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Performance Evaluation Study on Treated Effluent Effect on Irrigation Land in and Around Bhudihal Area, Davanagere Taluk

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Abstract; The increasing demand for freshwater resources, coupled with the growing need for sustainable agriculture, has led to the exploration of treated wastewater (TWW) as an alternative irrigation source. This study evaluates the impact of TWW irrigation on the physical and chemical properties of agricultural soil.Soil samples were collected from fields in Dodda Bhuhihal,Chikka Bhudihal and B.Kalpanhalli irrigated with TWW as surface irrigation , and analyzed for key physical properties, including dry density, bulk density, porosity, and moisture content, specific gravity, void ratio as well as chemical properties such as ph, electrical conductivity (EC) and nutrient concentrations (nitrogen, phosphorus, potassium). The results revealed a noticeable improvement in soil moisture retention and organic matter content due to TWW irrigation, contributing to enhanced fertility. Study concludes that while TWW irrigation can improve certain soil qualities and reduce dependence on freshwater, careful management is necessary to mitigate the potential long-term impacts of salinity and contaminants.

Keywords: *Treated Wastewater Irrigation, Soil Physical Properties, Soil Chemical Properties, Soil.*

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I. INTRODUCTION

Water is a copious renewable natural resource that is necessary for a variety of uses, such as industrial, agricultural, recreational, and domestic uses [1]. Around the world, industry uses 22% of freshwater, domestic consumption accounts for 8%, and agriculture uses 70% [2]. Water scarcity is made more difficult for crop development and subsistence by climate change and global warming [3]. Water scarcity can be lessened by treated wastewater (TWW), promoting environmentally friendly farming practices and environmental cleaning [4]. High yields, water replenishment, and pollution reduction are all facilitated by TWW use in agriculture [5]. This strategy helps achieve the Sustainable Development Goals (SDGs) of the UN, improves water security, and encourages sustainable farming methods [6].By contributing nutrients, boosting biological content, encouraging sustainable water use, and igniting microbial activity, TWW irrigation can improve soil health [7]. But close observation of Nonetheless, close observation of the environment, irrigation techniques, nutrient levels, and soil quality impacts are important [8]. putting in place safety precautions like crop rotation management and organic amendments, and stakeholder education, reduces the hazards connected to the usage of TWW [9].

II. MATERIALS AND METHODS

➢ *Study Area*

Located in the heart of Karnataka, Davanagere is being developed under the Central government's Smart City initiative. As to the census conducted in 2021, Davanagere city has approximately 5,30,000 residents. Municipal STP are made to handle garbage that originates in cities. One STP, with a 20MLD capacity, is situated in Shivanagar, Davanagere. This STP releases its treated wastewater into a canal that runs beside the villages of Doddabudihal, Chikkabudihal, and others before joining the Thunga Bhadra river. Doddabudihal, which is too close to the STP, is chosen as site 1 for sampling and analysis. Slightly away from the STP, Chikkabudihal is

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regarded as site 2, while B. Kalpanahalli is regarded as site 3. It is not close to STP. This treated effluent is a key supply of water for farmers in the villages of BKalpanahalli, Chikkabudihal, and Doddabudihal to use for agricultural purposes. The project's study area is depicted in Figure 3.3. These villages primarily farm coconut, sugar cane, arecanut, and paddy.

Fig 1 Study Area

➢ *Sample Collection*

- Physical Properties Analysis

Select a relatively flat spot before collecting a soil sample. On the soil's surface, place the steel dolly on the core cutter that is positioned vertically. Using the rammer, carefully and firmly press the core cutter into the ground up to it is fully installed. Before taking the soil sample from the ground, gently excavate the area around it to ensure that it stays inside the core cutter. Trim away any excess dirt so that the above and bottom of the core cutter line up with the cutter's ends.

- Chemical Properties Analysis

The V approach was used to gather samples from an agricultural area. A circle was formed by thoroughly mixing about 10 samples, taken in a zigzag pattern from each location. The 2 opposing portions and 4 equal divisions from this circle were then thrown away. Once more, the last 2 pieces fused to form a circle. Next, the diagonal 2 portions were removed and again divided into

4 equal sections once more. From the remaining soil weighed around 1/2kg was taken.

➢ *Conduction of Experiments*

- Physical Properties

The bulk density of the soil was determined using the Core Cutter method, which provides the mass of soil per unit volume. The dry density was calculated by considering the moisture content in the soil sample. The porosity and void ratio were derived from the density values, providing insights into the soil's pore structure. The specific gravity of the soil particles was measured using the Pycnometer method, which helps in understanding the relative density of the soil solids. The moisture content was evaluated using the Gravimetric method, which involves drying the soil sample and determining the loss of weight. To assess the soil's particle size distribution, the percentage of sand, silt, and clay were quantified using sieve analysis.

Table1 Analysis of Physical Properties methods

Physical Properties	Methods
Bulk Density(g/cc)	
Dry Density(g/cc)	Core Cutter method
Porosity	
Void ratio	
Specific Gravity	Pycnometer method
Moisture Content (%)	Gravimetric method
Percentage of Sand (%)	
Percentage of Silt (%)	Sieve analysis
Percentage of Clay (%)	

- Chemical Properties

The electrochemical approach was used to measure the soil's pH, which represents the acidity or alkalinity of the soil. Through electrochemical investigation, the soil's electrical conductivity—a measure of its capacity to conduct electricity due to the presence of soluble salts— was also ascertained. The Kjeldahl method, which includes digesting and distilling the soil sample to estimate nitrogen content, was used to determine the amount of accessible nitrogen in the soil. Osla's approach, which measures phosphorus that is readily available for plant absorption, was used to determine the amount of phosphorous that was available. Flame Emission Spectroscopy was used to measure the available potassium (FES).

Table 2 Analysis of Chemical Properties methods

Chemical Properties	Methods
pH	Electrochemical method
Electrical Conductivity	
Available Nitrogen	Kjeldahl Method
Available Phosphorous	Osla's Method
Available Potassium	FES
Organic Carbon	Wet Digestion method

III. RESULTS AND DISCUSSION

➢ *Analysis of Physical Properties*

Table 3 Results of Physical Properties

Parameters	Dodda Bhudihal	Chikka Bhudihal	B.Kalpan-halli
Gravel (%)	9.5	13.6	12.4
Silt and Clay (%)	5.5	11.9	13.6
Sand (%)	85	75	74
Bulk Density(g/cc)	1.33	1.33	1.34
Dry Density(g/cc)	1.26	1.25	1.26
Moisture Content(%)	29.8	29	28.6
Specific Gravity	2.65	2.82	2.65
Void Ratio	1.28	1.28	1.29
Porosity	0.561	0.561	0.563

The soil samples collected from Dodda Bhudihal, Chikka Bhudihal, and B. Kalpanahalli exhibit distinct physical properties. Gravel content varies from 9.5% to 13.6%, with higher values in Chikka Bhudihal and B. Kalpanahalli, indicating improved soil drainage and aeration, which is essential for root growth. Lower gravel content in Dodda Bhudihal suggests slightly reduced drainage, potentially leading to higher moisture retention.The silt and clay content ranges between 5.5% and 13.6%, with Dodda Bhudihal having the highest percentage. Soils with higher silt and clay content exhibit enhanced water retention and nutrient-holding capacity, which can support sustained plant growth in drier conditions. Conversely, lower silt and clay content, observed in B. Kalpanahalli, reduces water retention, promoting better drainage but possibly limiting nutrient availability.The sand content is relatively high across all sites, ranging from 74% to 85%, which significantly enhances drainage and aeration but increases the risk of erosion and rapid nutrient leaching, particularly in sandy soils. These characteristics are particularly pronounced in Dodda Bhudihal, with 85% sand content, making it more prone to water movement and requiring effective soil management to mitigate erosion. Bulk density values range from 1.33 to 1.34 g/cm³, while dry density values range from 1.25 to 1.26 g/cm³, indicating a loosely compacted structure across all locations. This loose structure is beneficial for root penetration and overall soil workability, while still maintaining a balanced structure to support plant growth. The higher values of moisture content (ranging from 28.6% to 29.8%) also suggest improved soil workability, as soils with moderate moisture are easier to till and manage.The specific gravity values range between 2.65 and 2.82, with Chikka Bhudihal having the highest value. This indicates the presence of denser soil minerals, possibly due to the influence of wastewater irrigation, which may introduce minerals like iron or other heavy particles. These higher values can contribute to improved soil stability but may also affect soil fertility depending on mineral composition.The void ratio (ranging from 0.561 **to** 0.563**)** and porosity (ranging between 12.4% and 13.1%**)** are fairly consistent across the sites. These parameters reflect adequate pore space for air and water movement, ensuring sufficient aeration and infiltration capacity, which are crucial for maintaining healthy root environments and facilitating plant growth.

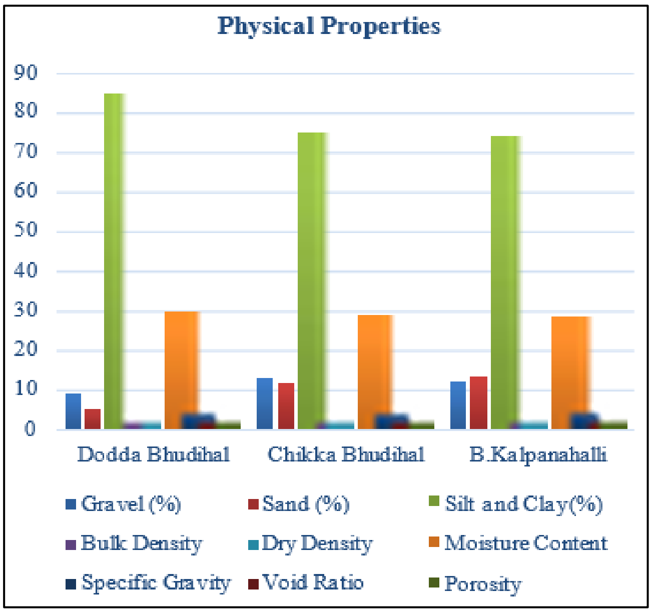

Fig 2 Analysis of Physical Properties Chart

➢ *Analysis of Chemical Properties*

Table 4 Results of Chemical Properties

Parameters	Dodda Bhudihal	Chikka Bhudihal	B.Kalpan-halli
pH	7.47	7.35	7.34
EC (ds/m)	0.12	0.07	0.09
Nitrogen(kg/ha)	230.2	226.18	228.88
Phosphorus(kg/ha)	23.81	28.61	29.88
Potassium(kg/ha)	233.81	286.18	288.7
Organic Carbon	0.81	1.09	1.09

Soil samples taken from Dodda Bhudihal, Chikka Bhudihal, and B. Kalpanahalli have comparable chemical values, with a few minor differences between the sites. The soils' pH values, which range from 7.34 to 7.47, suggest neutral to slightly alkaline conditions that are ideal for most crops and do not appear to pose any significant constraints on plant growth due to pH. Between 0.07 and 0.12 dS/m, the electrical conductivity (EC) values are comparatively low, indicating low concentrations of soluble salts and verifying

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that there are no notable salinity problems at any of the sites. A wide variety of crops thrive in these low EC values since high salinity might hinder plant growth.From 226.18 to 230.2 kg/ha, nitrogen (N) levels are moderate to high; Dodda Bhudihal has the greatest nitrogen content (230.2 kg/ha). All sites with adequate nitrogen levels indicate good fertility, which promotes plant growth and production. Long-term viability, however, depends on preserving the nitrogen balance, particularly in soils that are irrigated with wastewater.The largest amounts of phosphorus (P), which range from 23.81 to 29.88 kg/ha, are discovered in B. Kalpanahalli (29.88 kg/ha) and Chikka Bhudihal (28.61 kg/ha). Since phosphorus is necessary for root development, these moderate levels suggest that there is plenty of it available to sustain crop growth.The maximum potassium value (288.7 kg/ha) is found in B. Kalpanahalli. Potassium (K) levels are high, ranging from 233.81 to 288.7 kg/ha. Elevated potassium concentrations are beneficial for enhancing plant vitality, resilience to drought, and total productivity, especially for crops that require a lot of potassium.The range of organic carbon (OC) content is 0.81% to 1.09%, with Chikka Bhudihal having the highest levels.

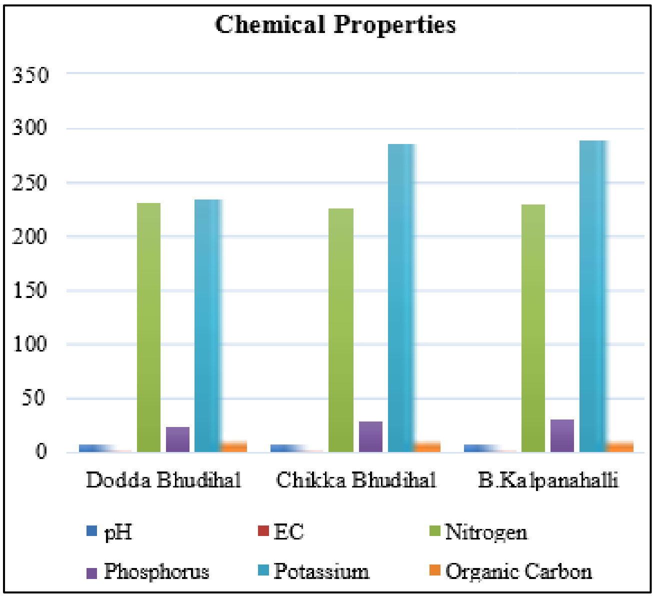

Fig 3 Analysis of Chemical Properties Chart

IV. CONCLUSION

Dodda Bhudihal, Chikka Bhudihal, and B. Kalpanahalli soil samples all have different physical qualities that make a big difference in how well the soil functions and how well plants develop. There is a range of gravel concentration from 9.5% to 13.6%, which impacts drainage and aeration, and a higher silt and clay percentage that affects water retention and holds more nutrients. Even though all sites have a reasonably high sand concentration, erosion and nutrient leakage are still risks because of this.An open soil structure that is good for root penetration and soil workability is indicated by the bulk and dry density values. In order to support healthy root conditions and plant growth, the medium moisture content, consistent void ratio, and porosity values guarantee sufficient pore space for air and water movement. The soils have low electrical conductivity (EC) values (0.07-0.12 dS/m), suggesting no serious salt problems, and neutral to slightly alkaline pH levels (7.34- 7.47), acceptable for most crops. Good fertility is suggested by the moderate to high nitrogen levels (226.18-230.2 kg/ha) and acceptable phosphorus levels (23.81-29.88 kg/ha), which encourage plant development and productivity. Elevated potassium concentrations (233.81-288.7 kg/ha) improve plant health, resistance to drought, and yield overall.Chikka Bhudihal has the greatest amounts of organic carbon content, which varies from 0.81% to 1.09%. These results show that the soils can support a range of crops and offer opportunities for sustainable farming methods.

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