Dominant Flora:

Identification of dominant species was worked out by applying relative values of the frequency and density.

Relative Frequency:

To study the degree of dispersion of individual species in an area in relation to other species present in it, the Relative Frequency (R.F.) of different species was calculated using the following formula;

$$\text{Relative Frequency} = \frac{\text{Frequency of one species}}{\text{Frequency of all the species}} \times 100$$

Relative Density:

To know the numerical strength of a species in relation to the total number of individuals of all the species Relative Density was calculated as below;

$$\text{Relative Density} = \frac{\text{No. of individuals of the sp. of all the quadrates}}{\text{No. of individuals of all the sp. in all the quadrates}} \times 100$$

Relative Dominance:

Relative dominance as basal coverage value of a species with respect to the sum of the basal coverage of rest of the species in an area was calculated as follows;

$$\text{Relative Dominance} = \frac{\text{The basal area of the sp. in all the quadrates}}{\text{Total basal area of all the sp. in all the quadrates}} \times 100$$

For determining an individual species, canopy of the species was clipped off and diameter of the stem emerging out of the ground was measured with the help of calipers.

Important Value Index-

In order to have an overall picture of an ecological importance of a species with respect to the community structure, the percentage of the relative frequency, relative density and dominance was added together and the sum value was called as Important Value Index (IVI).

$$\text{IVI} = \text{R.D.} + \text{R.F} + \text{R.Dominan}$$

3. Result and Discussion

Table 1: Mean variation (Annual) of Different parameters of effluent at different study sites of Orion Paper mill

Parameters	*Sites of collection*	
	S-1	S-2
Temperature (°C)	29.08 ±5.47	25.42±5.38
pH	7.5±0.14	7.1±0.11
Turbidity (NTU)	18.61±1.85	11.99±2.48
Electric Conductivity (dSm^{-1})	0.83±0.11	0.62±0.06
Total Alkalinity (mg L^{-1})	208.1±64.18	161.1±64.13
Total Acidity (mg L^{-1})	31.9±8.20	40.6±9.36
DO (mg L^{-1})	1.07±0.53	1.26±0.55
BOD (mg L^{-1})	185.8±46.33	98.83±30.49
COD (mg L^{-1})	512.1±147.08	404.0±172.97
Chloride (mg L^{-1})	390.9±47.87	205.0±32.14
Total Hardness (mg L^{-1})	232.4±45.02	183.7±39.19
Calcium (mg L^{-1})	89.5±21.50	75.5±19.88
Magnesium (mg L^{-1})	34.7±6.46	26.3±4.76
Nitrate Nitrogen(mg L^{-1})	49.7±6.80	31.5±5.41
Nitrite Nitrogen(mg L^{-1})	39.2±5.96	20.6±5.15
Phosphate(mg L^{-1})	27.5±3.98	20.4±1.95
TDS (mg L^{-1})	1862.3±434.62	1150.3±159.12
TSS (mg L^{-1})	531.9±115.53	365.8±49.60

Table 2: Phytosociological attribute of plant species growing at different sites of Orion Paper mill in winter season

Sl. No.	*Plant species*	*Study Sites*							
		S-1				S-2			
		Relative frequency	*Relative Density*	*Relative Dominance*	*Importance Value Index*	*Relative frequency*	*Relative Density*	*Relative Dominance*	*Importance Value Index*
1	Achyranthus aspera	9.43	8.42	4.58	22.43	9.5	3.6	2.77	15.87
2	Alternanthera sessilis	7.55	12.63	4.99	25.17	8.1	13.1	5.65	26.85
3	Astercantha longifolia	5.66	8.42	7.56	21.64	10.8	9.0	8.75	28.55
4	Bidance pilosa	5.66	6.32	1.68	14.47	10.8	7.7	3.31	21.81
5	Calotropis procera	5.66	3.16	11.36	20.18	-	-	-	-
6	Cassia tora	11.32	9.47	15.12	35.91	8.1	4.5	7.78	20.38
7	Commelina benghalensis	-	-	-	-	5.4	12.6	12.26	30.26
8	Croton sparciflorus	13.20	10.53	4.16	27.89	5.4	4.1	3.12	12.62

9	Cyanodon dactylon	11.32	9.47	1.68	22.47	9.5	4.1	0.44	14.04
10	Cyperus rotondus	-	-	-	-	4.1	9.0	1.73	14.83
11	Echhornia crapssipes	-	-	-	-	6.8	8.1	27.82	42.72
12	Eclypta alba	3.77	3.16	2.24	9.18	-	-	-	-
13	Euphorbia hirta	5.66	8.42	2.33	16.41	2.7	2.3	0.67	5.67
14	Lippia nodiflora	-	-	-	-	2.7	7.2	2.16	12.06
15	Marselia sp.	-	-	-	-	4.1	3.6	0.69	8.39
16	Parthenium sp.	11.32	12.63	27.46	51.41	8.1	7.6	15.53	31.23
17	Xanthium stramerium	9.43	7.37	16.01	32.81	4.1	3.6	7.31	15.01

(Data taken during the month of October-November)

Table 3: Phytosociological attribute of plant species growing at different sites of Orion Paper mill in summer season

Sl. No.	*Plant species*	*Study Sites*							
		S-1				S-2			
		Relative frequency	*Relative Density*	*Relative Dominance*	*Importance Value Index*	*Relative frequency*	*Relative Density*	*Relative Dominance*	*Importance Value Index*
1	Achyranthus aspera	11.48	10.20	6.64	28.32	10.77	6.57	6.88	24.22
2	Alternanthera sessilis	6.56	9.18	3.62	19.36	9.23	13.14	8.81	31.18
3	Astercantha longifolia	9.84	13.27	3.15	26.26	7.69	11.67	12.23	31.59
4	Bidance piloba		-	-	-	6.15	8.03	3.03	17.21
5	Calotropis procera	11.48	7.14	20.71	49.33	6.15	2.92	5.99	15.06
6	Cassia tora	8.20	6.12	8.32	22.64	6.15	5.11	9.04	20.30
7	Commelina benghalensis	-	-	-	-	7.69	10.95	9.28	27.92
8	Croton sparciflorus	13.11	13.27	6.82	33.20	10.77	6.57	6.88	24.22
9	Cyanodon dactylon	14.75	12.24	1.58	28.57	9.23	6.57	1.10	16.90
10	Cyperus rotondus	3.08	5.84	1.53	10.45	-	-	-	-
11	Eclypta alba	3.28	5.10	2.01	10.39	-	-	-	-
12	Lippia nodiflora	-	-	-	-	4.62	5.84	2.20	12.66
13	Parthenium sp.	9.84	14.29	25.83	49.96	12.31	13.14	23.25	48.70
14	Xanthium stramerium	11.48	9.18	21.32	41.98	6.15	3.65	10.21	20.01

(**Data taken during the month of April - May**)

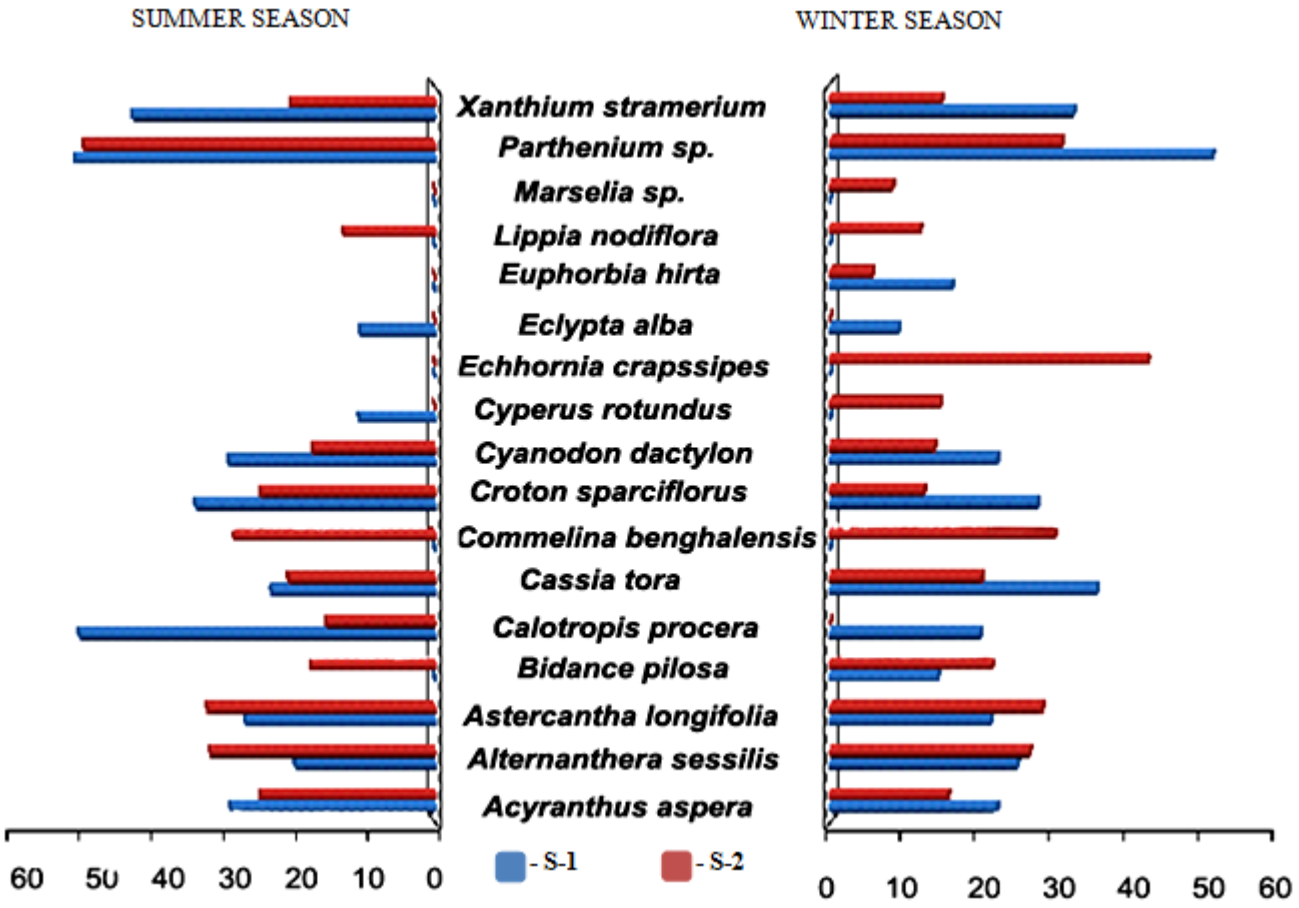

Plate I: Showing the IVI of different species during summer and winter season at the study site S-1 & S-2 of Orion Paper mill.

The quality and the concentrations of potentially toxic elements in effluent are summarized in Table -1. Effluents from both sites were slightly alkaline. In S-1 Dissolved Oxygen is less (1.07 mg/L) because there are more organic wastes in it & to remove these waste microbes requires more oxygen so BOD level is higher and in effluents of S-2 the value of Dissolved Oxygen is higher and BOD is lower in comparison to S-1. Total alkalinity of effluent of S-1 is higher (208.1 mg/L) than S-2(161.1mg/L). Chloride content was lower in S-2 (205.0 mg/L) than S-1(390.9mg/L). where hardness of S-1 was higher than S-2. Almost all parameter's values were haigher in effluent collected from S-1 in comparison to S-2.

Floristic composition (herbaceous) of two sampling sites (site- S-1 and site - S-2) for Orion paper mill was studied in during winter & summer season and observed data of Relative frequency, Relative density, Relative dominance and IVI of species have been represented in Table – 2 & 3. The entire observation has been presented by bar diagram in Plate –I. Significant variations in the floristic composition at different sites in two seasons are elucidated.

As per the observed floristic data present in the table –2 & 3 of winter & summer season from the study sites of Orion paper mill respectively. In winter season – Croton spaciflorus and Asteranthus longifolia have maximum Relative frequency at site S-1 and site S-2 respectively; whereas the higher value of Relative density is of Alternanthera sessilis at both sites, Parthenium sp. and Echhornia crapssipes have maximum Importance Value Index at site- S-1 and site S-2 respectively. In this season, the Relative dominance shown by Parthenium sp. at site S-1 and Echhornia crapssipes at site S-2, however, lowest Relative frequency and IVI represented by Eclypta alba and Relative density & Relative dominance represented by Calotropis procera & Bidance pilosa respectively at site S-1, whereas at site S-2 Relative frequency, Relative density and IVI shown by Euphorbia hirta, Relative dominance by Cyanodon dactylon .

In summer season – Cyanodon dactylon and Parthenium sp. have maximum Relative frequency at site S-1 and site S-2 respectively, whereas the higher value of Relative density, Relative dominance and IVI is of Parthenium sp. at both site, however, lowest Relative frequency Cyperus rotondus and Lippea nodiflora at site S-1 and site S-2 respectively, Relative density Eclypta alba and Calotropis procera at site S-1 and site S-2, Relative dominance represented by Cyperus rotondus & Cyanodon dactylon respectively at site S-1 and site S-2and IVI shown by Eclypta alba and Lippea nodiflora at site S-1 and site S-2.

Findings of present study reveal the existence of different community of plants along the drain carrying paper mill effluent. Such variation in community of plants may be attributed to variation in the habitats, each consist of a different environmental condition within the smaller area of investigation. High IVI indicates tolerance of species to the environment in which IVI has been measured. The variation in IVI between the sites indicates variation in the nature of specific dominant species.

Throughout experimental sites under the stress of effluents exhibited a narrow spectrum of flora with a distinct tendency for single species dominance, it elucidates natural selection under those species which have more efficient means to recover and propagate after stress. S-1 and S-2 sites showed variation in the dominant flora, such as Parthenium sp., Echhornia crapssipes, and Asteranthus longifolia in all the two seasons. Variations in these species may be due to poor establishment and lack of competitive powers. Floral composition at site S-1 and S-2 showed more mosaicism in plant species as compared to plants growing on in all the three seasons. This is evident from the number of total species presence at each site. This mosaicism of plant communities within a climatic region is determined by the combination of a number of factors such as microclimatic and biotic conditions which produce the most common and vegetation pattern.

From the result of present research work, as discussed above, it become clear that variations in the floristic composition of the sites (S-1 and S-2) is associated with variations in Physico–chemical characteristics of the effluent that is controlled by effluent and change in seasons. In light of present investigation it can be said that paper effluents may be utilized for agriculture practices by means of planned management towards proper treatment before releasing and dilution after discharge from the industries.

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