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Utilization of Amul Dairy effluent for agriculture practices

Sharma, N. K., Goswami Bhakti, Gajjar Bijal, Jain Chirag, Soni Deepak, Patel Krishna
Department of Biological and Environmental Science, N. V. Patel College of Pure and Applied Sciences, Vallabh Vidyanagar, Anand. Gujarat
dr.nitinsharma@gmail.com
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ABSTRACT

Pot experiments were conducted to evaluate the impact of Amul dairy effluent on certain physico-chemical properties of soil and on growth, and quality of Lady's finger (*Abelomoschus esculentus*) and Guar (*Cymopsis tetragonoloba*.). The effluent used in different concentration 20%, 40%, 60%, 80% and 100%. The pH of the waste water was near about neutral but it contained an enough amount of nitrogen, phosphate, chloride, calcium, carbonates, bicarbonates and suspended and dissolved solids when compared with fresh water. Soil receiving the waste water showed no significant changes in water soluble salts, electrical conductivity, cation exchange capacity, pH, total organic carbon etc. Moreover, waste water irrigation resulted in increased growth and nutrients of both the crops.

Keywords: Dairy effluent, germination, biochemical properties, soil quality.

1. Introduction

Diverse nature of agro-based industrial effluents from various industries are disposed off in to soil and water bodies, which has been causing major pollution problem. To economize the irrigation water industrial effluents are now a days commonly used for irrigation. So it is relevant to understand the response of industrial effluents to crops dependent on it. In this relation efforts have been made a cross the effect of dairy effluent on seed germination of crops.

Many workers reported beneficial effect of dairy effluent. Zabek (1976) working on light soils observed that the irrigation with dairy effluents increased NPK in soils and crops, green fodder and wheat grains. A series of experiments were carried out by Jenson (1981) in which dairy effluent was supplied to crops cultivated in sandy soils and received positive response. Ajmal *et al*. (1984) observed that the plant height was reduced by the use of 100% dairy processing effluent but 25 to 75% effluent increased the plant height in kidney bean and pearl millet. Arora *et al*. (2005) worked on the organic pollution load of Aachal dairy mill effluent in terms of physicochemical and bacteriological characteristics and their effects on seed germination of certain agricultural crops. Gautam and Bishnoi (1990) carried out experiments on germination of wheat seed with undiluted and diluted (1:1) dairy effluent and found more growth in diluted effluent. Pandit *et al*. (1996) found that the 25% diluted dairy effluent is beneficial for the cultivation of *Sorghum bicolor L.* Graeme and McKenzie (2004) studied the effect of dairy effluent on dry matter yield, nutritive characteristics and mineral content of perennial pasture. Their study indicated that dairy effluent increased pasture dry matter yield during late spring and summer in dry land areas. Jacobs and Ward (2006) also observed increase in dry matter yield in Chicory (*Chichorium intybus L.*), Hunter (*Brassica campestris* L.) and Winfred (*Brassica napus* L.) under the influence of dairy effluent.

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Bhatnagar and Gupta (2002) studied the effect of dairy effluent on soil properties and reported no change in soil physico-chemical properties.

Germination is a critical stage which ensures reproduction and consequently controls the dynamics of population, so it is a critical test for the probable crop productivity Radosevich *et al.* (1997). The dairy effluent is mixture of organic and inorganic nutrients and has been reported to have a beneficial effect on seed germination Subramani *et al.* (1999). Nevertheless the sensitivity of the plants varies from species to species to the effluent salinity, Raman (2002). A laboratory experiment was premeditated to know the effect of different concentration (10-100%) of dairy effluent on seed germination in some vegetables like Lady's Finger (*Abelomoschus esculentus*) and Guar (*Cymopsis tetragonoloba*).

2. Materials and Method

The treated effluent was collected from the Amul dairy, Anand, (Gujarat), India where over diluted effluent has been released by the Industry. The Physico-chemical properties of the effluent were analyzed following the procedure of APHA (1997). To bio-assay the concentration of the effluent control, 20%, 40%, 60%, 80% and 100% was made by diluting the effluent with distilled water. Fifty seeds of Lady's Finger (*Abelomoschus esculents*) and Guar (*Cymopsis tetragonoloba*) were sterilized by 0.1% of mercuric chloride solution to remove the microbes after thorough wash; seeds were sown in the pots. The seeds were irrigated with equal volume of different concentrations of dairy effluent, for each treatment three replicates and in each replicate 50 seeds were taken were recorded at a fixed interval at a fixed time the seeds germinated were counted and removed from the petri dish until there was no further germination. Criterion for germination was visible protrusion of the seed coat and was expressed in percentage. The methods followed for the data recording, calculations and analysis was speed of germination Maguire (1962).

3. Results and Discussion

3.1 Physico-chemical Properties of Effluent

Treated and untreated effluents as well as tap water were alkaline. Where dissolved oxygen is zero in untreated effluent because there are more organic wastes in it & to remove these wastes microbes requires more oxygen so BOD level is higher. Treated effluent contains higher amount of dissolved oxygen (5.2 mg/L) (Figure 1). The control water sample contains no organic wastes hence it have higher amount of Dissolved Oxygen (11.8 mg/L). Oil & grease contents in control water, untreated & treated effluents of Amul were investigated and the value ranges from 0.389-1.958 mg/L. Oil and grease was reported 1.958 mg/L in untreated wastewater. They were present in comparatively lower in amount (0.673mg/L) in treated wastewater (Figure 2). Total dissolved solids value of untreated wastewater (1200mg/L) was very higher than the control water (650mg/l). Normally the untreated effluent of Amul dairy had higher content of sediments which were reduced by treatment thus the treated effluent (1050 mg/L) had reduced TDS (Figure 3).

Total alkalinity of effluent is from 2600-2760 mg/L. Chloride content was lower in the treated effluent (97.96mg/L) than untreated effluent (109.96mg/L) (Figure4).Chloride value founds maximum in control water (119.96mg/L). Where hardness of control water eas lower than the wastewater of amul dairy. The nitrate content was higher in untreated effluent (0.379µg/L) than control water (0.224µg/L) & treated effluent (0.290µg/L) (Figure 2). The amount of phosphate in treated wastewater (1.073µg/L) was higher than control water

(0.083µg/L) (Figure 2) where the amount of phosphate in untreated wastewater was 0.825µg/L, which is lower than the treated water sample.

3.2 Physico-chemical Properties of Soil

From 20-100 % effluent alkalinity ranges from 350-450 (mg/l) and for control alkalinity was found to be 475 mg/l which was slightly higher than that of 100% concentration (Figure 6). Pot chloride content of control pot (soil) was 151.1(mg/100gm) which was found to be higher than the soil of 100% treated effluent. Range of the chloride content in 20-100% treated effluent was found in the range 63.97-135.9 mg/100gm (Figure 6). Where organic matter of the soil irrigated with the effluent (20-100%) was found to be decreased with increase in concentration which was 69-190 mg/100gm and in control the concentration was 50 mg/100gm (Figure 6). In treated effluent nitrate concentration were ranging from 0.03-0.041 mg/L for 20-100 % effluent and control contains 0.025 mg/L nitrate concentration so we can conclude that treated effluent has more nitrate (Figure 5). Phosphate concentration was reported in treated effluent range of (20-100 %) 0.626-0.800 mg/L (Figure 5). Whereas that of in the control water sample is 0.414 mg/L, which is lesser than treated effluent.

3.3 Seedling Growth rate and Germination Percentage

Germination percentage

Seed germination rate was 64% in *Abelomoschus esculentus* (Figure 7) and 68% in *Cymopsis tetragonoloba* (Figure 7).

Growth rate

As the concentration of the effluent increases the length of the saplings increases from range 13.8 to 18.4 cm in *Abelomoschus esculentus* (Figure 8) and 16.7 to 19.0 cm in *Cymopsis tetragonoloba.* (Figure9) from control sample to 100% effluent (Plate-1).

Fresh weight

The fresh weight of the sapling were found to be increase as the concentration of the effluent increased. It ranged from 0.25 to 0.33 gm in *Abelomoschus esculentus* (Figure 8) and 0.31 to 0.55 gm in *Cymopsis tetragonoloba* (Figure 9).

Dry weight: The dry weight of the sapling was found to be increase as the concentration of the effluent increased. It ranged from 0.015 to 0.03 gm in *Abelomoschus esculentus* (Figure 8) and 0.02 to 0.04 gm in *Cymopsis tetragonoloba* (Figure 9).

3.4 Nutrient Quality

Protein: Protein content of 20-100% concentrated effluent was investigated in the range of 0.24-0.292 mg/100gm and 0.041-0.104 in *Cymopsis tetragonoloba* and *Abelomoschus eschulentus* respectively. Protein content of seedling was slightly higher in treated effluent from the control seedlings. In *Cymopsis tetragonoloba* (Figure 11), Control and 20% concentration having same sugar content that is 0.433 and 40-100% concentration shows increase in the sugar level in the range of 0.44-0.49 and in *Abelomoschus eschulentus* (Figure 10) control had 0.255 and 20-40% concentration having sugar level 0.068-0.196. Chlorophyll content ranges from 1.443-1.835 mg/l in *Abelomoschus esculentus* (Figure 12) 1.45-1.539 mg/l in *Cymopsis tetragonoloba* (Figure13).

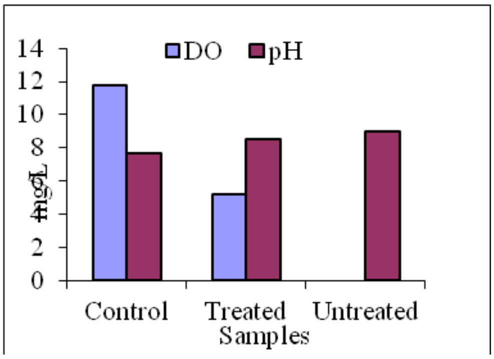


Figure 1: Dissolved Oxygen and pH of water samples

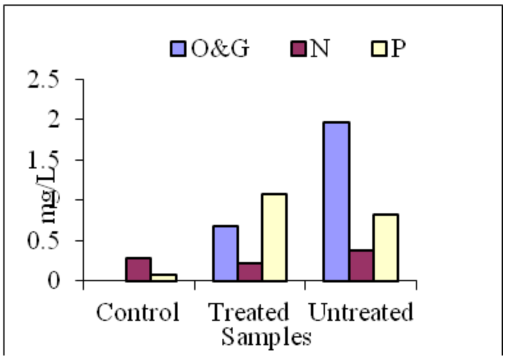


Figure 2: Oil and Grease, Nitrate and Phosphate of water

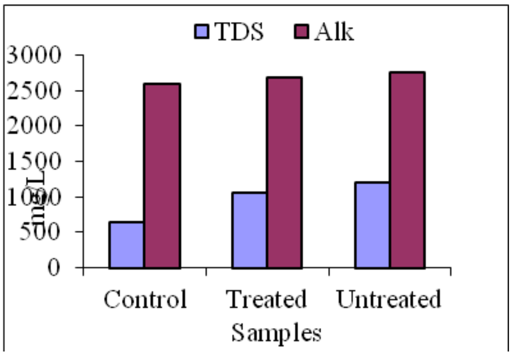


Figure 3: Total dissolved solids and alkalinity of water samples

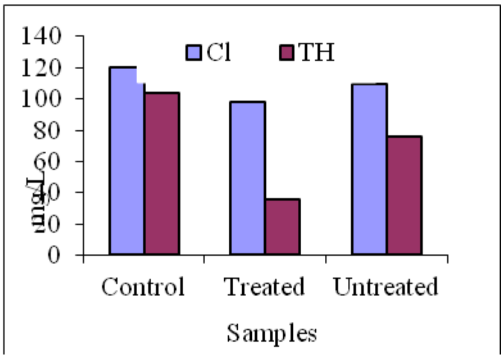


Figure 4: Chloride and Total Hardness of water samples

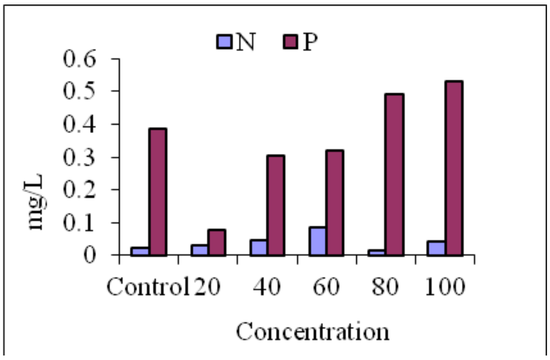


Figure 5: Nitrogen & Phosphorus content in soil

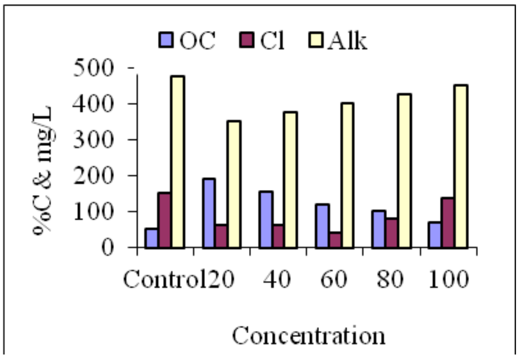


Figure 6: Organic Matter, Chlorine and alkalinity in soil

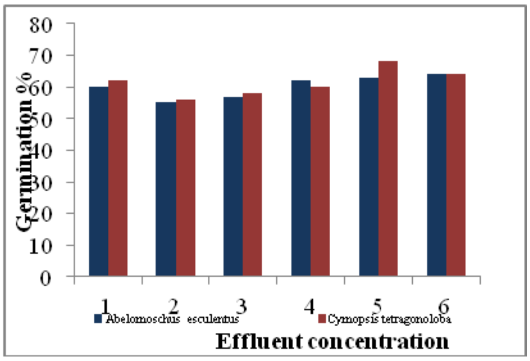


Figure 7: Germination % of *A. esculents C. teragonoloba*

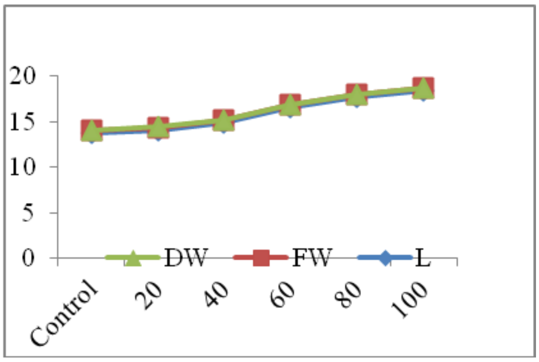


Figure 8: Dry weight, fresh weight & length of *Abelomoschus esculentus*

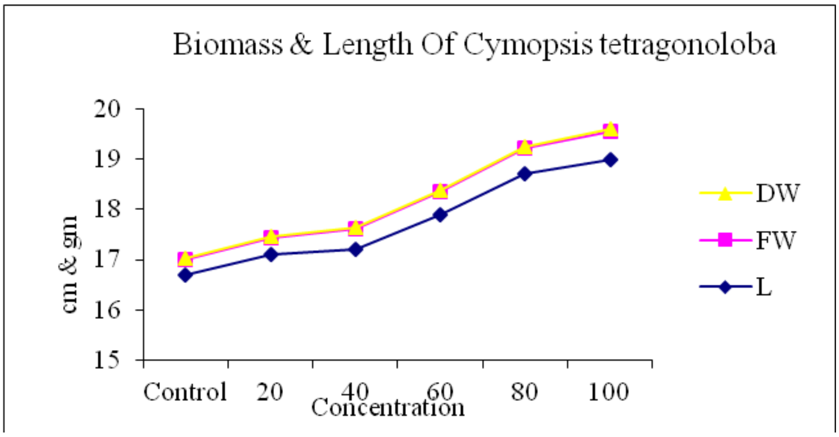


Figure 9: Comparison of dry weight, fresh weight & length of *Cymopsis tetragonoloba*

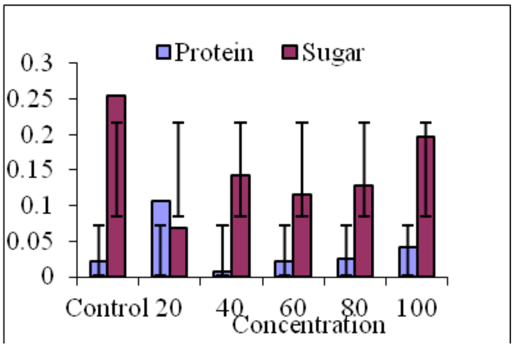


Figure 10: protein & sugar of *Abelomoschus esculentus*

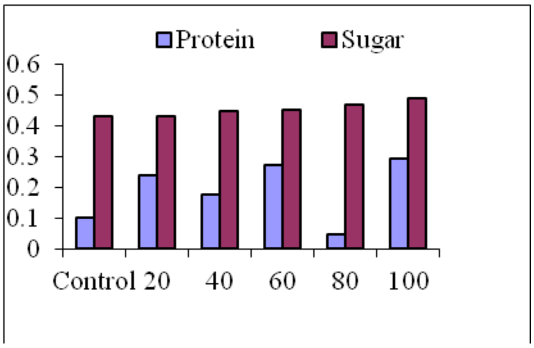
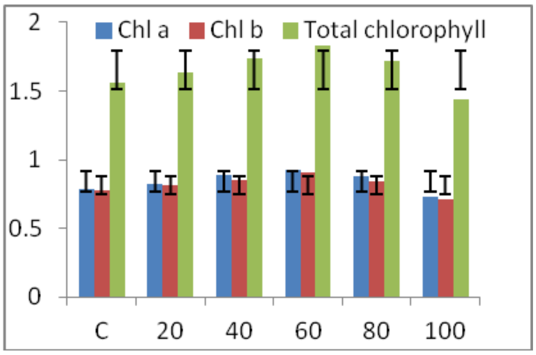


Figure 11: protein & sugar of *Cymopsis tetragonoloba*



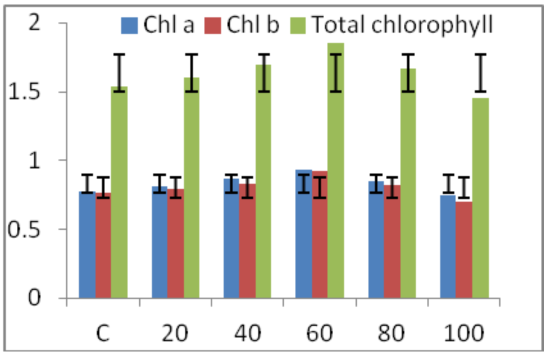


Figure 12: Figure 13: Chlorophyll content (chl a, chl b & total chlorophyll) of *Abelomoschus esculentus and Cymopsis tetragonoloba*

3.5 Discussion

3.5.1 Physico-chemical Properties of Effluent

Water is known as a natural solvent. Before it reaches to the consumers tap, it comes into contact with many different substances, including organic matter, chemicals & other contaminants. pH was found alkaline range between 7.7 to 9.0 (control, treated, untreated) pH of the control samples are normal in range but untreated samples were having highly alkaline pH. From the past studies it is concluded that free CO_2 in the water are partly responsible for the increased or initial pH reading (Park, 1997). Lower pH generally causes lower cation exchange capacity because the higher concentration of H^+ in solution will neutralize the negative charges in the organic matter. Total dissolve solids of the Amul Dairy effluent were as follows control contains 650 mg/L, treated -1050mg/L, untreated- 1200mg/L but total dissolved solids can have an important effect on the taste of drinking water (Sawyer, 1980) so that both effluent of Amul Dairy are having range above from the normal Bruvol & Ongerth, 1969 concluded that the range between 658-758 mg/L was good enough and range between 1283-1333 mg/L was unpalatable for drinking. In our present study TDS was found in the range 650-1200 mg/L which was within the desirable limit. Hardness is defined as the concentration of calcium & magnesium ions content of water (Kumar & Kakrani, 2000). The principal sources of hardness in water are seepage and run off from soil (Sawyer & Mc Carty, 1967). Hardness of the untreated effluent was higher than the treated & control that is (36 & 30mg/L). Alkalinity is a measure of how much acid it takes to lower the pH below certain level, also called buffering capacity. Under most conditions the ions that have the greatest effect on alkalinity are carbonates like calcium and magnesium etc. The common problems associated with high alkalinity result from its tendency to increase substrate pH can cause micronutrient deficiency. Low alkalinity is a tendency for substrate pH to drop over time which can cause micro nutrient toxicity (Bill, 2003). Alkalinity in natural waters is due to free hydroxyl ions & hydrolysis of salts formed by weak acids & strong bases. Water with low alkalinity is more likely to be corrosive & high alkalinity may affect the pH, which on boiling converts bicarbonates to carbonates. In AMUL dairy effluent study, control having 2600 mg/L alkalinity where as treated & untreated having more than the controls alkalinity that is 2680 & 2760 mg/L so that it is considered

Chlorides occur naturally in all types of water. In drinking water the presence of chlorides is due to irrigation drainage (Bond et al, 1973).The average intake of chlorides through drinking water is approximately 10 mg/L (Pettyjohn, 1971). The chlorides ions play a more active & independent role in renal function (Jaina et al, 1980, Toto et al; 1984) nutrition (Honeyfield

& froseth,1985) the threshold for chloride in drinking water is generally in the range 200-300mg/l (Trivedi & Goel,1986). In present study control contains higher amount of chlorides than the untreated and treated. However the value did not cross the limit.

Nitrogen is needed by plants for the production of proteins, nucleic acids, and chlorophyll. Nitrogen deficiency may cause chlorosis of leaves, stunted and slow growth, and necrosis of older leaves (Jones, 1998). Insufficient amount of nitrogen in cereals results in few tillers, slender stalks, short heads, and grains with low protein content. Nitrate is naturally occurring ions that is part of the nitrogen cycle. All living system need nitrogen to exist since it is used to build many essential components such as proteins, DNA, RNA & vitamins (hallberg, 1989). Nitrate level in the Amul dairy effluent study, were found in the range of 0.224-0.379 μg/L untreated water contains higher level of the nitrate. Leaf expansion and leaf surface area may also be inhibited, causing leaves to curl and be small (Grundon, 1987). During our present work effluent contains lower level of phosphate that is in untreated water sample where as treated contains high level of phosphate than untreated.

3.5.2 Physico-chemical properties of soil

The organic matter was reported in enough amount in the soil fascilited by the dairy effluent. The present study results correlates by the other worker. There was positive effect on the organic matter status of the soil by the addition of different industrial waste (Raman *et al*., 1996; Dang and Verma, 1996; Mohammad and Awad, 1998; Fierro *et al*., 1999 and Shrikanth *et al*., 2000)). The effluent contains organic material, which is responsible for increase in organic matter of the soil (Subba Rao, 1972; Ajmal and Khan, 1984; Stahl and Williams, 1986; Somawanshi and Yadav, 1990 and Zalawadia and Raman, 1994). Ogoke (1980) reported that crude oil pollution reduced weed weight and increased organic matter content of the soil. Palaniswami *et al*. (1994) found increase in organic matter of soil due to irrigation of distillery effluent and suggested that this was due to microbial decomposition. In the present study also the increase in organic matter of soil was observed after the irrigation of treated effluent. This was beneficial effect of treated effluent.

In soil which is irrigated by dairy water having low chlorine content (151.1mg/100gm) than the soil irrigated with tap water (135.9mg/100gm). Smitha *et al*. (2007) reported an increase in alkalinity in soil irrigated by fertilizer industrial effluent. Ozair *et al*. (1998) in their study reported an increase in carbonates and bicarbonates in soil irrigated with treated effluent of petroleum refinery industry. Certain effluents have no beneficial effect on nitrate content. The study of Godson and Sridhar (2002) showed nitrate content was lesser in the soil irrigated by chemical fertilizer factory effluent than control. The nitrate content of pot treated with 60% of effluent is found to be high. So it can be concluded that proper concentration of dairy effluent can be suggested for irrigation. Over 80% of phosphate can enter from sewage effluents (De, 2002). The main source of phosphate is detergents and agricultural, fertilizers, run off (Park, 1997).The soil which is irrigated by dairy effluent have high phosphate content (0.800 mg/L) than the soil which is treated with tap water (0.414 mg/L).

3.5.3 Seedling Growth rate and Germination Percentage

Seed germination

The germination rate was found nearly 60% in the pots treated with 100% concentrated effluent. On an average there was nearly 55% of germination in all the pots. Several workers have studied the effect of effluent of different industries on seed germination. Yadav and

Meenakshi (2007) reported that the percentage of germination was higher in 25 % surgical effluent than control in wheat, guar and radish but higher concentration of effluent affected germination percentage.

Arora *et al*. (2006) observed the different effect of sugar industry effluent on seed germination of different plants. They found maximum seed germination of *Solanum melongena* in 5% effluent and of *Lycopersicon esculentum* in 100% effluent.

Fresh and dry weight

The fresh weight of the saplings, were found increased in weight as the concentrations of the effluent increased. Thus the nutrient content is increased in the saplings. Yoshika (1989) also substantiates these results in maize and wheat and saving K fertilizer requirement by applying potato starch factory effluents. Bahirat et al. (1989) confirmed that total consumption of N requirement can be curtailed by applying fertilizer factory effluents to groundnut and jute crops simultaneously increased yield of 49.8% and 80.4% respectively. The above results are also in accordane with those of Totawat (1991).

4. Conclusion

From the results of this study, it can be concluded that for this particular condition, application of full water requirement of plants is economical. It is advisable to irrigate with water requirement. This gives similar yield while saving a lot on water and labor. However, treatment should be used as it translates to higher yield and more protection for the soil. The above results confirmed that use of dairy effluent water for agricultural purpose, provided not only water to the plants but also increased the nutrient availability to the plants and efficiency of the fertilizer applied.

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