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Impact of Amalai paper mill effluent on root and shoot length of seedlings

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Abstract
In the present study an attempt has been made to access the impact of Amalai Paper Mill effluent on root and shoot length of seedlings. The effect of the paper mill effluent on the root and shoot length of seedlings also has been studied in *Zea mays*, *Pisum sativum*, *Daucus carrata*, *Spinacia oleraceae*, *Allium cepa* and *Solanum tuberosum* the mean length of the seedlings increased in the lower concentration of the paper mill effluent but decreased in higher concentration. In *Spinacia oleraceae* the mean length of the seedling decreased from the lower (10%) concentration to higher (100%) concentration of the paper mill effluent.

Keywords: Amalai paper mill effluent, root and shoot, length, effluent treatment plant

1. Introduction
The paper industry is one of the largest industries in India, consuming large amount of water (Bajpai, *et al.* 1993) [1]. The effluent generated is normally considered to be highly polluting and the presence of the chemicals from the effluent may affect soil and in turn the growth and development of plants (Binkley and Wolfrom, 1983 and Chandra, 1996) [2, 3]. The paper production process generates a considerable volume of effluents, which must be treated before they can be disposed of in order to meet environmental standards. Therefore, disposal of these wastewater products through irrigation can be an attractive alternative (environmentally as well as economically) for the final destination of these effluents, which currently are drained into surface waters. In addition to eliminating an additional treatment process, the wastewater can be considered a source not only of water but also of supplementary nutrients (Joshi and Kapandnis, 1992) [4].
Rajannan and Oblisami (1979) [5] studied the effect of paper mill effluents on the plant length of Rice, (*Oryza satiya*), gram (*Cicer arietinum*), Tomato (*Lycopersicum esculentum*). Renjini and Janardhanan (1989) [6] also studied the effects of polluted water on the length of *S. indicum* var. co-1 c and *S. indicum* var. T.M. V-4. In accordance with the same principles of investigation underlying their studies, this experiment of root and shoot length of seedlings were carried out. The seed of the following six species maize (*Zea mays*), peas (*Pisum sativum*), carrot (*Daucus carota*), spinach (*Spinacia oleraceae*), onion (*Allium cepa*), and potato (*Solanum tuberosum*) were taken up for study. The aim of present study to explore impact of paper mill effluent on root and shoot length of seedlings.

2. Material and Methods
Healthy seeds of maize, peas, carrot, spinach, onion and potato were soaked separately in paper mill effluent solution (10, 20, 30, 50, 80 and 100%) along with control for the whole night.
20 ml of each solution mentioned above were used to soak the filter paper in each of the neat and clean petridish. Triplicate sets of petridish for each solution were prepared. The seeds were spread at the rate of 20 per petridish, 60 seeds of each species were tested for each concentration, A control germination was also run simultaneously. From the second day of sowing of seeds, the germination was studied and carried out upto fifth day. (Tables 1-2)

3. Results and Discussion

At 10% effluent concentration the mean length of the seedlings of *Zea mays*, *Pisum sativum*, *Daucus carota*, *Spinacia oleraceae*, *Allium cepa* and *Solanum tuberosum* was increased, whereas the mean length of seedling of *Spinacia oleracea* decreased when compared with their control condition of the seedlings.

At 20% of effluent concentration the mean length of seedlings of *Allium cepa* and *Solanum tuberosum* was promontory when compared with the control condition of the seedlings. In case of *Pium sativum*, *Spinacia oleracea* and *Zea mays* the mean length of the seedlings was inhibited. But there were no effects on the mean length of seedlings *Daucus carota* in respect of control condition seedlings.

Table 1: Average Root and shoot length (cm) of seedlings

% of paper mill effluent	*Zea mays*		*Pisum sativum*		*Daucus carota*		*Spinacia oleracea*		*Allium cepa*		*Solanum tuberosum*	
	Root	**Shoot**	**Root**	**Shoot**	**Root**	**Shoot**	**Root**	**Shoot**	**Root**	**Shoot**	**Root**	**Shoot**
10	4.30	8.50	4.50	8.00	3.75	3.25	0.85	2.75	2.75	4.45	2.75	5.24
20	4.00	8.00	4.00	8.40	3.10	3.00	0.80	2.50	2.50	4.45	2.25	5.00
30	3.75	7.75	3.75	7.75	2.50	2.75	0.75	2.00	2.00	4.50	2.50	4.85
50	3.50	7.75	3.50	7.50	2.50	2.55	0.65	1.85	1.75	4.00	2.00	4.00
80	3.00	7.00	2.95	7.75	2.35	2.45	0.45	1.35	1.45	3.75	1.75	3.75
100	2.75	6.75	2.50	6.00	2.00	2.30	0.30	1.25	1.30	3.25	1.50	3.75
Control	4.25	8.32	4.25	5.75	3.02	3.25	0.95	2.50	2.50	4.75	1.15	5.15
r	-0.99	-0.97	-0.98	-0.81	-0.86	-0.94	-0.99	-0.96	-0.95	-0.97	-0.95	-0.94
SD	±0.59	±0.65	±0.72	±0.83	±0.63	±0.36	±0.22	±0.60	±0.58	±0.50	±0.47	±0.67

Table 2: Average length (cm) of seedlings

% of paper mill effluent	*Zea mays*	*Pisum sativum*	*Daucus carota*	*Spinacia oleracea*	*Allium cepa*	*Solanum tuberosum*
10	12.80	12.50	7.00	3.60	7.20	7.99
20	12.00	12.40	6.10	03.30	06.95	07.25
30	11.50	11.50	5.25	02.75	06.50	07.35
50	11.25	11.00	5.05	02.50	05.75	06.00
80	10.00	10.70	4.80	01.80	05.20	05.50
100	9.50	08.50	4.30	01.55	04.55	05.25
Control	12.57	10.00	6.27	3.45	7.25	06.30
r	-0.98	-0.94	-0.89	-0.98	-0.99	-0.96
SD	±1.23	±1.47	±0.98	±0.81	±1.04	±1.12

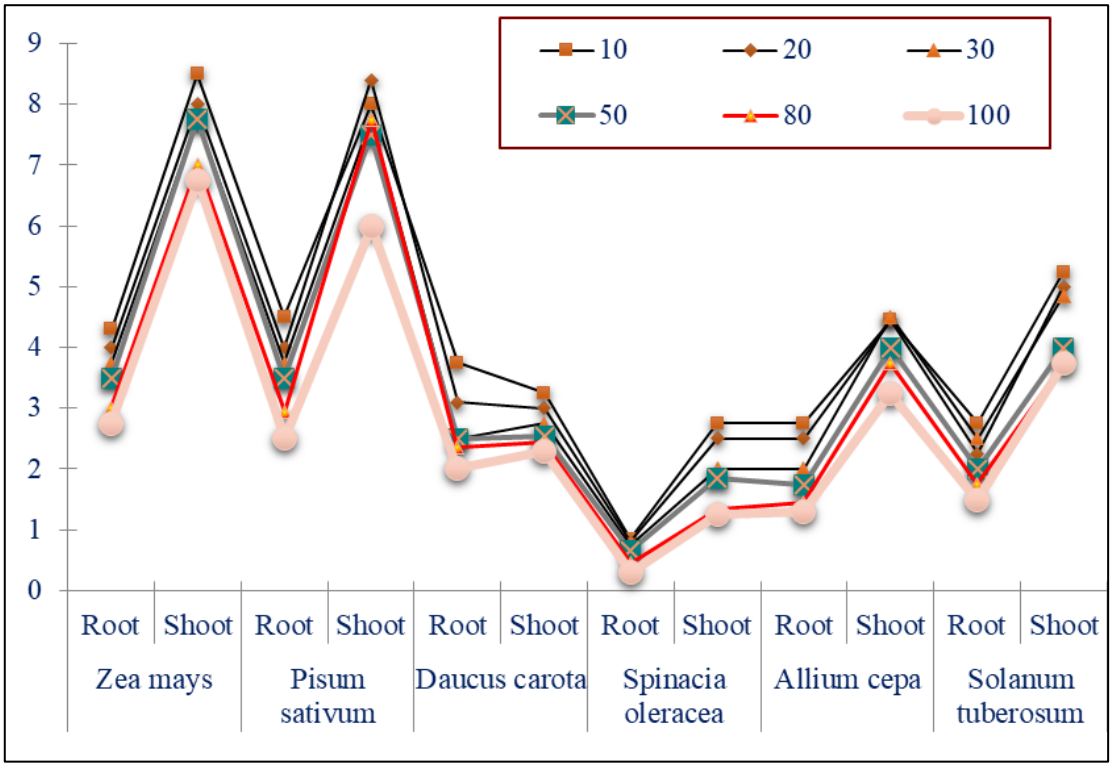

Fig 1: Average Root and shoot length (cm) of seedling

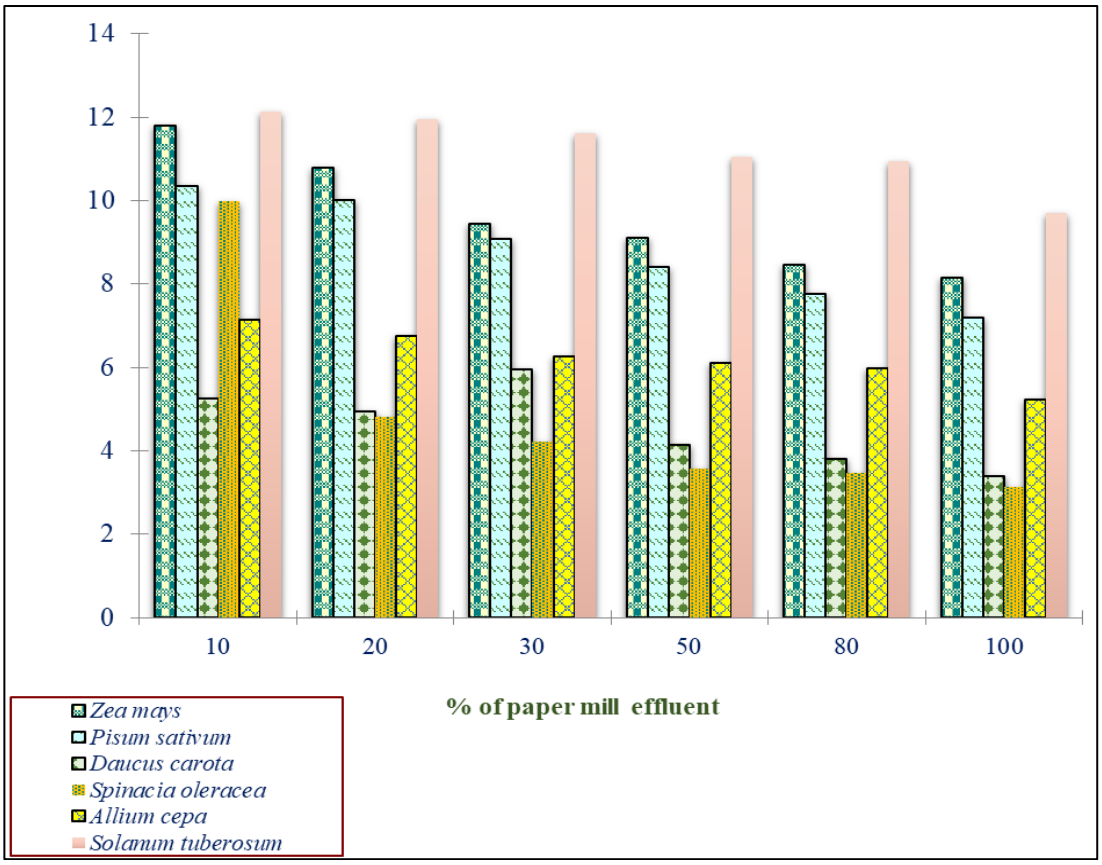

Fig 2: Average length (cm) of seedlings

At 30% to 100% effluent concentration the mean length of the seedlings of all the species was inhibitory when compared with the mean length of seedlings of control condition. Similar topic effects were observed by Renjini and Janardhanan (1989) [6].

In *Zea mays* the mean length of the seedlings has promontory effects at 10% concentration, when compared with the seedlings of (12.57 cm.) The 20% to 100% concentration was observed to be inhibitory when compared with the control conditions seedlings. With increase in the percentage of 20% to 100% mean length decreased from 12.00 cm. to 9.50 and the control length was 12.57 cm. Malla and Mohanty (2005) [7] have also been similar effects when they treated *Vigna mungo* seed with effluents.

In *Pium sativum* the mean length of the seedlings had promotory effects at 10% to 80% of concentration but 100% of concentration the seedlings showed inhibitory effects when compared with the control (10.00 cm). The mean length of the seedlings decreased from 12.50 cm to 8.50 cm. The correlation of the root and shoot length against the % of effluent concentration was also calculated (-0.94) which show higher negative value. Mehta and Bhardwaj (2012) [8] also observed similar results when they treated *Vigna sinsensis* with paper mill effluent.

In *Daucus carota* the mean length of the seedlings had promontory effects at 10% of concentration. But there is no effect at 20% of concentration on the mean length of the seedlings. At 30% to 100% of concentration inhibitory effects were seen when compared with control seedlings. With the increase of the concentration of 30% to 100% the mean length of the seedling decreased from 5.25 cm. to 4.30 cm. in respect of control seedlings of 6.27 cm. The correlation was also calculated between concentration and root and shoot length of above species (-0.89). Likewise Jacob *et al.* (2016) [9] have also observed the impact of distillery effluent on the growth and development of *Oryza sativa* L.

The seeds of *Spinacia oleracea* showed synergistic effects when they were treated with percentage of effluent concentration when compared with the same under control. With the increase of concentration from 10% to 100% the mean length of the seedlings decreased from 3.60 cm to 1.55 cm, under control of 3.45 cm. The correlation of root and shoot length was also calculated against the concentration of effluent (-0.98). Rajannan and Oblisami (1979) [5] and Jacob *et al.* (2016) [9] observed very similar results when they treated rice (*Oryza sativa*) seed with paper mill effluent.

In case of the *Allium cepa* the mean length of seedlings has inhibitory effects at 10% to 100% concentration when compared with control of (7.25 cm.). The mean length decreased from 7.20 cm. to 4.55 cm. with the increase in the percentage concentration of the effluents. The correlation and regression values were calculated against the percentage concentration of effluents and they showed higher negative value (-0.99). Kumar *et al.* (2010) [10] observed very similar results when they treated *Trigonella foinumgrecum* seed with paper mill effluent.

The seed of *Solanum tuberosum* showed a deleterious effects of the effluents. At 10% and 30% of concentration the mean length of seedlings moved to be promotory when compared with control seedlings of (6.30 cm) whereas the seedlings from 50% to 100%; of concentration showed inhibitory effects when compared with control of (6.30 cm.). The mean length of seedlings decreased from (6.00 cm. to 5.25 cm.) by increasing the concentration of effluents. Correlation of effluents showed higher negative value (-0.96). Iqbal *et al.* (2013) [11] observed very similar results

when they were treated *Brassica* seed with distillery effluent.

4. Conclusion

It was observed in all the species that with the increase in the percentage of concentrations of effluents, there was a almost a continuous decrease in the root and shoot length of the seedlings. It was also seen that the shoot length was higher than the root length. The paper mill effluents have high C.O.D. value at different places indifferent seasons. Due to this reason, germinated seeds get a low amount of oxygen in the form of dissolved oxygen, restricting their energy supply through aerobic respiration which is essential for the growth and development of young seedlings. High concentration of total dissolved solids like sodium, Chloride and sulphate inhibiting the uptake of potassium, Calcium, Magnesium and phosphate.

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