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EFFECT OF SOUTH INDIA VISCOSE FACTORY EFFULENT ON SEED GERMINATION, SEEDLING GROWTH AND CHLOROPLAST PIGMENTS CONTENT IN FIVE VARIETIES OF MAIZE (*Zea mays L*)

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In the present study an attempt is made to understand the effect of different concentrations of South India Viscose factory effluent on seed germination and seedling growth in five varieties of maize (*Zea mays* L.). The seed germination percentage and seedling growth parameters viz., roots length, shoot length and number of lateral roots formed on the first seminal root have shown an inverse relationship with increase in concentration of the effluent. Likewise, increasing concentrations of the effulent correspondingly decreased the fresh and dry weights of the treated seedlings. The contents of chloroplast pigments, chlorophylls and carotenoids, also decreased correspondingly with increase in concentration of the effluent. Therefore, it is concluded that South India Viscose factory effluent cannot be utilised for irrigation purpose without prior treatment.

Effluents from Industries are the main source of water pollution. They contain organic compounds, acids, alkalies suspended solids and other toxic materials. Often untreated or partially treated effluents are discharged into the river waters. South India Viscose factory effluent is let into Bhavani river waters. Some farmers utilise the polluted river water for irrigation of crop plants like paddy, maize and sugarcane.

To gain a better understanding on the effect of industrial effluents on crop plants, adequate pilot tests should be carried out to determine the effect of industrial effluents on individual crop plants. With this view in mind, in the present srudy, an attempt is made to assess the effect of different concentrations of South India Viscose factory effluents on seed germination, seedling growth, changes in fresh and dry weights of seedling and chloroplast pigments content in five varieties of *zea mays* L. viz,, umi-51, Co-1, umc-11, umi-29 and umH-9.

MATERIALS AND METHODS

Five varieties of maize viz., umH-9, Co-1, umi-51, umi-29 and umc-11 were procured from Tamil Nadu Agricultural University, Coimbatore. The industrial effluent was collected from South India Viscose factory, Sirumugai, Coimbatore on two different dates viz., 5th September, 1987 and 20th September, 1987.

On 6th September, 1987 healthy and uniform sized seeds were selected and divided into batches of 25 each. The different concentrations of the effluent were prepared as given below.

1 ml of collected effluent + 99 ml of distilled water = 1% effluent

2.5 ml of collected effluent + 97.5 ml of distilled water = 2.5% effluent

5 ml of collected effluent + 95 ml of distilled water = 5% effluent

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10 ml of collected effluent + 90 ml of distilled water = 10% effluent
25 ml of collected effluent + 75 ml of distilled water = 25% effluent
50 ml of collected effluent + 50 ml of distilled water = 50% effluent

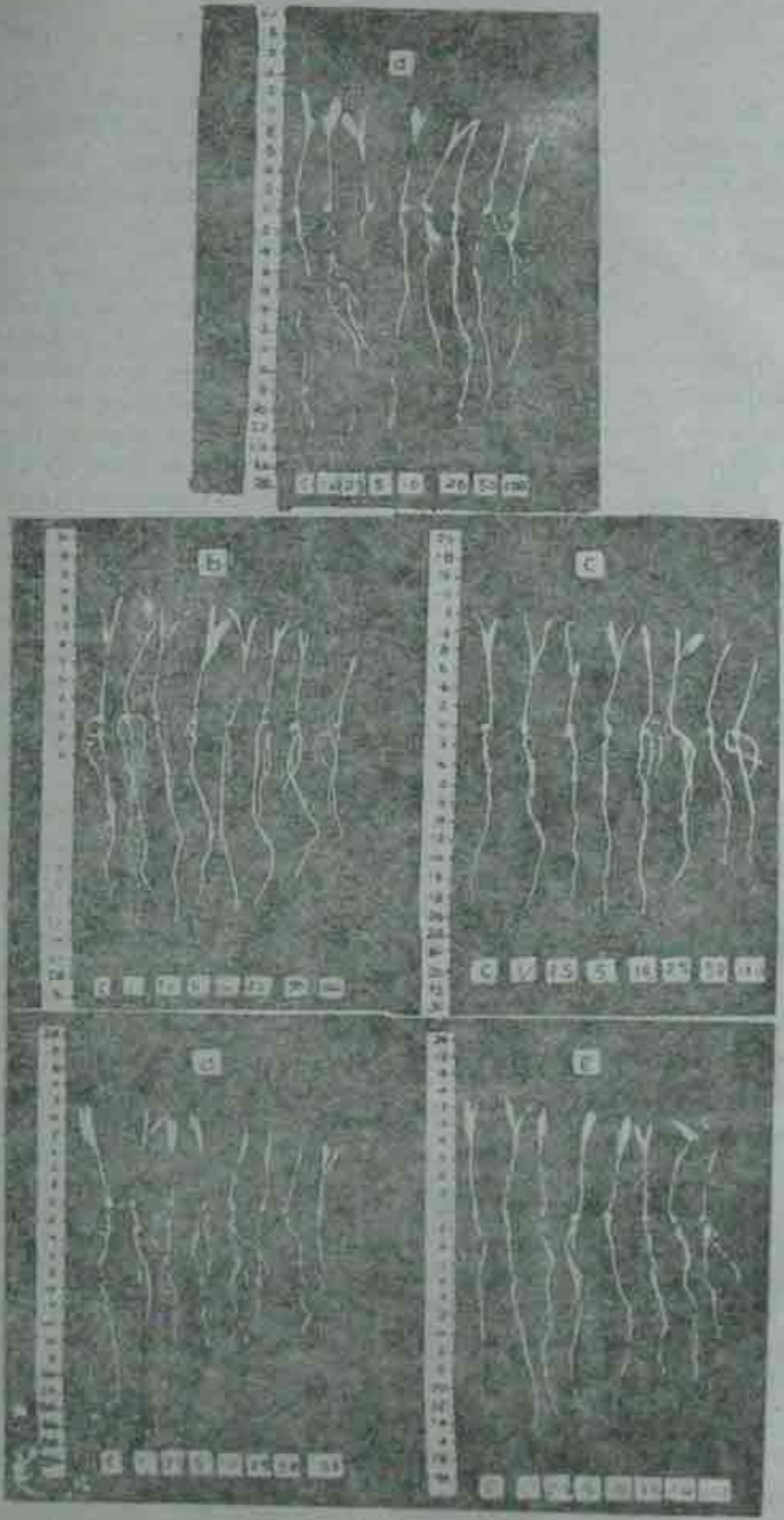
The collected effluent without dilution was used as 100% effluent. The selected lots of seeds were surface sterilized with 0.1% mercuric chloride solution for 1-2 min., rinsed with distilled water repeatedly and soaked in peteridishes containing equal volumes of different concentrations of the effluent for 24 hr. One batch was kept as control by soaking the seeds in equal volumes of distilled water for every variety. The soaked seeds were washed with distilled water and allowed to germinate in paper towels for 8 days. On the day of termination of the experiment (8th day) number of seeds germinated and the different seedling growth parameters viz. 1) the length of the first seminal root, 2) the length of the shoot, 3) the number of lateral roots formed from the first seminal root, and 4) the average fresh weight of all the seedlings were recorded. Control as well as experimental samples of the seedlings were dried in an electric oven at 80°C for 24 hr. and the average dry weight also was recorded. The experiment was repeated on 21st September, 1987 as narrated above. Average values for the percentage of seed germination and seedling growth parameters of duplicate experiments were tabulated. Employing the 't' test significant differences of seedling growth parameters of the treated seedlings with that of control were statistically evaluted at $p = 0.05$ and 0 01 levels. The content of chlorophylls extracted in 80% acetone were estimated according to the formula of Arnon (1949). Total carotenoids were extracted and estimated following the method of Mahadevan and Sridhar (1982).

RESULTS AND DISCUSSION

The Physico-chemical properties of South India Viscose factory effluent are presented in Table, 1. The results on the effect of different concentrations of South India Viscose factory effluent on seed germination percentage and different growth parameters of seedlings and chloroplast pigments content in maize vars. umi-51, Co-1, umc-11, umi-29 and umH-9 are shown in Tables, 2 & 3. The results are supported by photographic evidence in Fig, 1a, b, c, d and e, respectively.

The findings of the present study indicate that the lower concentrations of the effluent did not affect seed germination in all the five varieties of maize investigated excepting the var. umi-29. Higher concentrations (10% upto 100%) in the vars. Co-1, umi 51 and umc-11, (50% and 100%) in the var. umH-9 and all the employed concentrations in the var. umi-29, suppressed seed germination.

Without any exception in all the fivevarieties of maize investigated, with increase in concentration of the effluent there was a corresponding decrease in the root length, shoot length and number ot lateral roots formed (Tables, 2 & 3 and Fig. 1a to e). Higher concentrations (25%, 50% and 100%) in the vars. umH-9, umi-51 and umc 11 significantly retared the shoot extension growth. Effluent concentrations 5% up



Legend to Fig. 1. Effect of different concentrations of South India Viscose factory effluent on seedling growth in: (a) *Zea mays* L. var. [illegible] (b) *Zea mays* L. var. Co-1 (c) *Zea mays* L. var. [illegible] (d) *Zea mays* L. var. [illegible] (e) *Zea mays* L. var. [illegible]

to 100% in the var. umi-29 markedly inhibited lateral roots formation. Earlier, similar results have been reported in sorghum and cowpea seedling treated with paper mill effluent (Ravindranath, 1987).

The high amount of T.D S. (Total Dissolved solids), lower D.O. (Dissolved Oxygen) seem to be responsible for the inhibition of seed germination and seedling growth because they would disturb the osmotic relations of the seed by enhancing salinity and conductivity of the solutes being absorbed by seeds prior to germination. Further more, the germinating seeds would get low amount of oxygen in the form of dissolved oxygen, which restricts the energy supply through aerobic respiration. The supply of energy through aerobic respiration is essential for growth and development of young seedlings. The net result would be the restriction of growth of the radicle and plumule, ultimately, leading to inhibition of seed germination (Kittock and Law, 1968; Hadas, 1976).

Excess accumulation of chloride ions (Cl^-) under salt stress reduces turgor pressure inside the cells of the treated seedlings which in turn causes reduction in growth of seedling (Sheoran and Garg, 1983). Therefore, in the present investigation suppression of seedling growth by South India Viscose factory effluent might be attributed to the excess accumulation of chloride ions or to a combination of both depleted O_2 supply and excess Cl^- accumulation (Bernstein, 1963, Layerwreff, 1969, Greenway and Munnes, 1980).

Fresh and dry weights of the treated seedlings showed an inverse relationship with effluent concentrations in all the five maize varieties studied. More than 50% of the dry weight was reduced in the seedlings treated with the highest concentration of the effluent (100%) in the vars. umH 9, Co-1 and (50% and 100%) in the other three varieties. Similar observations have been reported, earliar, in *Pistia*, *Eichhornia* and *Salvinia* treated with distillery effluent (Arokiaswamy and Gnanarathinam, 1980). Increasing concentrations of the effluent correspondingly decreased the chloroplast pigments content in the treated seedlings in all the five varieities. Higher concentrations (25% upto 100%) in the vars umH-9, umc-11 and umi-51, inhibited more than 50% of chlorophyll 'a' content Effluent concentrations 10% and above 10% markedly reduced the chlorophyll 'b' content in the vars umH-9, Co-1 and umi-29. Effluent concentrations 5% upto 100% significantly reduced carotenoids content in the maize var. umi-29. Increasing salinity levels are known to, gradually, reduce the pigments content and chloroplast activity in cotton (Mukhameoov and Safarov, 1982). The results of the present study indicate that South India Viscose factory effluent should not be employment for irrigation of crop fields without prior treatment.

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Table 1 : Physio-chemical properties of the effluent from South India Viscose factory

a)	*General parameters*	
i)	pH	6.8
ii)	Colour	—
iii)	Suspended solids	
a.	Total (mg/1)	20
b.	Fixed (mg/1)	10
c.	Volatile (mg/1)	10
iv).	Dissolved solids	
a.	Total (mg/1)	1455
b.	Fixed (mg/1)	1155
c.	Volatile (mg/1)	300
v)	Total volatile solids (mg/1)	310
vi)	B.O.D. 5 days 20° (C mg/1)	20
vii)	C.O.D. (mg/1)	325
b)	*Chemical parameters* :	
i)	Ammoniacal nitrogen (mg/1 as N)	1.26
ii)	Nitrates (mg/1 as N)	Nil
iii)	Chlorides (mg/1 as C1)	100
iv)	Phosphates (mg/1 as P)	0.18
v)	Phenolic compounds (mg/1 as phenol	Nil
vi)	Cyanides (mg/1 as CN)	Nil
vii)	Sulphates (mg/1 as S)	90
viii)	Insecticides (mg/1)	—
ix)	Total residual chlorides (mg/1 as C1)	Nil
x)	Fluorides (mg/1 as F)	Nil
xi)	Percent sodium	25
xii)	Pesticides (mg/1)	—
c)	*Heavy Metals*	
i)	Boron (mg/1 as B)	Nil
ii)	Arsenic (mg/1 as As)	Nil
iii)	Barium (mg/1 as Ba)	Nil
iv)	Cadmium (mg/1 as Cd)	Nil
v)	Copper (mg/1 as Ca)	0.36
vi)	Lead (mg/1 as Pb)	Nil
vii)	Chromium	Nil
a)	Total (mg/1 as Cr)	Nil
b)	Hexa-Valent (mg/1 as Cr)	Nil
viii)	Mercury (mg/1 as Hg)	Nil
ix)	Nickel (mg/1 as Ni)	Nil
x)	Selenium (mg/1 as Se)	Nil
xi)	Silver (mg/1 as Ag)	Nil
xii)	Zinc (mg/1 as as Zn)	0.46

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Table 2. Effect of South India Viscose factory effluent on seed germination, seedling growth, changes in fresh and dry weights and chloroplast pigments contents in maize varieties umi-51, Co-1 and umc-11.

Efficient concentration (%)	Seed germination (%)	Length of root in cm	Length of shoot in cm	Number of lateral roots formed on the 1st seminal root	Fresh wt. in gms	Dry weight in gms	Chlorophyll a (ug/gm fr. wt.)	Chlorophyll b (ug/gm fr wt.)	Total Chlorophylls (ug/gm fr. wt.)	Total amount of carotenoids (ug/gm fr. wt.)
Var. umi-51										
Control	100	25.47±0.69	12.72±0.75	74±0.75	0.70±0.01	0.22±0.02	369.18	477.40	846.58	0.28
1	100	25.41±0.91	12.56±0.77	73±3.34	0.68±0.01	0.21±0.01	339.46	445.64	782.10	0.21
2.5	100	25.08±0.61	12.46±0.79	73±5.46	0.67±0.02**	0.19±0.01	261.01	363.90	624.91	0.21
5	100	24.95±0.89	12.16±0.72	71±3.55	0.64±0.01**	0.17±0.01	229.29	332.14	561.43	0.18
10	92	24.15±1.17	12.11±0.54	69±4.49	0.58±0.02**	0.14±0.01**	213.65	249.90	463.55	0.15
25	92	23.58±0.36*	11.22±0.63*	68±3.38	0.52±0.01**	0.13±0.04**	178.99	135.90	314.89	0.15
50	92	19.93±0.79**	10.98±0.70*	66±4.27	0.47±0.00**	0.11±0.00**	145.27	99.46	245.73	0.14
100	80	17.59±0.83**	8.65±0.59**	48±3.74*	0.43±0.001**	0.09±0.006**	136.26	81.24	217.50	0.12
Var. Co. 1										
Control	88	25.79±0.81**	13.58±0.78	53±2.22	0.70±0.01	0.23±0.01	425.36	412.88	838.24	0.20
1	88	25.08±0.59	13.25±0.92	52±2.31	0.67±0.03	0.21±0.00*	377.25	408.70	785.95	0.20
2.5	88	23.66±0.75	12.55±0.87	50±4.69	0.66±0.04	0.19±0.01**	344.53	376.94	721.47	0.20
5	88	23.43±0.99	12.30±0.88	48±2.69	0.65±0.01	0.18±0.01**	249.06	258.76	507.82	0.18
10	80	23.32±0.66**	12.18±0.48	47±1.87	0.63±0.01*	0.17±0.01**	234.42	176.76	411.18	0.17
25	80	21.18±0.79**	11.47±0.65**	47±2.09	0.60±0.00*	0.04±0.00**	217.09	117.18	334.27	0.16
50	76	19.76±0.79**	10.77±0.50**	43±2.05**	0.58±0.01**	0.12±0.01**	161.66	71.88	233.54	0.16
100	76	19.50±0.72**	9.21±0.52**	41±4.36**	0.54±0.00**	0.10±0.01**	90.84	54.16	146.00	0.14
Var. umc-11										
Control	100	23.68±0.60	12.52±0.85	62±3.58	0.54±0.01	0.18±0.00	334.52	358.72	693.24	0.21
1	100	22.50±0.92	12.50±0.67	62±2.95	0.63±0.01	0.18±0.00	327.20	313.60	640.80	0.20
2.5	100	22.03±2.05	12.10±0.76	59±3.24	0.62±0.01	0.17±0.00	269.08	295.20	564.28	0.20
5	100	21.99±0.47	12.05±0.61	58±2.71	0.59±0.00**	0.15±0.01*	236.36	263.44	499.80	0.16
10	96	21.82±0.78*	11.90±0.45	58±1.95	0.56±0.00**	0.12±0.01*	216.34	222.00	443.34	0.16
25	96	21.18±0.71**	11.53±0.52*	57±0.20	0.48±0.02**	0.10±0.00*	158.22	204.60	362.82	0.13
50	96	20.99±0.20**	9.85±0.20**	56±2.56*	0.45±0.00**	0.09±0.00**	120.87	108.82	229.69	0.12
100	93	19.17±0.82**	8.10±0.41**	56±2.97*	0.41±0.00**	0.07±0.01**	103.54	99.48	153.02	0.12

±: Denotes the standard error; * Denotes the significant difference from control at p=0.05 level

** Denotes the significant diff[illegible]

Table 3. Effect of South India Viscose factory effluent on seed germination, seedling growth, changes in fresh and dry weights and chloroplast pigments contents in maize varieties umi-29, and umH-9.

Efficient concentration (%)	Seed germination (%)	Length of root in cm	Length of shoot in cm	Number of lateral roots formed on the 1st seminal root	Fresh wt. in gms	Dry weight in gms	Chlorophyll a (ug/gm fr. wt.)	Chlorophyll b (ug/gm fr. wt)	Total Chlorophylls (ug/gm fr. wt.)	Total amount of carotenoids (ug/gm fr. wt.)
Var. umi-29										
Control	100	25.91±0.19	12.30±0.73	77±3.15	0.61±0.01	0.20±0 01	346.47	463.86	810.33	0.28
1	92	25.91±0.19	11.40±0.89	74±3.53**	0.59±0.01	0.19±0.01**	303.74	413.88	717.62	0.20
2.5	92	22.77±0.73**	10.91±0.69*	69±4.05**	0.56±0.00	0.17±0.00**	276.40	336.32	612.72	0.17
5	92	22.51±0.56**	10.57±0.85*	64±2.61**	0.53±0.01**	0.15±0.00**	236.36	263.44	499.80	0.14
10	92	22.65±0.79**	10 35±0.83*	59±2.04**	0.51±0.00**	0.14±0.00**	224.41	126.54	350.95	0.14
25	92	21.02±0.71**	99.59±0.79**	48±2.85**	0.50±0.00**	0,13±0.00**	191.69	117.18	308.87	0.13
50	92	19.08±0.98**	9.39±0.82**	48±4.80**	0.46±0.00**	0.10±0.00**	161.66	71.88	233.54	0.12
100	92	18.60±0.63**	8.50±0.82**	47±4.80**	0.41±0.00**	0.08±0.01**	103.54	49.48	153.02	0.12
Var. umH-9										
Control	96	27.82±0.43	14.32±0.91	106±6.53	0.82±0.05	0.24±0.01	395.33	358.22	753.55	0.31
1	96	26.70±0.69	14.17±0.23	93±5.60	0.71±0.05	0.23±0.00	273.71	354.04	627.75	0.28
2.5	96	25.04±1.11*	12.95±0.73*	90±5.44*	0.70±0.03	0.22±0.01*	243.68	304.56	548.24	0.27
5	96	24.90±1.00*	12.11±0.64**	90±4.51*	0.66±0 04	0.21±0.00*	219.03	204.10	423.13	0.24
10	96	24.87±1.13**	12.00±0.74	88±4.39*	0.62±0.05*	0.17±0.01**	199.01	167.66	366.77	0.18
25	96	24.85±0.75**	11.54±0.93	86±4.58*	0.60±0.03*	0.15±0.01**	178.99	131.22	310.21	0.18
50	88	24.58±0.41**	9.95±0.77	78±6.17*	0.50±0.05**	0.14±0.01**	136.26	81.24	217.50	0.18
100	84	23.54±0.76**	8.64±0.70	76±2.56*	0.45±0.01**	0.12±0.00**	103.54	49.48	153.02	0.14

± Denotes the standard error; * Denotes the significant difference from control at p=0.05 level
** Denotes the significant difference from control at p=0.01 level