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RESEARCH ARTICLE

IMPACT OF DISTILLERY WASTEWATER ON SOME OF THE GROWTH PARAMETERS OF *PISUM SATIVUM* L. VAR. FPP11

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ABSTRACT

In developing countries like India wastewater fertigation for crop cultivation is a regular practice. Effluents from various industries are considered as the main industrial pollutants containing organic and inorganic compounds. The increasing agricultural reuse of treated effluent serves goals such as promoting sustainable agriculture, preserving scare water resources and maintaining environmental quality. The wastewaters being used include both untreated and treated, although the former predominates the later. The present experiment was aimed to investigate the effect of tap water (clean water), primary treated and secondary treated distillery wastewater on various growth parameters i.e. (root length, shoot length, seedling length, fresh root weight, fresh shoot weight, fresh seedling weight, root shoot ratio) and various stress indices i.e. Shoot Length Stress Tolerance Index (SLSTI), Root Length Stress Tolerance Index (RLSTI), Root Fresh Weight Stress Tolerance Index (RFSTI), Shoot Fresh Weight Stress Tolerance Index (SFSTI) of *Pisum sativum* L. var. FPP11. The results depicted that the maximum values for all growth parameters mentioned above were observed in seedlings treated with tap water (control Set-1) which was followed by Set-3 treated with secondary treated wastewater and minimum was shown by seedlings treated with primary treated distillery wastewater i.e. (Set 2). Maximum stress tolerance was shown by Set 1(Control set) i.e. (100%) which was followed by Set 3 i.e. (Secondary treated wastewater) and minimum stress tolerance for all the indices was shown by Set 2 i.e. (Primary treated wastewater).

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INTRODUCTION

Water is one of the most important natural resource to form life. The quality of water is of vital concern for mankind since it's directly linked with human welfare. Various industries such as distillery, sugar industry, paper and pulp, chemical, pharmaceutical and tanneries dispose off their untreated or partially treated wastewater directly into the soil and water bodies which causes serious problem of pollution. Distillery is an agro based industry and gaining importance in agricultural sector. Manufacture of ethyl alcohol in distilleries constitutes a major industry in Asia and South America. The distillery effluent known as spent wash is a dark brown highly organic effluent and is approximately 12-15 times by volume of the product alcohol. It is one of the most complex and strongest organic industrial effluents (Sharma, 2013). At present, there are 319 distilleries in India with an installed capacity of 3.29 billion litre of alcohol (Pandita and Malaviya, 2016). The spent wash is characterized by high BOD (5,000-8000 mg^{-1}) and COD (25,000-30,000 mg^{-1}) having an unpleasant smell of burnt or caramelized sugar. The brown colour of the spentwash could be attributed to the presence of melanoidin, the reaction product of sugar-amine condensation. The unpleasant odour due to the presence of skatole, indole and other sulphur compounds which are not effectively decomposed by yeast or methanogenic bacteria during distillation is also an issue of public concern (Narain *et al*., 2012). The disposal of wastewater is a major problem faced by industries, due to its generation of high volume of effluent and with limited space for land based treatment and disposal. If the wastewater generated from industries could be recycled and reused in environmental friendly manner, it may solve water scarcity and pollution problems (Salian *et al*, 2018). Whereas, wastewater is also a resource that can be applied for productive uses, since it contains nutrients that can be used for the cultivation of agricultural crops (Hati *et al*., 2007; Chandra *et al*., 2009; Rath *et al*., 2011). The distillery effluent contains organic and inorganic nutrients and has been reported to have a positive effect on crop yields However; the distillery effluent with its high salt load may pose a severe inhibitory effect on germination and growth. Nevertheless, different crop species may have differential tolerance or sensitivity to the salinity (Ramana *et al*., 2002).

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Table 1. Impact of different distillery effluents on growth parameters [1] [shoot length, root length, seedling length, fresh root weight, fresh shoot weight, fresh seedling weight and root-shoot ratio (length basis)] of *Pisum sativum* L.var. FPP11

Treatment	Root length (cm)	Shoot length (cm)	Seedling length (cm)	Fresh root weight (g)	Fresh shoot weight (g)	Fresh seedling weight (g)	Root shoot ratio
Control	7.133^a±1.211	17.666^a±0.333	24.800^a±0.888	0.224^a±0.027	0.793^a±0.026	1.017^a± 0.053	0.407^b±0.077
PTE	1.266^b±0.145	2.200^c±0.173	3.466^b±0.317	0.008^b±0.000	0.066^b±0.003	0.074^b±0.002	0.572^a±0.233
STE	2.033^b±0.437	3.066^b±0.066	5.100^b±0.400	0.016^b±0.001	0.092^b±0.001	0.212^b±0.128	0.667^a±0.152

Table 2: Stress Tolerance Index (%) of *Pisum sativum* L.var. FPP11 treated with different types of distillery wastewater

	Stress Tolerance Index (%)			
Treatment	SLSTI	RLSTI	SFSTI	RFSTI
Control	100^a±0.000	100^a±0.000	100^a±0.000	100^a±0.000
PTE	12.494^c±1.205	18.094^c±1.306	4.032^c±0.662	8.331^c±0.407
STE	17.364^b±0.350	28.291^b±2.429	7.396^b±0.423	11.677^b±0.598

PTE= primary treated effluent, STE= secondary treated effluent, SLSTI= shoot length stress tolerance index, RLSTI= root length stress tolerance index SFSTI=shoot fresh weight stress tolerance index, RFSTI= root fresh weight stress tolerance index. [1]Values are means of three replicates ± S.E.; within each column values not followed by the same letters are significantly different at $p<0.05$.

Many workers have carried out different investigations to find the impacts of various types of effluents on germination and growth of multiple crops (Malaviya and Sharma, 2011a; 2011b; Narain *et al*., 2012; Malaviya *et al*., 2012; Pandita and Malaviya, 2016). The present study investigates comparative effects of tap water (control), primary treated and secondary treated distillery wastewater on growth attributes and Stress tolerance indices (%) of *Pisum sativum* L. variety FPP11. Field pea (*Pisum sativum* L.) is a popular pulse crop of India. India is the second largest producer of pea in the world after Russia. Pea is rich in protein, carbohydrates, vitamin A and C, calcium and phosphorus (Bhat *et al*., 2013).

MATERIALS AND METHODS

Seeds of *Pisum sativum* L. variety FPP11 used in the present experiment were procured from SKAUST Jammu. The primary treated and secondary treated distillery waste water used in the present experiment was collected in pre cleaned containers from M/S Dewans Breweries Ltd. (Brewers and Distillers) located at Talab Tillo, Jammu. Various physiochemical characteristics of the effluent samples were analyzed using standard methods (APHA, 1998). Analysis for sodium and chloride ions in the effluent samples were carried out using 850 Professional Ion Chromatograph supplied from Metrohm, Switzerland. The experimental set up was designed in the Department of Environmental Sciences, University of Jammu, Jammu. Three sets were made, Set-1 was taken as control in which tap water was used for treatment and for Set 2 and 3 primary treated and secondary treated distillery wastewater respectively, were used for irrigation of seeds. Petri plates were prepared by placing sterilized absorbent cotton layer in it. The cotton was moistened with 50 ml of tap water for control and with the same quantity of primary treated and secondary treated distillery wastewater. Seeds were treated with antifungal solution (Bavistine) and washed thoroughly with double distilled water before using for experiment. Ten seeds of *Pisum sativum* L. variety FPP11 were sown in the pre labelled Petri plates. All the experiments were carried out in triplicate and the mean was calculated. The Petri plates were incubated at 25±1^{0}C in a BOD incubator. The plates of Set 1, 2 and 3 were moistened everyday with control (tap water), primary treated and secondary treated wastewater respectively, at a fixed hour up to 10 DAS (Days after Sowing). On the termination of experiment growth parameters were studied in terms of root length, shoot length and seedling length (cm), fresh root weight, fresh shoot weight and total seedling fresh weight (g). Seedlings were collected and cut at root-shoot junction and length of their root and shoot were measured by using a metre scale and values were expressed in centimetres. The length of root and shoot was added to get the length of total seedling of *Pisum Sativum* L. var. FPP11. The fresh weight of root and shoot samples were recorded using Metler-Toledo digital balance and expressed in gram per plant. Stress Tolerance Index is a useful tool for determining the high yield and stress tolerance potential of genotypes. Stress tolerance indices (%) i.e. Shoot Length Stress Tolerance Index (SLSTI), Root Length Stress Tolerance Index (RLSTI), Root Fresh Weight Stress Tolerance Index (RFSTI) and Shoot Fresh Weight Stress Tolerance Index (SFSTI) of the *Pisum sativum* L. var. FPP11 were calculated using formulae given by (Wilkins, 1957).

Statistical analysis: All the experiments were conducted in triplicate. The data obtained were statistically analysed using SPSS Inc. (v. 17.0) software for mean ± S.E. (standard errors). The quantitative changes due to effluent application were evaluated at 5% using Duncan's multiple range Test.

RESULTS

Various physicochemical characteristics of distillery wastewater showed that the primary treated wastewater was light brown in colour having unpleasant odour whereas secondary treated was almost colourless. The pH was slightly alkaline (7-8) in both the effluents. The turbidity of primary treated wastewater was 706 NTU and for secondary treated it was 009 NTU. The concentration of sodium was found to be 498.002 ppm and 308.465 ppm whereas, concentration of chloride was 330.688 ppm and 250.582 ppm in primary treated and secondary treated distillery wastewater, respectively.

Growth parameters: The effect of distillery wastewater on various growth parameters of *Pisum sativum* L. variety FPP11 are shown in Table-1. It depicts that all the parameters (root length shoot length, seedling length, fresh root weight, shoot weight, fresh seedling weight) followed the similar trend i.e. seedlings performed better in control treatment (tap water) which was followed by the secondary treated seedlings and minimum values were seen in the primary treated. The maximum values of all the parameters of *Pisum sativum* L. var. FPP11 like root length (7.133cm), shoot length (17.666cm), seedling length (24.800 cm), fresh shoot weight (0.793 g), fresh root weight (0.224 g), fresh seedling weight (1.017 g) were observed in control treatment followed by secondary treated distillery wastewater. The minimum values for all these parameters were shown by seedlings irrigated with primary treated wastewater.

Stress Tolerance Index: Stress Tolerance Index (%) of *Pisum sativum* L.var. FPP11 treated with different types of distillery wastewater are shown in Table-2. It can be seen by the results that maximum stress tolerance index% (100±0.000) in all indices i.e. SLSTI, RLSTI, SFSTI and RFSTI is shown by the control treatment. The secondary treated distillery wastewater seedlings showed greater stress tolerance index SLSTI (17.364^b±0.350), RLSTI (28.291^b±2.429), SFSTI (7.396^b±0.423) and RFSTI (11.677^b±0.598) compared to primary treated seedlings although much lesser than the control treatment.

DISCUSSION

Plants face different abiotic stresses such as salinity, drought, cold and heat. Among these stresses, salinity is on the top, which limits the plant growth and productivity (Munns, 2002). Salt stress affects plant physiology at both whole plant and cellular levels through osmotic and ionic stresses (Murphy *et al*., 2003). This deficiency in available water under saline conditions causes dehydration at cellular level and ultimately osmotic stress occurs. The excessive amounts of toxic ions like Na^+ and Cl^- create an ionic imbalance by reducing the uptake of beneficial ions such as K^+, $Ca^{2+,}$ and Mn^{2+} (Hasegawa *et al*., 2000). As we know that the distillery wastewater contains high-salt load (Ramana *et al*., 2002) hence seedlings could not regulate ion concentration and there may have been severe physiological dysfunctions leading to decreased growth rates (Zhu, 2007). This might be the reason that as compared to control treatment primary and secondary treated distillery wastewater was phytotoxic for the growth attributes of *Pisum sativum* L. var. FPP11. Similarly, inhibitory effect of distillery wastewater calculated as stress tolerance index was more pronounced in treatment Set 2 in which primary treated wastewater was used where the high nutrients and high salt content might have produced toxic impact on seedlings. The toxicity caused by distillery effluent also declined the fresh biomass and length of root and shoot as compared to Set 1.

Conclusion

In the present experiment it was observed that primary treated distillery effluent showed more toxic effects on seedling growth parameters and stress tolerance index (%) of *Pisum sativum* L. var. FPP11 in comparison to secondary treated distillery effluent

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