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Effect of Paper Mill Effluent Irrigation and Compost Application on Soil Nutrients and Yield of Groundnut

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ABSTRACT

The investigation was carried out to investigate the impact of paper mill effluent irrigation and compost application on yield of groundnut and soil fertility during *kharif* 2023 with well water and treated paper mill effluent at varying concentrations, at 0% (well water), 25%, 50%, 75% and100% enriched by organic manures (main plot 12.5 t/ha of farm yard manure and 5 t/ha of press mud compost) in groundnut cv VRI 10. The results indicated that among chemical properties, soil pH ranged from 7.40 to 7.97, with variations during different growth stages of the groundnut. The soluble salts in the experimental soil ranged from 0.28 to 0.43 dSm^{-1} during the entire crop duration. Available nutrients in soil generally showed higher concentrations with paper mill effluent irrigation and organic amendments, with values ranging from 184.3 to 198.3 kg/ha for nitrogen, 7.6 to 8.7 kg/ha for phosphorus, 186.0 to 205.5 kg/ha for potassium and 3.5 to 4.6 mg/kg for sulphur. Haulm yield ranged from 2016 to 3133 kg/ha and pod yield ranged from 1440 to 1934 kg/ha, indicated a 25.5% (494 kg/ha) increased yield at 75% paper mill effluent irrigation combined with press mud compost application over control (well water irrigation). The findings from this study indicated that the use of treated paper mill effluent, particularly when combined with organic manures, can be a sustainable approach for crop production.

Key Words: Groundnut, Irrigation, Organics, Soil Nutrients, Wastewater.

INTRODUCTION

Water is a precious and indispensable natural resource in the world base of all life on the earth. The availability of water per person per year was calculated to be 1545 m^3 in 2001 and 1816 m^3 in 2011. In 2021 and 2031 these numbers could further drop to 1486 m^3, and 1367 m^3, respectively (PIB, 2020). Over the past 20 years, water availability has decreased and demand in many industries has increased, making it a crucial economic, social, and political concern. More than 50% of all water used in agriculture, is penalized. In India, wastewater irrigation of crops is a widely used practise (Arora et al, 2008). The paper mill is the top water consumers as well as top producers of wastewater in the world. In India, about 700 paper mills are functioning (Kumar et al, 2017). To produce one tonne of paper typically it requires 273-450 m^3 of water (Hazarika et al, 2007) that consequently, generates 300 m^3 of waste water. Treated wastewater includes additional amount of nutrients that is helpful for crop growth. Wastewater reuse in agriculture offers the widest range of potential applications because it frequently possesses the ability to satisfy the increasing water demands, preserve potable resources, minimize pollution discharge into lakes and rivers, permit lesser costs for wastewater treatment, and boost their income of farmers due to decreased rates of fertilizers application. Consequently, farmers divert and use wastewater in a partially treated, diluted, or untreated form to grow a variety of crops (Murtaza *et al,* 2010). Since it provides a supply of nutrients, this frequently minimize the need for fertilizer application. As a result, recently some nations are focusing on increasing the use of treated

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wastewater for both environmental preservation and agricultural productivity.

Groundnut playing a crucial role in the Indian economy, groundnut is the second most important oilseed crop in India. India is the top three producers of groundnuts worldwide (Raghunatha Reddy, 2022). In 2022, the production of groundnut in India was 10 million MT. It contributes about 13-15% of the world's oilseeds area 8-9% of the world's oilseeds output and 10-11% of the world's vegetable oil consumption and 90% of the crop's total area. Inadequate and imbalanced use of nutrients is a major reason for low yields on groundnut world-wide and nutritional disorder cause yield reduction from 25-40% depending upon the soil types, fertility level of soil and groundnut varieties used. Groundnut is a crop that removes a significant amount of macro and micronutrients. In India, groundnut is grown under rainfed condition because of irrigation water scarcity. The rising use of treated or untreated wastewater worldwide is a result of the increased demand for water for irrigation (Ruma and Sheikh, 2010). Due to the high levels of macronutrients as well as other essential nutrients, wastewater irrigation has recently grown to be an important way to use wastewater and effluent irrigation can reduce water shortage and the need for chemical fertilizer and could enhance soil fertility. The experiment was conducted with the objectives- to study the effect of paper mill effluent irrigation and compost application on yield of groundnut; and to study the effect of paper mill effluent irrigation and compost application on changes in soil properties.

MATERIALS AND METHODS

The study was carried out at Mondippatti village in Manapparai taluk, Tiruchirappalli district, Tamil Nadu under Tamilnadu Newsprint and Papers Ltd.sponsored project sanctioned during 2019-2023 in a groundnut crop of 0.20 ha. The paper mill effluent (treated) from the TNPL-II paper board industry exhibited key characteristics, including light brown colour, a slightly alkaline pH of 7.74 and electrical conductivity ranging from 2.58 to 2.71dSm^{-1}. The effluent exhibited a biological oxygen demand (BOD) of 31.04 mg L^{-1} and a chemical oxygen demand (COD) of 92.08 mg L^{-1}(Akoteyon *et al*, 2011). It contained 15.2 mg L^{-1} of nitrogen (Bremner method), 1.3 mg L^{-1} of phosphorus (spectrophotometry method) and 12.7 mg L^{-1} of potassium (flame photometry method). Among the cations, sodium (Na^{+}) was the dominant ion, with concentrations of 763.06 mg L^{-1}, followed by calcium (Ca^{2+}) (135.96 mg L^{-1}) and magnesium (Mg^{2+}) (94.28 mg L^{-1}) (Versenate method).

The experiment involved irrigating groundnut crop (sub plot) with a mixture of paper mill effluent (treated)and well water at varying concentrations, specifically at 0%(well water) (S1), 25% (S2, 50% (S3), 75% (S4) and100% (S5). Additionally, the soil has been enriched without compost (M1) and compost farmyard manure 12.5 t/ha (M2) and 5 t/haof press mud compost (M3). Dry pods obtained from the observational plants were weighed and recorded per hectare basis. Soil samples were taken from each plot, shade dried, and then sieved using a 2 mm nylon sieve before being placed in polythene bags for additional examination. The data were analysed using the conventional "Analysis of variance" method (Panse *et al,* 1945). The standard error of the means (S.E.m+) was calculated for every factor and interaction. The critical difference (C.D.) was calculated (at 5 per cent) for any results that were deemed significant. Graphs and figures were used appropriately to illustrate the data at the relevant points.

RESULTS AND DISCUSSION

Pod and haulm yield was assessed and showed significant improvements with paper mill effluent application in combination with farmyard manure (FYM) and press mud compost (Fig.1&2). The Haulm yield ranged from 2016 to 3133 kg/ha and pod yield varied from 1440 to 1934 kg/ha, showing a 25.5% (494 kg/ha) increased yield at 75% paper mill effluent irrigation combined with

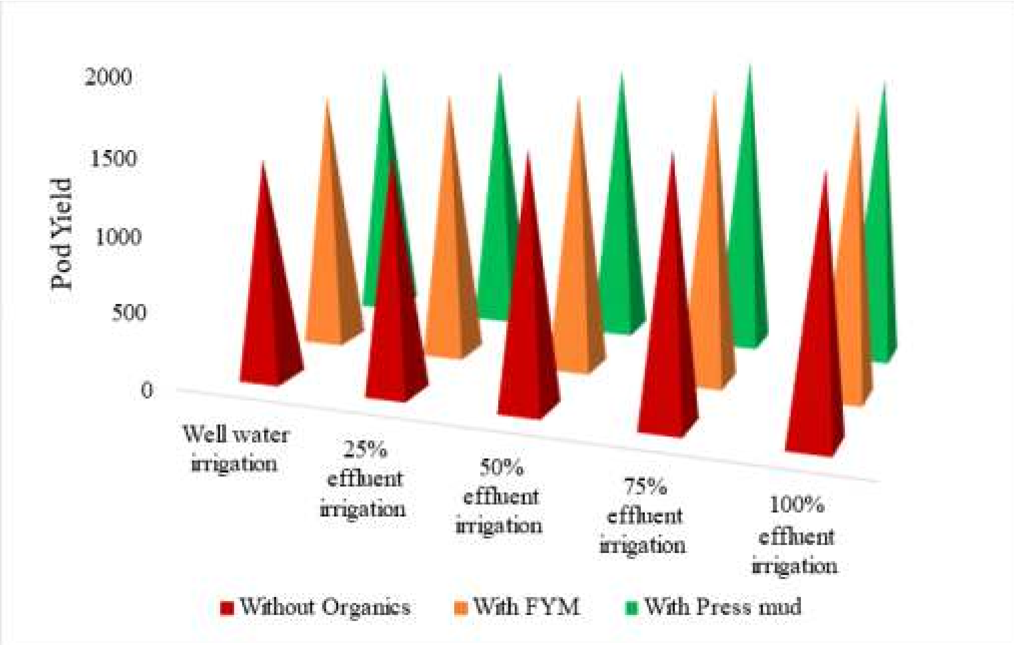

Figure 1. Paper mill effluent and organics application on pod yield (kg ha^{-1})

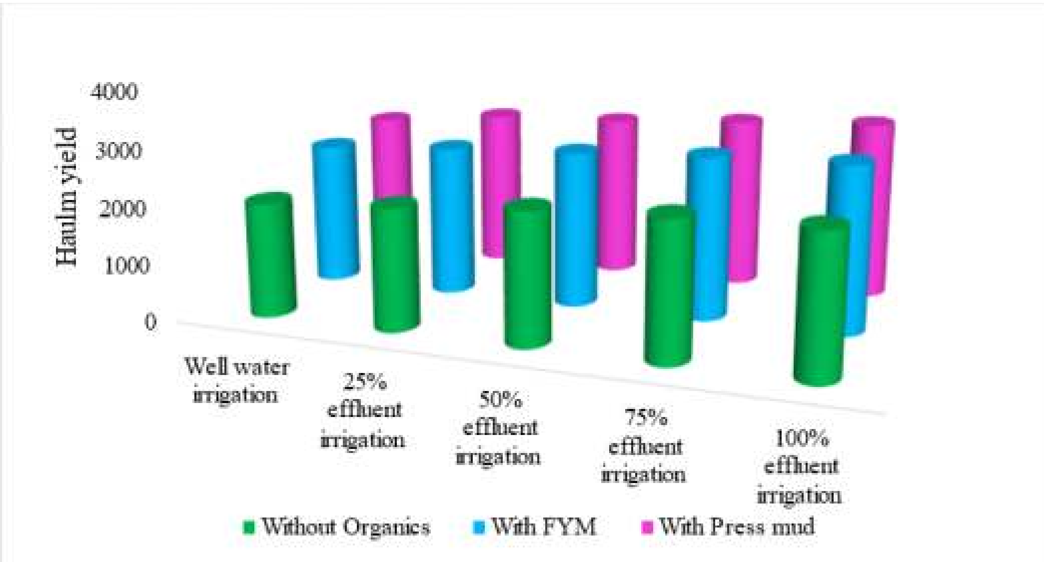

Figure 2. Paper mill effluent and organics application on haulm yield (kg ha^{-1})

press mud compost application over control (well water irrigation). These results demonstrated significant variations in yield, clearly indicating that paper mill effluent can serve as substitute for irrigation. These results are in proximity with the findings obtained by Singh *et al* (2020) and Rashid *et al* (2021). These results are attributed to the combined use of effluent with enriched press mud compost provides an adequate supply of nutrients and creates a favourable physical and microbiological environment. This environment is conducive to better peg formation and enhancing groundnut yield. Improved yield is also a result of the addition of farmyard manure, which improves the biological conditions of the soil, and effluent irrigation, which provides vital nutrients. The combined use of effluent irrigation and additives

Table 1. Influence of paper mill effluent irrigation and organics application on soil reaction.

Treatment	pH				EC (dS m^{-1})			
	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean
S_1	7.71	7.60	7.60	7.64	0.32	0.31	0.30	0.31
S_2	7.82	7.60	7.70	7.71	0.34	0.33	0.32	0.33
S_3	7.83	7.90	7.90	7.88	0.38	0.37	0.36	0.37
S_4	7.93	7.80	7.90	7.88	0.40	0.39	0.37	0.39
S_5	7.90	7.90	7.80	7.87	0.43	0.41	0.39	0.41
Mean	7.84	7.76	7.78		0.37	0.36	0.34	
	M	S	M at S	S at M	M	S	M at S	S at M
SEd	0.08	0.08	0.16	0.15	0.004	0.004	0.007	0.007
CD (P=0.05)	NS	0.18	NS	0.31	0.012	0.008	NS	0.014

Table 2. Influence of paper mill effluent irrigation and organics application on soil nutrients status.

Treatment	Nitrogen (kg /ha)				Phosphorus (kg /ha)				Potassium (kg /ha)				Sulphur (kg / ha)			
	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean
S_1	184.3	191.2	194.4	190.5	7.6	8.3	8	8.07	186	195.5	198.2	193.2	3.5	3.9	4.2	3.9
S_2	186.1	194.1	194.0	190.8	7.9	8.2	8.2	8.10	188.1	197.3	198.3	194.5	3.6	4.1	4.5	4.1
S_3	189.2	197.5	196.2	194.3	7.7	8.2	8.4	8.10	189.2	196.2	201	195.4	3.8	4.2	4.3	4.1
S_4	189.5	194.2	195.3	193.0	7.9	8.4	8.7	8.23	190.4	199.4	203.4	197.7	3.6	4.5	4.5	4.2
S_5	191.4	198.3	195.0	194.9	7.8	8.5	8.6	8.30	191.4	201.2	205.5	199.3	3.8	4.4	4.6	4.3
Mean	188.1	195.0	194.9		7.78	8.32	8.38		189.0	197.9	201.2		3.7	4.2	4.4	
	M	S	M at S	S at M	M	S	M at S	S at M	M	S	M at S	S at M	M	S	M at S	S at M
SEd ±	0.63	0.63	1.17	1.1	0.096	0.091	0.171	0.159	0.07	0.13	0.22	0.23	0.049	0.044	0.085	0.077
CD (P=0.05)	1.75	1.32	2.66	2.28	0.266	NS	0.392	0.328	0.21	0.28	0.48	0.48	0.138	0.092	0.196	0.159

has also been shown in earlier research to have good impacts on the growth parameters of a variety of crops, including sorghum, maize, sunflower, and peanuts. Similar results were obtained by Gandhi *et al* (2010).

The soil reaction exhibited values, from 7.60 to 7.93 at post-harvest stage, respectively. Similarly, the electrical conductivity (EC) in the soil ranged from 0.30 to 0.43 dSm^{-1} during a post-harvest stage. Notably, irrigation with paper mill effluent had no discernible effect on the soluble salts in the soil or the soil reaction. Plots that received greater irrigation concentrations of paper mill effluent showed higher pH and EC values. The buildup of soluble salts brought in by the irrigation of paper mill effluent is probably the cause of this increase in pH and EC. In contrast, control plots that were irrigated with well water exhibited lower pH and EC levels, mainly because they received fewer soluble salts compared to the paper mill effluent-irrigated plots. Dhumgond (2014), Udayasoorian and Ponmani (2009) and Giri *et al* (2014) also reported that paper mill effluent application increases the pH and EC in post-harvested soil.

The concentrations of available macronutrients, namely nitrogen, phosphorus, potassium, and sulphur, were generally higher in most of the treatments, ranging from 184.3 to 198.3 kg/ha for nitrogen, 7.6 to 8.7 kg/ha for phosphorus, 186.0 to 205.5 kg/ha for potassium and 3.5 to 4.6 mg /kg for sulphur (Table 2). Generally, as the effluent was diluted, there was a reduction in available nitrogen content. Improvement in available nitrogen might be due to a more rapid mineralization of suspended solids within the effluent. Another possibility is that the

transformation of organically bound nitrogen into inorganic forms was aided by the growth of soil bacteria. The results indicated the soil available phosphorus and potassium levels also increased noticeably in proportion to the concentrations of paper mill effluent. Singh *et al* (2021) and Kumar *et al* (2010) also reported similar results by the application of raw coffee pulp effluent and paper mill effluent. This rise might be due to the solubilization of unavailable phosphorus, which is made possible by the organic acids released during the acidic mineralization of suspended particles and root exudates.

CONCLUSION

It is possible to grow crops using paper mill effluent after treatment and compost manures without experiencing any negative effects on crop yield. The results of effluent application in groundnut crop have shown greater uptake of the nutrients by the crop plants and kernel and an increase of available nutrient in the irrigated soils as well. The results indicated that haulm yield ranged from 2016 to 3133 kg ha^{-1}and pod yield ranged from 1440 to 1934 kg ha^{-1}, indicated a 25.5% (494 kg ha^{-1}) increased yield at 75% paper mill effluent irrigation combined with press mud compost application over control (well water irrigation). Positive changes in yield in response to effluent application are observed at even higher concentrations of effluents. Additionally, it was noted that effluent had no discernible effect on groundnut yield, suggesting that crop plants were able to withstand the physiological stress caused. However, it is imperative to carry out long-term irrigation studies with effluent to have a clear scenario of effects on crop plants and soil fertility and decide the optimum loading rate of effluents for a crop and soil type.

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