5. Gogate MG, Faroojqui UM, Joshi VS. Sewage water as potential for free growth–a study on teak Tactonagrandis plantation. AndianForester. 1995; 121(26):472–81.
6. Naidu K, Madhusree, Raman GK. Distillery water-impact on Arachis hypogeal. L. Journal of Environmental Biology.1995; 16:181–6.
7. Saravanamoorthy MD, Ranjitha-Kumari BD. Effect of textile water on morphology and yield on two varieties of peanut. Journal of Agricultural Technology.2007; 3(2):335–43.
8. Ale R, Jha PK, Belbase N. Effects of distillery effluents on some agricultural crops A case of environmental injustice to local farmers in Khajura VDC Banke. Scientific World. 2008; 6(6):68–75.
9. Aghabarati A, Hosseini S M, Maralian H. Heavy metal concentration of soil and olive trees (Oleaeuropaea L.) in Suburban areas of Tehran. Iran. Research Journal Environment Science. 2008; 2(5):323–9. Crossref
10. Mahasneh. Treated waste water reuse in agriculture. I. Hussein medical centre project issue number 12. Bulletin of water research and study center University of Jordan; 1989
11. Monroy HO, Vazquezz M, Derramadero JC, Guyot JP. Anerobic-aerobic treatment of Dairy waste water with national technology in Maxico the case of El Sanz. 3rd international symposium on waste management problems in Agro-industries, Mexico City; 1995. p. 202–9.
12. Chang CW. Enzymatic degradation of starch in cotton leaves. Phytochemistry. 1982; 21(6):1263–9. Crossref
13. Patel B, Kumar P, Kumar KTR. Study of physiochemical characteristics of sugar factory waste and its effect on seed germination of some wild trees. 1991, 4, pp. 90-91.
14. Bishnoi&Gautam, D.D. Effect of diary effluents on seed germination and seedling growth of some crop plants. International Journal ofEconimic Environment Science. 1992; 4:111–15.
15. Gupta, Arun, Nathawat GS. Effect of textiles effluents on germination and seedling growth of Pisumsativumvar RPG-3. Acta- Ecologica. 1992; 12(2):109–12.
16. Nath K, Singh D, Sharma YK. Combinatorial effect of distillery and sugar factory effluent in crop. Journal EnvironmentalBiology. 2007; 28(3):577–82. PMid:18380078
17. Pratap P. Impact of fertilizer factory effluent on seed germination, seedling growth and chlorophyll content of gram (Ciceraeritenum). Journal of Environmental Biology. 2006; 27(1):153–6.
18. Bathla R, Kapoor RP. Studies on effect of pharmaceutical effluent on soil and early growth of paddy (Oryza sativa L). Environmental Pollution Control Journal. 2008; 11(4):42–9.
19. Veer B, Lata K. Effects of polluted municipal waste water on growt yield and levels of some biochemical components of Triticumaestivum. 1987; 15(2):242–6.
20. Swaminathan KJ, Aryan R. Effect of glucose factory effluent on seed germination and seedling development of Groundnut. The Academy of Environmental Biology; 1997.p. 81–7.
21. Al Omron AM, El-Maghraby SE. Long term effect of irrigation with the treated sewage effluent on some soil properties of Al-Hassa Governorate Saudi Arabia. Journal of the Saudi Society of Agricultural Sciences. 2012; 11(1):15–18. Crossref
22. Abd El-Hady BA. Compare the effect of polluted and river Nile irrigation water on contents of heavy-metals of some soils and plants. Research Journal Agriculture Biology. 2007; 3(4):287–94.
23. Cameron KC, Rate AW, Noonan MJ, Moore S, Smith NP, Kerr LE. Lysimeter study of the fate of nutrients following

subsurface injection and surface application of dairy pond sludge to pasture. Agriculture EcosystemsEnvironment. 1996; 58(2–3):187–97. Crossref

24. Kumar S. Effect of steel factory effluent on seed germination and seedling growth of Phaseolus mungo. 2006; 17(2):277–83.
25. Pandey SN. Effect of brewery effluent on seedlings of Cajanuscajan and Virgo mungo. JournalApplied Bioscience. 2006; 32:199–222.
26. Rusan MJM, Hinnawi S, Rousan L. Long term effect of waste water irrigation of forage crops on soil and plant quality parameters. Desalinization. 2007; 215(3):143–52. Crossref
27. Samuel S, Muthukkaruppan SM. Physico-chemical analysis of sugar mill effluent contaminated soil and its effect on seed germination of paddy. International Journal of Pharmaceutical & Biological Archive. 2011; 2(5):1469–72.
28. Sumithra S, Ankalaiah C, Rao DJ. Case study of physio chemical characterization of soil around industrial and agricultural area of Yerraguntla Kadapa District AP India. International Journal of Geology Earth & Environmental Sciences. 2013; 3(2):8–34