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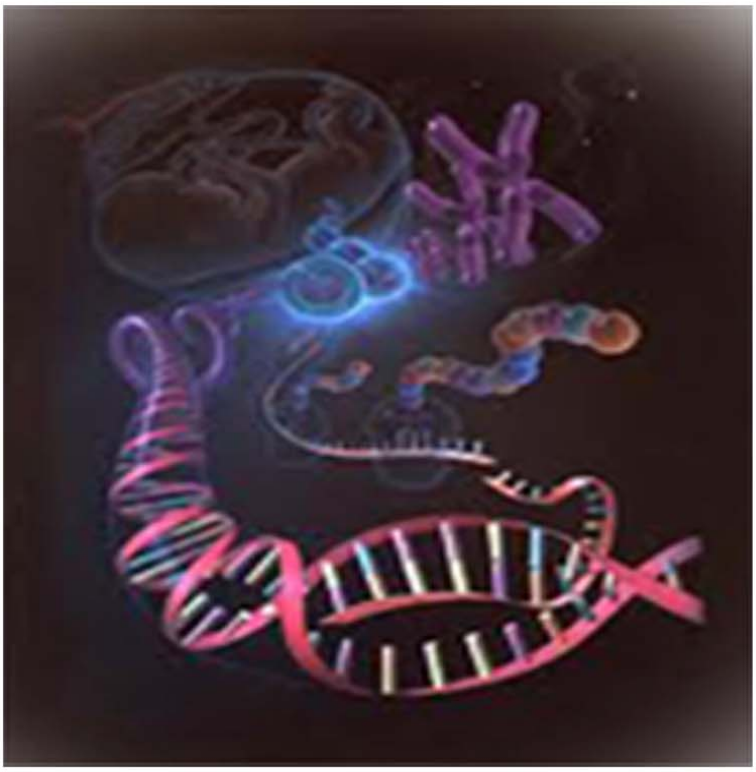

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Research Paper

EFFECT OF SAGO FACTORY EFFLUENT ON SEED GERMINATION AND SEEDLING GROWTH OF GINGELLY (*SESAMUM INDICUM* L.) VARIETIES

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The crisis of environmental pollution on account of essential industrial growth is due to the problem of discarding of industrial waste as well, whether solid, liquid or gaseous. Polluted water, in addition to other effects, directly affects soil not only in industrial areas but also in agricultural fields and rivers bodies and all ecosystems, thereby creating secondary source of pollution. Water resources are most often affected by industrial pollution. The sago factory effluent is a serious concern in throughout the salem district of Tamil Nadu. So the present investigation effect of sago factory effluent on germination and growth performance of eight varieties of Gingelly (*Sesamum indicum* L.) such as TMV 3, TMV 4, TMV 5, TMV 6, VRI 1, VRI 2, CO 1 and SVPR 1. The experimental surveillance in lower concentration of sago factory effluent the germination percentage and growth were moderately higher than the control, but gradual decrease in the germination of seedlings, seedling growth with increase in effluent concentration. The best germination of seedling growth, root length, shoot length, fresh weight and dry weight and tolerant verity was observed in 20% concentration of sago factory effluent with growth promoting effect and significantly better than control. Beyond 20% effluent, root and shoot length was decreased. Hence the sago factory effluent can be carefully used for agricultural irrigation purposes with appropriate treatment and dilution methods.

Keywords: Environmental pollution, Sago factory effluent, *Sesamum indicum* L., Germination percentage, Tolerant variety

INTRODUCTION

Manufacturing rebellion is a great benefit to mankind but there is a wide range of environmental impacts created by industries. Majority of these industries are water based. Over 3/4th of fresh water drawn by the domestic and industrial effluents unavoidably end up in surface water bodies or in the ground water affecting water quality. The industrial use of water is very low as compared to agricultural use, the disposal of industrial effluents on land or surface water bodies make water assets inappropriate for other

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uses (Buechler and Mekala, 2005). Population explosion has resulted in heavy industrialization. The industries are the cause of different types of pollution. One of the major problems is the discharge of the industries dumped into our atmospheres. The industrial effluents are generally considered harmful but sometimes used for irrigating various crops. (Nath *et al.,* 2009 and Malaviya *et al.,* 2007).

Industrial effluents (including agro-industrial wastewaters) are result from human activities which are associated with raw-material processing and manufacturing. These wastewater streams arise from washing, cooking, cooling, heating, extraction, reaction by-products, separation, conveyance, and quality control resulting in product rejection. Water pollution occurs when potential pollutants in these streams reach certain amounts causing undesired alterations to a receiving water bodies. While industrial wastewaters from such processing or manufacturing sites may include some domestic sewage, the latter is not the major component.

Industrial are established to fulfill the demand of the growing population in the country. The introduction of industries on one hand manufactures useful products but at the same time generates waste products in the form of solid, liquid or gas that leads to the creation of hazards, pollution and losses of energy. Most of the solid wastes and wastewaters are discharged into the soil and water bodies and thus ultimately facade a serious threat to human and routine functioning of ecosystem (Tariq *et al.,* 2006).

In India (Tamil Nadu) main contributors to the surface and ground water pollution are the by-products of a variety of industries such as textile and dying (Kaushik *et al.,* 2005) tannery groundnut (Indira *et al.,* 2012; Ravi Mycin *et al*., 2012) sugar (Thamizhiniyan *et al.,* 2009); processing, chemicals, pesticides, fertilizer, pulp and paper (Malla and Mohanty, 2005), distilleries, food processing Dairy and Sago (Dhanam, 2009), mining, electroplating and others (Sah *et al.,* 2000). The discharge of industrial effluents, municipal sewage, farm and urban wastes carried by drains and canals to rivers worsen and broadens water pollution. High levels of pollutants in river water causes an increase in Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Dissolved Solids (TDS), Total Suspended Solids (TSS), toxic metals such as Cd, Cr, Ni and Pb and fecal coliform and the presence of heavy metals in the environment causes deleterious effects to plants and human beings, particularly at certain levels of exposure and absorption. Among the heavy metals processes whereas others like cadmium, nickel and chromium have no physiological function but often results in harmful disorders at a higher concentration of effluent (Kavitha, 2010). Hence make such water unsuitable for drinking, irrigation and all aquatic life.

Tapioca is one of the most imperative subsistence food and industrial crop for the developing countries. Worldwide, about 158 million tons of tapioca is produced from an area of 15.7 million ha with an average productivity of 10 tons/ha. As mentioned earlier, among the tapioca producing continents in the world, Asia ranks next only to Africa with an area and production of 3.97 million ha and 51.44 million tons, respectively. Tapioca is an important tuber crop cultivated in many tropical countries, while in some states (Kerala and North Eastern states) it is used as food crop. Tapioca industry is an agro based on regular industry with huge employment potential in India. Tapioca is mainly processed into starch and sago. Tamil Nadu state stands first in respect of processing of tapioca into starch and sago, in India. In India, Sago was produced first in Salem and Namakkal Districts of Tamil Nadu. About in 1943 to 1944, Last 65 years ago, sago production started on a cottage scale basis in India by pulping the tapioca roots, filtering the milk-extract and after settling the milk, forming globules and roasting these globules. There are about 30 to 35% starch contents generally in Indian tapioca root. India is one of the leading countries in tapioca production. Almost all tapioca processing industries in Tamilnadu have prevailed with two major problems. The first problem is the huge requirement of water for better extraction of starch from tubers. Second is the generation of large volumes of effluent. Many factories are being closed due to the unavailability of water resource (Amuthavalli and Murugesan, 2012).

Oil seeds are essential part of Indian diet. It constitutes the second largest agricultural produce next to food grains Gingelly (*Sesamum indicum* L.) is an important irrigational oil crop in Tamilnadu, India. It is otherwise called as 'Queen of oilseeds". Sesame is the third important oil seed crop in the world and widely grown in tropical and sub-tropical regions for high quality edible oil. So the present investigation carried out sago factory effluent on the seed germination, seedling growth of gingelly verities.

MATERIALS AND METHODS

Seed Material

The experimental seeds Gingelly (*Sesamum indicum* L.) eight varieties such as, TMV 3, TMV 4, TMV 5, TMV 6, VRI 1, VRI 2, CO 1 and SVPR 1 were obtained from Oil Seeds Research Station, Thindivanam, Tamil Nadu, India.

Collection of Effluent Sample

The sago factory effluent samples were collected in plastic containers from the outlet of a sago factory, Aathur, Salem District.

Seed Treatment

The seeds were surface sterilized, with 0.2% mercuric chloride ($HgCl_2$) solution to avoid the seed pathogen. The seeds were thoroughly washed under tap water and then distilled water.

Pot Culture Experiments

The seeds were arranged especially in sterilized plastic pots. Each plastic pots were filled with 2 kg soil and irrigated with uniform quantity of different concentration of the sago factory effluent in addition, a set of plastic pots were irrigated with distilled water treated as control. Each treatment including control was replicated for five times.

Irrigation Schedule

One litre of various concentration of raw sago factory effluent was poured uniformly in relevant pots and the control pots were irrigated with well water. The irrigation was done thrice in a week.

Treatment Details

The treatment details are as follows:

T_1 – Control (Untreated)

T_2 – 10% effluent + 90% water

T_3 – 20% effluent + 80% water

T_4 – 30% effluent + 70% water

T_5 – 40% effluent + 60% water

T_6 – 50% effluent + 50% water

T_7 – 100% raw effluent.

Germination Percentage

Germination refers to the initial appearance of the radicle by visual observation. It was calculated by using the following formula.

Germination percentage =

$$\frac{\text{Number of seeds germinated}}{\text{Total number of seeds sown}} \times 100$$

Root Length and Shoot Length

The root length and shoot length of gingelly was taken at 7th day after showing. The seedling length was measured using a centimeter scale.

Fresh Weight and Dry Weight

The fresh weight and dry weight of gingelly seedlings were taken and dried a hot air oven at 80°C for 24 h. After drying sample were weighted in an electrical single pan balance.

RESULTS AND DISCUSSION

Germination Percentage

Germination percentage values of gingelly under sago factory effluent irrigation are presented in (Table 1). The germination percentage was found to be highest in 20% effluent concentration. It was found to be (90.0, 92.0, 95.0, 95.0, 98.5, 95.0, 92.0 and 95.0) in TMV 3, TMV 4, TMV 5, TMV 6, VRI 1, VRI 2, CO 1 and SVPR 1, respectively. Similarly the lower values were observed at 100% effluent concentration. The higher concentration of sago factory effluent condensed the germination of gingelly seeds. The presence of extreme dissolved solids and high BOD values may be guilty for germination inhibition and consequent decline in germination percentage (Yadav and Meenakshi, 2007) and some mechanism involved in delayed germination might be linked with the reduced activity of several enzymes (Agarwal and Hemalatha, 1992). They have also shown that surplus amount of TDS is

Table 1: Effect of Sago Factory Effluent on Seed Germination Percentage of Gingelly (*Sesamum indicum* L.) varieties

Effluent Concentration (%)	Seed Germination Percentage							
	Gingelly Varieties							
	TMV 3	TMV 4	TMV 5	TMV 6	VRI 1	VRI 2	CO 1	SVPR 1
Control	80.0	80.0	83.2	85.5	90.0	88.5	85.0	85.5
10	85.0(+6.25)	85.0(+6.25)	88.0(+6.02)	90.0(+5.88)	92.5(+2.22)	90.0(+2.22)	88.0(+3.40)	88.5(+3.52)
20	90.0(+12.5)	92.0(+15.0)	95.0(+14.45)	95.0(+11.76)	98.5(+9.44)	95.0(+7.95)	92.0(+8.23)	95.0(+11.76)
30	75.0(-6.25)	78.0(-2.50)	80.0(-3.61)	80.5(-5.88)	85.5(-5.00)	82.5(-6.81)	78.5(-8.23)	80.0(-5.88)
40	70.5(-11.87)	72.5(-9.37)	74.0(-10.84)	75.0(-11.76)	80.0(-11.11)	80.0(-0.09)	70.5(-17.64)	78.0(-8.23)
50	68.5(-14.37)	70.0(-12.50)	70.5(-15.66)	72.0(-15.29)	75.5(-16.66)	76.0(-13.63)	65.5(-23.52)	75.0(-11.76)
100	60.2(-24.75)	62.5(-21.87)	63.0(-24.09)	65.5(-23.52)	70.0(-22.22)	68.0(-22.72)	60.0(-29.41)	65.0(-23.52)

Note: Percentage over control values are given in the parentheses.

responsible for retardation of germination and subsequent growth of young seedlings because they would disturb the osmotic relation of the seeds with effluent water and thus reduce the amount of water absorbed (Akbar *et al*., 2009). The increase in germination percentage over control at lower concentrations indicates the stimulation of physiologically inactive seeds of the lot by the treatment as suggested by (Lenin and Thamizhiniyan, 2009). And anther mechanisms it may also be due to the reduction in level of toxic metabolites by dilution and better consumption of nutrients present in the effluent (Kannan, 2001). The other possibility of reduction in germination percentage at higher concentration of effluent may be due to presence of excess amount of ammonia and other heavy metals in effluent, causing exhaustion of the Tricarboxylic acid cycle, which reduces the respiration rate and subsequently germination (Karande and Ghanvat, 1994).

Root and Shoot Length

Root length values of gingelly under sago factory effluent irrigation are presented in (Table 2). The root length was found to be utmost in 20% effluent concentration. It was found to be (5.0, 5.2, 5.3, 5.5, 6.0, 5.7, 5.5 and 5.0) in TMV 3, TMV 4, TMV 5, TMV 6, VRI 1, VRI 2, CO 1 and SVPR 1, respectively. Similarly the lower values were observed at 100% effluent concentration. The gingelly root which incessantly remains in direct contact with sago factory effluent with higher concentrations of the effluent could affect cell multiplication or the root growth Kannan and Upreti (2008). Another reason for such deeds might be due to the fact that heavy metals trigger the release of protective organic acids and chemical compounds exclusively from the root-tips into the adjacent environment. These chemicals form multifaceted with the toxic pollutants when released, prevent their entry into the roots and allow the essential nutrients to enter the body Augusthy and Sherin (2001) and Yousaf *et al*. (2010).

Shoot length values of gingelly under sago

Table 2: Effect of Sago Factory Effluent on Root Length (cm/Seedling) of Gingelly (*Sesamum indicum* L.) Varieties

Effluent Concentration (%)	Root length (cm/seedling)							
	Gingelly Varieties							
	TMV 3	TMV 4	TMV 5	TMV 6	VRI 1	VRI 2	CO 1	SVPR 1
Control	4.0	4.2	4.2	4.5	5.6	5.2	5.0	4.3
10	4.5(+11.11)	4.7(+10.63)	4.5(+7.142)	4.7(+4.44)	5.8(+3.57)	5.5(+5.76)	5.3(+6.00)	4.5(+4.65)
20	5.0(+20.00)	5.2(+19.23)	5.3(+21.15)	5.5(+22.22)	6.0(+7.14)	5.7(+9.61)	5.5(+10.00)	5.0(+16.27)
30	3.8(-5.26)	4.0(-5.00)	4.0(-4.76)	4.4(-22.21)	5.5(-17.85)	5.0(-3.84)	4.5(-10.00)	4.2(-23.25)
40	3.5(-12.5)	3.7(-13.51)	3.8(-9.52)	4.0(-11.11)	5.0(-10.71)	4.5(-13.46)	4.0(-20.00)	4.0(-20.00)
50	3.0(-25.00)	3.5(-20.00)	3.6(-14.28)	3.8(-18.42)	4.5(-19.64)	3.8(-26.92)	3.5(-0.00)	3.2(-25.58)
100	3.0(-33.33)	3.3(-27.27)	3.0(-28.57)	3.5(-22.22)	4.0(-28.57)	3.4(-34.61)	3.0(-0.00)	3.0(-0.00)

Note: Percentage over control values are given in the parentheses.

factory effluent irrigation are presented in (Table 3). The shoot length was found to be most in 20% effluent concentration. It was found to be (9.5, 10.2, 10.8, 11.0, 12.0, 11.0, 11.2 and 10.5) in TMV 3, TMV 4, TMV 5, TMV 6, VRI 1, VRI 2, CO 1 and SVPR 1, respectively. Similarly the lower values were observed at 100% sago factory effluent concentration. The seedling point is the most responsive stage in the life of a plant and more susceptible to physical and chemical adversities. We may narrate the decline in seedling (root and shoot) lengths with the elevated amounts of total dissolved solids at higher concentrations of sago factory effluent. This could also be related to the fact that some of the nutrients present in the sago factory effluents are essentials but at above a particular (100%) concentration, they become dangerous. The study of Panaskar and Pawar (2011a and b) also showed that effluent was not inhibitory at low concentrations but with the increase in concentration growth of seedlings was pretentious. The seed might have required some nutrients for their normal metabolic activities. The effluent also contains plant nutrients and trace elements, which are essential for plant growth Dhanam, (2009). The higher concentrations (above 50%) of effluent reduced the growth of seedlings and it seems that these concentrations of the sago factory effluent contain an excess of total nitrogen, phosphate, potassium, calcium, chloride and sulphate which are adverse to plant growth by affecting the water adsorption and other metabolic process of the gingelly plants.

Fresh and Dry Weight of Gingelly Seedling

Fresh weight values of gingelly under sago factory effluent irrigation are presented in (Table 4). The fresh weight was found to be maximum in 20% effluent concentration. It was found to be (0.312, 0.305, 0.325, 0.355, 0.378, 0.338, 0.330 and 0.315) in TMV 3, TMV 4, TMV 5, TMV 6, VRI 1, VRI 2, CO 1 and SVPR 1, respectively. Similarly the lower values were observed at 100% effluent concentration. Dry weight values of gingelly under

Table 3: Effect of Sago Factory Effluent on Shoot Length (cm/seedling) of Gingelly (*Sesamum indicum* L.) Varieties

Effluent Concentration (%)	Shoot length (cm/seedling)							
	Gingelly Varieties							
	TMV 3	TMV 4	TMV 5	TMV 6	VRI 1	VRI 2	CO 1	SVPR 1
Control	8.0	8.5	8.8	9.2	10.8	10.0	10.2	9.0
10	9.2(+15.00)	9.5(+11.76)	9.5(+7.95)	9.7(+5.43)	11.2(+3.70)	10.5(+5.00)	10.5(+2.94)	9.5(+5.55)
20	9.5(+18.75)	10.2(+20.00)	10.8(+22.72)	11.0(+19.56)	12.0(+11.11)	11.0(+10.00)	11.2(+2.94)	10.5(+5.55)
30	7.8(-2.50)	8.2(-3.52)	8.5(-3.40	9.0(-2.17)	10.0(-7.40)	9.5(-5.00)	9.8(-3.92)	8.5(-5.55)
40	7.0(-12.5)	7.5(-11.76)	7.5(-14.77)	8.0(-13.04)	9.2(-14.81)	9.0(-10.00)	8.5(-16.66)	7.0(-22.22)
50	6.6(-17.50)	7.0 (-17.64)	7.2(-18.18)	7.5(-18.47)	9.0(-16.66)	8.0(-20.00)	7.8(-23.52)	6.7(-25.00)
100	6.0(-25.00)	6.5(-23.52)	6.5(-26.13)	7.0(-23.91)	8.5(-2.12)	7.5(-25.00)	7.5(-26.47)	6.0(-33.33)

Note: Percentage over control values are given in the parentheses.

Table 4: Effect of Sago Factory Effluent on Fresh Weight (mg/f.w) of Gingelly (*Sesamum indicum* L.) Varieties

Effluent Concentration (%)	Fresh Weight (mg/f.w) Gingelly Varieties							
	TMV 3	TMV 4	TMV 5	TMV 6	VRI 1	VRI 2	CO 1	SVPR 1
Control	0.280	0.270	0.285	0.290	0.295	0.280	0.282	0.288
10	0.291(+3.57)	0.280(+3.70)	0.290(+3.57)	0.312(+6.89)	0.322(+10.34)	0.285(+0.00)	0.292(+3.57)	0.290(+3.57)
20	0.310(+10.71)	0.300(+11.11)	0.325(+14.28)	0.355(+20.68)	0.378(+27.58)	0.338(+17.85)	0.330(+17.85)	0.315(+10.71)
30	0.260(-7.14)	0.260(-3.70)	0.272(-3.57)	0.278(-6.89)	0.290(-0.00)	0.265(-7.14)	0.272(-3.57)	0.270(-0.28)
40	0.240(-14.28)	0.230(-14.81)	0.240(-14.28)	0.260(-10.34)	0.285(-3.44)	0.240 (-14.28)	0.250(-10.71)	0.248(-14.28)
50	0.210(-25.00)	0.200(-25.92)	0.213(-25.00)	0.244(-17.24)	0.262(-10.34)	0.212(-25.00)	0.200(-28.57)	0.215(-25.00)
100	0.192(-32.14)	0.178(-37.03)	0.195(-32.14)	0.210(-27.58)	0.240(-17.24)	0.206(-28.57)	0.185(-37.71)	0.195(-32.14)

Note: Percentage over control values are given in the parentheses.

sago factory effluent irrigation are presented in (Table 5). The dry weight was found to be greatest value in 20% effluent concentration. It was found to be 0.132, 0.135, 0.135, 0.132, 0.140, 0.135, 0.122 and 0.128 in TMV 3, TMV 4, TMV 5, TMV 6, VRI 1, VRI 2, CO 1 and SVPR 1, respectively.

The gingelly seedling dry weight was also increased at lower concentrations and decreased at the higher concentrations of sago factory effluent. The reduction in seedling dry weight at higher concentrations of sago factory effluent may also be due to the presence of excess amount of

Table 5: Effect of Sago Factory Effluent on Dry Weight (g/seedling) of Gingelly (*Sesamum indicum* L.) Varieties

Effluent Concentration (%)	Dry Weight (mg/dw) Gingelly Varieties							
	TMV 3	TMV 4	TMV 5	TMV 6	VRI 1	VRI 2	CO 1	SVPR 1
Control	0.115	0.118	0.115	0.117	0.120	0.118	0.113	0.110
10	0.120(+9.09)	0.121(+9.09)	0.122(+9.09)	0.12(+9.09)	0.128(+0.00)	0.125(+9.09)	0.120(+9.09)	0.122(+9.09)
20	0.130(+18.18)	0.135(+18.18)	0.135(+18.18)	0.132(+18.18)	0.140(+16.66)	0.135(+18.18)	0.122(+9.09)	0.128(+9.09)
30	0.098(-18.18)	0.095(-18.18)	0.092(-18.18)	0.105(-9.09)	0.110(-16.66)	0.102(-9.09)	0.105(-9.09)	0.096(-18.18)
40	0.095(-18.18)	0.090(-18.18)	0.085(-27.27)	0.090(-18.18)	0.102(-16.66)	0.080(-27.27)	0.095(-18.18)	0.090(-18.18)
50	0.072(-36.36)	0.068(-45.45)	0.060(-54.54)	0.072(-45.45)	0.095(-25.00)	0.065(-45.45)	0.070(-36.36)	0.072(-36.36)
100	0.065(-45.45)	0.060(-45.45)	0.055(-54.54)	0.062(-45.45)	0.090(-25.00)	0.060(-45.45)	0.065(-45.45)	0.060(-45.45)

Note: Percentage over control values are given in the parentheses.

Table 6: Effect of Sago Factory Effluent on Tolerant Variety (VRI 1) of Gingelly (*Sesamum indicum* L.)

Effluent Concentrations(%)	Germination (%)	Root length	Shoot length	Fresh weight	Dry weight
Control	92.0 ± 4.6	5.7 ± 0.28	10.5 ± 0.52	0.292 ± 0.01	0.120 ± 0.006
10	95.0 4.0	5.8 ± 0.29	12.0 ± 0.60	0.320 ±Q 0.01	0.125 ± 0.004
20	98.5 ± 4.0	6.8 ± 0.31	13.5 ± 0.60	0.575 ± 0.01	0.138 ± 0.004
30	85.5 5.0	5.6 ± 0.26	10.0 ± 0.50	0.285 ± 0.02	0.110 ± 0.004
40	80.5 4.0	5.2 ± 0.25	9.0 ± 0.45	0.280 ± 0.01	0.105 ± 0.002
50	75.0 4.5	4.8 ± 0.24	8.5 ± 0.42	0.262 ± 0.01	0.090 ± 0.002
100	70.5 3.0	4.2 ± 0.21	8.2 ± 0.42	0.238 ± 0.01	0.085 ± 0.001

Note: ± Standard deviation

elements present in the sago factory effluent which results in the poor growth of seedlings under the sago factory effluent irrigation.

Germination Studies of Tolerant Variety

Table 6 represents that the germination percentage, root length, shoot length, fresh weight and dry weight of gingelly under sago factory effluent irrigation. The higher germination percentage (98.5), root length (6.8 cm/seedling), shoot length (13.5 cm/ seedling), fresh weight (0.575 g/seedling) and dry weight (0.138 g/ seedling) were observed at 20% effluent concentration. The lower values were observed at 100% sago factory effluent.

On the basis of the data obtained from varietal screening trial, the variety VRI 1 was found to be extra tolerant for sago factory effluent. The differences in the tolerance ability of the eight varieties of gingelly seeds might be due to their difference in their potential to accumulate the elements, which might be a genetic factor (Appalaraju, 1986). Among the varieties studied, the variety exhibited further tolerance for sago factory effluent treatment. This variety was selected for secondary experiments.

CONCLUSION

Finally the article fulfilled that the results the higher concentration (30%) of sago factory effluent act as a stress in gingelly plants from the trial observations and it may be concluded that sago factory effluent at 20% v/v concentration may act as a good liquid fertilizer in the plants this kind of approach will prevent and reduce the water and soil pollution in all ecosystems. And the identified variety VRI 1 was found to be extra tolerant for the sago factory effluent for the further research work.

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