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# Effect of Microbial Treated Effluent on Growth and Productivity of Black Gram

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## ABSTRACT

**Background:** Water pollution is prime cause of unavailability of the suitable water for irrigation purpose. Since many industries discharge their effluent on to open lands because of high cost of dilution and inadequate treatment facilities effective and profitable utilization of the effluent of the industries needs greater attention. Hence an attempt has been made to study the effects of tannery effluent (both treated and untreated) on black gram crop.

**Methods:** Field experiments were conducted using different concentrations of microbially treated effluent applied to blackgram plants. The following parameters such as plant growth and yield. Biochemical constituents, enzyme activities, heavy metal content, macronutrient content were analysed. Additionally, plant N, P and K content and microbial population dynamics was also studied. The experiment was conducted under similar conditions in the next year and completed.

**Result:** Results revealed that microbially treated effluent up to a 40% concentration imparted significant change in the observed parameters. Beyond this concentration, a reduction was observed in growth, yield, biochemical and enzymatic parameters.

**Key words:** Black gram, Growth and yield parameters, Tannery effluent.

## INTRODUCTION

Water pollution is prime cause of unavailability of the suitable water for irrigation purpose. Since many industries discharge their effluent on to open lands because of high cost of dilution and inadequate treatment facilities effective and profitable utilization of the effluent of the industries needs greater attention (Mishra *et al.,* 2023). The rapid industrialization is accompanied by both direct and indirect adverse effect on environment. Industrial development results in the generation of industrial effluents and if untreated, results in water sediment and soil pollution. It has been observed that a wide majority of industries discharge untreated effluent into river (Obaideen *et al.,* 2022).

The tannery industry represents an important sector in the economy of many countries. Tannery industry in the state of Tamil Nadu, India, is a major income for the local people and a source of the foreign exchange (Mohanty *et al.,* 2024). On the other hand, depending on the leather process, it generates large quantities of wastewater with ammonium, sulfates, surfactants, acids, dyes, sulfonated oils and organic substances, including natural or synthetic tannins. These chemical substances are applied to transform the animal skin into products with great capacities for dyeing, as well as to increase the mechanical and hydrothermal resistance. Considering that the greater part of these organic compounds are resistant to conventional chemical and biological treatments, the wastes discharged into natural waters increase environmental pollution and the health risks (Mao *et al.,* 2025). The treatment of this type of wastewater is very complex mainly because of the variety of chemical products added in different concentration and as an effective alternative, in biological treatment, the microorganisms able to degrade the organic pollutants,

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using them as a carbon source to produce metabolic energy to survive (Merlyn *et al.,* 2024).

Though, several methods have been described in the scientific literature, these treatment methods do not solve the problem because of the transfer of contaminants from one phase to another. However, in biological treatment, the microorganisms degrade the organic pollutants using them as a carbon source to produce metabolic energy to survive (Hu *et al.,* 2023). The effects of various industrial effluents, sludge materials and metal elements on growth and yield of crop plants have captivated the attention of many workers (Peng *et al.,* 2023; Chalaris *et al.,* 2023; Younas and Younas, 2022). However, no detailed experiments have been performed on plant growth and productivity using treated and untreated tannery effluents. Hence an attempt has been made to study the effects of tannery effluent (both treated and untreated) on black gram crop.

## MATERIALS AND METHODS

### Sample collection and field experimental setup

The tannery effluent was collected in plastic containers from the outlet of the tannery industry located in Vaniyambadi, Vellore district, Tamil Nadu. A field experiment was carried out on clayey loam soil at Department of Microbiology, Annamalai University during *Kharif* season during the last week of June 2022 and the experiment was repeated in the subsequent year under similar conditions. The experiment was laid out in completely randomized design (CRD) design and replicated 3 times. The experiment comprised of six treatments of different concentrations (Control, 20, 40, 60, 80 and 100%) of treated and untreated effluent Farmyard manure was incorporated into each plot. Black gram seeds were sterilized with 0.1% mercuric chloride for 2-3 minutes before sowing. Black gram cv. “ADT-3” was sown at spacing 30 cm (between rows) × 10 cm (between plants). The effluent (20 litres) was irrigated periodically at an interval of 9 days.

For bioremediation treatment the tannery effluent water was taken and autoclaved and allowed to cool to room temperature for treatment purposes. An aerator was used to continuously flow sterile dry air as a 1% inoculum yielding $10^6$ CFU/ml by bacterial consortium was injected. Field tests were conducted using the various concentrated bioremediated effluents (Mythili and Karthikeyan, 2011; Raza *et al.,* 2022). In detail, the sample was filtered under aseptic conditions after 72 h. and it is used as bioremediated effluent. Six distinct concentrations of effluent were taken in in six 100-liter containers containing various concentrations: 0, 20, 40, 60, 80 and 100 per cent. Twenty percent effluent is produced, when twenty liters of wastewater are combined with eighty liters of fresh water. Similarly, the remaining concentrations (40, 60 and 80) were made. There is no requirement for dilution with water when the effluent concentration is 100%. Data pertaining to plant height, yield and yield attributes were obtained at harvest.

The carbohydrate content in the seeds was determined using the Dubois method (Dubois *et al.,* 1956). Total free amino acid content of the plant was quantified according to the procedure described by Moore and Stein, (1948). Antioxidative enzymes was determined by method of Chance and Machly, (1955). Heavy metals (chromium, nickel and zinc) were estimated using the standard methods (APHA, 1998). Available nitrogen was determined as described by Subbiah and Asija, (1956). Available phosphorus was determined using method described by Olsen *et al.* (1954) and Jackson, (1973). Soil microbial population was determined as per standard procedure described by Johnson *et al.* (1960).

### Statistical analysis

The observations recorded during investigation were tabulated and subjected to analysis of variance techniques as described by Gomez and Gomez, (1984).

## RESULTS AND DISCUSSION

### Effect of microbial treated tannery effluent on growth and yield of black gram

Data with respected to plant height, yield attributes and yield presented at Table 1 revealed that significantly highest plant height, yield attributes and yield recorded with microbial treated 40% concentration this might have happened due to fact that leather industry wastewater has high BOD and COD levels due to the presence of dissolved salts (mostly NaCl), proteins, amino acids, pigments, oils and surfactants in addition to detrimental heavy metal contamination (Singh *et al.,* 2023). Saxena *et al.* (2020)

**Table 1:** Effect of bioremediated tannery effluent on growth and yield parameters of black gram.

| Effluent conc. (%) | Plant height (cm/plant) | No. of root nodules | No. of pods | Dry weight of seeds (g/plant) | 100 seeds weight (g/plant) | Yield/ hectare (kg) |
|---|---|---|---|---|---|---|
| Control | 53.24 | 20.65 | 28.67 | 9.38 | 38.74 | 1045.32 |
| 20 | 55.84 | 22.72 | 29.68 | 9.94 | 39.98 | 1120.47 |
| 40 | 56.96 | 25.75 | 30.84 | 10.53 | 40.97 | 1203.77 |
| 60 | 56.72 | 24.67 | 30.44 | 10.16 | 40.69 | 1186.42 |
| 80 | 54.05 | 20.11 | 28.76 | 8.46 | 37.46 | 1038.42 |
| 100 | 52.97 | 19.88 | 27.54 | 8.22 | 36.96 | 1004.23 |
| SEd | 0.11 | 0.53 | 0.14 | 0.07 | 0.09 | 7.13 |
| CD (5%) | 0.22 | 1.07 | 0.29 | 0.14 | 0.18 | 14.33 |

reported that the successful detoxification of leather wastewater with bacterial consortium developed with strain GS-TE1310. These results on the influence of microbially treated leather industry waste water corroborate with the findings of Zaheer *et al.* (2023) showed that a 25% dilution of tannery effluent improved the growth of certain plants, specifically *Cucurbita maxima, Citrullus vulgaris* and *Cucumis melo*. In contrast, a 50% dilution of the effluent did not yield any significant growth changes for *Citrullus vulgaris* and *Cucumis melo*. Another study by Yadav *et al.* (2021) reported that *Orchrobacterium intermedium* strain IITR 002 strain treatment on tannery effluents improved germination and plant growth on black gram.

**Effect of microbial treated tannery effluent on biochemical and heavy metals**

The highest values of carbohydrate (22.468 mg/g), total free amino acid (9.984 mg/g), protein (16.904 mg/g), catalase (1.90 units/g), peroxidase (0.18 units/g), Cr (1.0 mg/g), Ni (0.5 mg/g), Zn 0.7 (mg/g/plant) were recorded in the 40% bioremediated effluent (Table 2). These results go well with the findings of Tiwari *et al.* (2023) that the concentrations of reducing sugar, total sugar, non-protein nitrogen, catalase activity, peroxidase, ribonuclease, acid phosphatase, proline and lipid peroxidation increased in legume (*Cyamopsis tetragonoloba* L.) plants resulting from 15 days of exposure to Cr at lower levels (0.25 mM). This could be explained through the mechanism that low Cu concentration in the nutritional solution increased antioxidant activities (Saleem *et al.,* 2020).

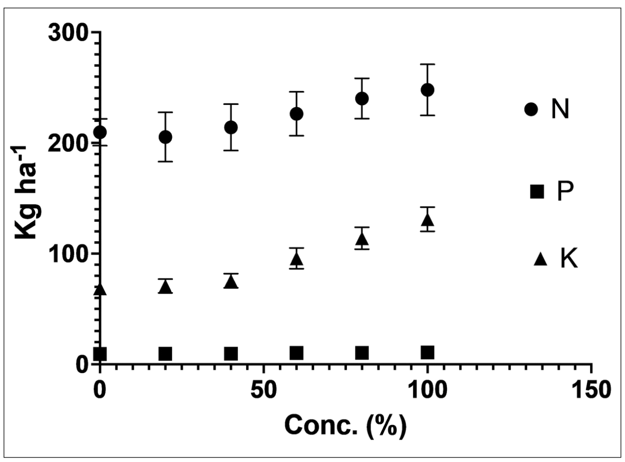


**Fig 1:** Effect of bioremediated effluent on N, P, K content of black gram.

**Effect of microbial treated tannery effluent on the NPK content**

The N, P, K content of control and bioremediated soil were analyzed and the results are presented in the Fig 1. Treated tannery effluent at concentrations of 20, 40, 60, 80 and 100 per cent contained 209.62, 205.37, 214.10, 226.37, 240.08 and 247.92 kg/day nitrogen/ha, respectively. At similar concentrations the phosphorus content was found to be 9.3, 9.62, 9.75, 10.22, 10.40, 10.80 kg/hectare and potassium content was found to be 68.75, 70.75, 75.55, 95.87, 113.95, 131.07 kg/hectare. Dey *et al.* (2023) observed that wastewater-accumulated nutrients (N, P and K) were found in remediating cyanobacteria biochemical characterizations. These authors also added that nutrient-loaded biomass enhanced the growth of rice and chickpea seedlings when utilized as a growth enhancer. In line with the circular economy concept, Mikula *et al.* (2023) reported that solid tannery waste-like shavings can be used as high-protein materials for fertilizer production. The hydrolysates contained primarily glycine, alanine and proline, which are primarily responsible for stimulating plant growth by supporting chlorophyll synthesis, chelating micronutrients, improving pollen fertility, or tolerant to low temperatures.

**Effect of microbial treated tannery effluent on soil microbial population**

The effect of microbial population dynamics on black gram treated with control and bioremediated effluent under field condition were presented in the Fig 2. The bacterial population was higher in all the concentration of bioremediated effluent. The maximum bacterial population (36.71 $\times$ $10^6$ cfu/mL) was observed in the 100% concentration at 45 DAS. The maximum fungi population (19.90 $\times$ $10^4$ cfu/mL) was observed in the untreated effluent at 45 DAS. These results on less changes

**Table 2:** Effect of bioremediated tannery effluent on biochemical, enzymes and heavy metals.

| Effluent conc. (%) | Biochemicals (mg/g/plant) | | | Enzymes (units/g) | | Heavy metals (mg/g) | | |
|---|---|---|---|---|---|---|---|---|
| | Carbohydrate | Total free amino acid | Protein | Catalase | Peroxidase | Cr | Ni | Zn |
| Control | 20.68 | 8.34 | 15.48 | 1.88 | 0.17 | 0.5 | 0.2 | 0.4 |
| 20 | 21.20 | 9.24 | 15.97 | 1.94 | 0.16 | 0.5 | 0.2 | 0.5 |
| 40 | 22.48 | 9.98 | 16.90 | 1.99 | 0.20 | 1.0 | 0.5 | 0.7 |
| 60 | 21.86 | 9.69 | 16.57 | 1.90 | 0.18 | 0.8 | 0.2 | 0.5 |
| 80 | 20.84 | 8.15 | 14.66 | 1.42 | 0.15 | 1.1 | 0.6 | 0.8 |
| 100 | 20.10 | 7.64 | 13.36 | 0.92 | 0.14 | 1.3 | 0.8 | 0.9 |
| SEd | 0.025 | 0.02 | 0.11 | 0.015 | 0.0025 | 0.05 | 0.1 | 0.1 |
| CD (5%) | 0.50 | 0.04 | 0.22 | 0.03 | 0.0050 | 0.11 | 0.2 | 0.1 |

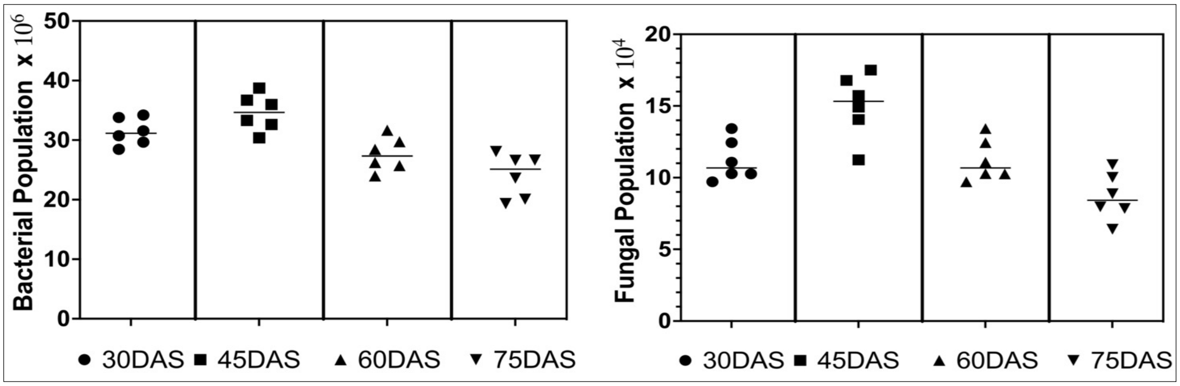


**Fig 2:** Effect of microbial population dynamics on black gram treated with bioremediated effluent.

in microbial population due to lower dosage of bioremediated effluent go well with the study of Pino-Otín *et al.* (2023) that very high concentrations of Tannic acid (TA) (of the order of 200 mg/L) is required to reduce the growth of the river microbial population, though at a low concentration of 20 mg/L, some changes in the metabolic profile can be observed in contrast to the control, especially with regard to the capacity to metabolize amines and amino acids. According to Lejri *et al.* (2022), industrial effluents from a tannery in southern Tunisia were microbiologically characterized by the existence of revivable aerobic bacteria, including fungus, *Pseudomonas*, *Enterococcus*, total and fecal coliforms and sulphite-reducing bacteria. *Bacillus* sp. and *Pseudomonas* sp. were the most common bacteria found in these effluents, according to Mohammed *et al.* (2017) due to their capacity to withstand and endure the presence of chromium and other heavy metals in the tannery effluent.

## CONCLUSION

Based on experimental results, it could be concluded that microbial-treated tannery effluent at 40% concentration does not affect plant growth and was found suitable for maximizing black gram yield.

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### Conflict of interest

The authors declare that there is no conflict of interest.

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