Original Research Article

AGRO-POTENTIALITY OF TREATED PAPERBOARD MILL EFFLUENT ALONG WITH ORGANIC AMENDMENTS ON GROWTH AND YIELD CHARACTERISTICS OF OKRA

ABSTRACT

Paper and pulp industry is categorized under 17 most polluting industries due to discharge of large volumes of black liquor with high nutrients. It ranks third in the world in terms of utilization of fresh water for processing. The paper mills generating appreciable quantities of solid wastes and effluent every day. The average quantity of water consumed for each tonne of paper produced is about 300 m^3 and this significant amount recur as effluent causing wide spread of environmental pollution. Results show that irrigation with treated paperboard mill effluent increased the plant growth characters as well as the fruit quality parameters. Compared to well water, reuse of treated paperboard mill effluent increased the plant vegetative growth vigorously. **This is because of the nutrients present in the treated paperboard mill effluent. The scientific ways and means of recycling this wastewater in an integrated, eco friendly manner is the main objective of this study.**

Key words: Treated Paperboard Mill Effluent, Okra, Growth characteristics, Organic Amendments

1. INTRODUCTION

Paper and pulp industry is categorized under 17 most polluting industries due to discharge of large volumes of black coloured liquor with high nutrients. It ranks third in the world in terms of utilization of fresh water for processing. The paper mills generating appreciable quantities of solid wastes and effluent every day. The average quantity of water consumed for each tonne of paper produced is about 300 m^3 and this significant amount recur as effluent causing wide spread of environmental pollution [4]. Utilization of this wastewater for irrigation purpose makes the soil healthier due to the presence of plant nutrients [15]. Some researchers had reported that the nutrient status of soil like N, P and K has been increased with proper application of paper mill wastewater [3]. The crop yield and growth also showed positive correlation with the increasing dose of irrigating paper mill waste water and application of sludge compost up to certain limits [10]. Keeping the aforementioned points in mind, the study has been designed to assess the influence of paper board mill effluent irrigation on growth and yield of okra.

2. MATERIAL AND METHODS

2.1. Experimental Design

Field experiment was conducted in ITC (PSPD) model farm, Thekkampatti, Mettupalayam, Coimbatore District, Tamil Nadu to assess the impact of ITC treated effluent and solid wastes on crop growth, yield and quality of bhendi and soil. The experiment was a 7 x 2 factorial arranged in a randomized complete block design (RCBD) and replicated three times. The treatment combinations consisted of seven amendments**conducted under factorial randomized designed and replicated by three times. The number of treatments was used for the cultivation of okra is seven with two factors *viz.,* *and two sources of irrigation water* (**well water and effluent water)**irrigation**. The seven **treatments are** amendments were T_1-Control (100 % NPK), T_2-FYM 25 t ha^{-1}+NPK, T_3-ETP Sludge 5 t ha^{-1}+NPK, T_4-Biochar 2.5 t ha^{-1}+NPK, T5-Vermicompost 3.5 t ha^{-1}+NPK, T_6-Pressmud 6 t ha^{-1}+NPK and T_7-Fly ash 5 t ha^{-1}+NPK. **The**Plant spacing used was **between the crops is** 45 x 30 cm and irrigated at weekly intervals.

2.2. Plant Biometric Observation

Plant height, **N**number of leaves per plant, **N**number of branches, **I**internodal length, **L**leaf **A**area **I**index **was**were measured at different stages of plant growth. The height of the plant from the ground level to the tip of the main stem was measured at 30**,** and 60 days after sowing (DAS) and at harvest stage **and expressed in cm**. Total number of fully opened leaves in a plant was recorded at 30 DAS, 60 DAS and at harvest stage **and**

Comment [Z1]: Include experimental location, experimental design used, treatments, data collected and statistical analysis. Then state your recommendations based on your findings

Comment [Z2]: Which plant

Comment [Z3]: Arrange the keywords alphabetically

Comment [Z4]: References are numbered as they first appear in the text and not based on alphabet.

Comment [Z5]: Give full meaning at first mention

Comment [Z6]: What does bhendi stands for? Is it the local name for okra, you should explain that in your introduction but use the common name, okra, in all your write up.

expressed as number of leaves per plant. The total number of main branches whose origin is in the leaf axils and the main stem was taken**recorded** from **on** 10 randomly selected plants at 30 DAS, 60 DAS and at harvest stage.

2.3. Yield and Quality Parameters

Individual fruit weight, **F**fruit length, **F**fruit girth, **F**fruit yield and **D**dry matter production (DMP) **is**were recorded at matured stage of the plant. Fruit yield was calculated by weighing of all the fruits in the plants from each plot and expressed in t ha^{-1}. Five randomly selected plants **at random** were cut from **close to** the ground level for the estimation of DMP. The plant **S**samples were sun dried for three days followed by oven drying at 70 ^{0}C till constant weight was obtained. The dry weight of the plant samples were recorded and expressed in kg ha^{-1}. The leaf sample of 500 mg was taken and total phenol content in the leaves was estimated using Folin-Ciocalteau reagent and expressed as mg 100 mg^{-1} of the material [7]. Crude fibre content was estimated by the method [2] and expressed in percentage. The protein content of fruits was estimated by the method suggested by Lowry *et al.* (1951) [6] and expressed in per cent.

2.4. Statistical Analysis

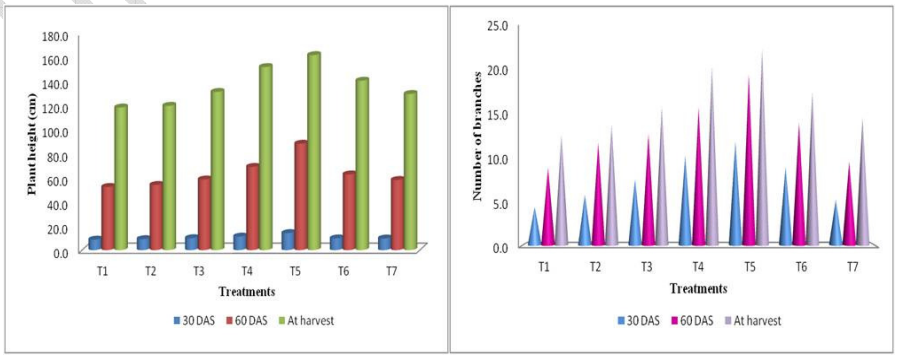
The data generated during this investigation for various characters were statistically analysed by the method given by Gomez and Gomez (1984). Results are presented and discussed at five per cent probability level uniformly. Treatment differences that are not significant were noted as non significant (NS).

3. RESULTS AND DISCUSSION

3.1. Plant Biometric Observation

Effluent irrigation produced taller and stronger plant than the well water irrigation. Among the treatments, VC + NPK had a favorable influence on plant growth attributes of okra**in bhendi** at all the stages of growth **period** with effluent irrigation compared to well water irrigation (Fig. 1). This is because the treated effluent supplies appreciable amounts of plant nutrients than well water. Similarly, Udayasoorian *et al.* (2003) [14] reported that effluent irrigated okra**bhendi** recorded higher plant height and yield than the well water irrigated okra**bhendi**. In the present study, the vermicompost might have contributed all essential plant nutrients which helped to maintain the soil moisture ultimately resulted in the promotion of the plant height of okra**bhendi**. Najar and Khan (2013) [8] reported that the application of vermicompost increased the number of clusters per plant, fruits per cluster, number of fruits per plant, mean fruit weight and yield in tomato. Roseta and Innocent (2012) [9] found that agro industrial effluents and agricultural wastes like poultry manure increased the growth parameters like plant height, number of leaves per plant, stem girth and dry matter of okra**the bhendi** in different combinations.

Fig. 1. Effect of treated paperboard mill effluent irrigation and solid waste on plant height and number of branches of okrabhendi**



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Comment [Z8]: References are to be represented in numbers only as they first appear in the text.

Comment [Z9]: Your Fig. 1 does not show comparison between the two irrigation water sources but only between growth stages

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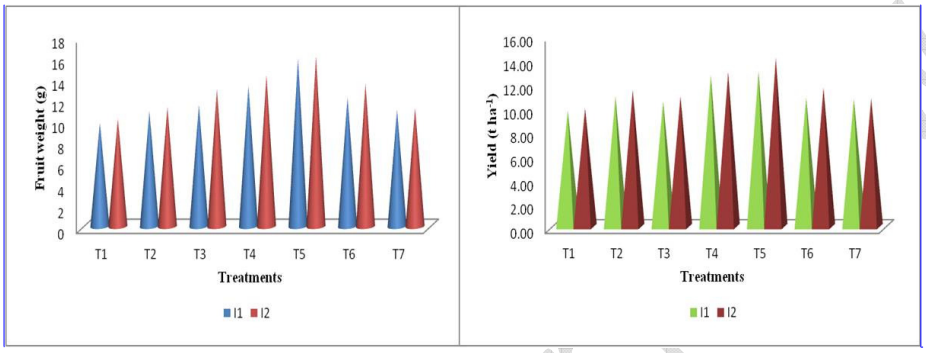
3.2. Yield Parameters

In the present study, a Application of vermicompost along with NPK had favorable influence on yield attributing characters of okra**bhendi** *viz.,* fruit weight, fruit length and fruit girth with effluent irrigation. The plot**treatment** receiving vermicompost along with NPK along with effluent irrigation gave**registered** the highest fruit weight and fruit yield compared to other treated plots**treatments** (Fig. 2). This could be due to increased level of major nutrients in the effluent which might have contributed to higher fruit yield of okra**bhendi**. Similar observations were recorded in cowpea [1], chillies and brinjal [14].

Fig. 2. Effect of treated paperboard mill effluent irrigation and solid waste on fruit weight and yield of okra bhendi



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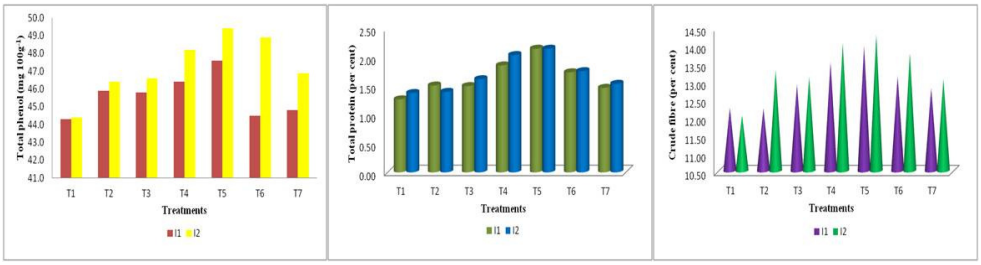
3.3. Quality Parameters

The quality parameters of okra**bhendi** *viz.*, total protein, total phenol and crude fibre content were higher in paperboard mill effluent irrigation when compared to well water irrigation. **In bhendi, t**The quality parameters of okra were better in plots **treatment** receiving VC + NPK (Fig. 3). This might be due to combined use of treated effluent along with amendments, which might have provided enough nutrients with better physical and microbial environment and thus improving the soil fertility and ultimately resulted in improved quality parameters.

Similar results were also reported in radish and onion [12], chillies and brinjal (Udayasoorian and Ponmani, 2009) when these crops were**are** grown in organic amended soil along with paperboard mill effluent irrigation. In *Allium cepa*, application of vermicompost combined with mineral fertilizers increased the bulb qualities like bulb size, total number of bulbs and fresh weight of bulbs [11]. Najar *et al.* (2013) reported similar findings that the application of vermicompost increased the number of marketable fruits and in the same way decreased the non marketable fruits which were**are** infested. Biochemical components of **bhendi**okra like crude proteins, crude fibre and crude carbohydrates were found maximum with 25 per cent paperboard mill effluent fertigation [5].

Fig. 3. Effect of treated paperboard mill effluent irrigation and solid waste on total phenol, total protein and crude fibre of bhendiokra



4. CONCLUSION

Application of vermicompost along with NPK under treated paperboard mill effluent irrigation had a favorable effect on the growth of okra**bhendi**. The yield attributes *viz.*, fruit length, fruit girth and individual fruit weight were significantly increased in VC + NPK under treated paperboard mill effluent irrigation. The yield increase of okra was 37.8 per cent **in bhendi under**with VC + NPK treatment than that of control (100 % NPK). The quality parameters of okra**bhendi** *viz.,* total phenol, crude fibre and total protein were not affected due to effluent irrigation along with solid waste application. But a slight increase was noticed in quality parameters. Based on the results, it could be concluded that the treated paperboard mill effluent can be used as an effective irrigation source with addition of vermicompost along with NPK. Treated effluent irrigation combined with **and** vermicompost had provided necessary plant nutrients in the soil thereby **to bhendi,** resulting in higher yield of okra**and without causing any adverse effect on soil health and crop quality parameters**. These findings conclude that the future perspective of treated effluent in agriculture is favorable due to its effect on increased crop yield and growth, but there is also a possible accumulation of various nutrients and heavy metals in soil and in the ground water that may cause potential problems after long term reclaimed wastewater irrigation.

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