Discussion

5. DISCUSSION

The results obtained in the present investigation on the effect of plant growth-promoting substances in tannery effluent-fed *Crotalaria juncea* have been discussed, for the various aspects studied and given here under.

The effect of plant growth-promoting substances on tannery effluent-fed *C. juncea* have been studied in terms of physico-chemical composition of the growth-promoting substance, exo-morphological characters, biochemical variations, anatomical variations, and genetic variations of the experimental plant.

5.1. Settingup of Vermiwash Unit

The vermiwash unit was setup by standard procedures and the prepared vermiwash was collected after 45 days and allow to ripen before use. This was in accordance with the set-up maintained by Ismail (2005) and the vermiwash collected was similar in characteristics.

5.2. Usage of Plant Growth Regulators

Plant growth regulators enhance plant growth and in the present study gibberellin was used to stimulate the growth in tannery effluent-fed *C. juncea.* Gibberellin is a growth-promoting substance that brings about stem elongation and flowering in plants (Jain 2017). In earlier literature also gibberellin has been used as a growth regulator to enhance stem elongation (Aloni, 1992; Aloni *et al.,* 2000; Aloni, 2007). Fathima and Balasubramanian (2006) and Elumalai *et al*. (2013) studied the effects of gibberellin in *Abelmoschus esculentuts.*

5.3. Collection of Tannery Effluent

Tannery effluent from the leather industry, in Chromepet, Tamilnadu was collected at weekly intervals for eight weeks. Every time the effluent was collected at three different spots in the effluent discharge area and then pooled for use in this study. From the effluent, 50% diluted tannery effluent was prepared, and this was used for soil drenched setups along with the raw effluent. Sample was collected and preserved in accordance with standard methods. Similar diluted effluent treatment studies have been attempted by Babyshakila and Usha (2009); Asgharipour and Azizmoghaddam (2012).

5.4. Physico-chemical Analysis of Vermiwash and Tannery effluent

The physico-chemical analysis of vermiwash and tannery effluent was done to determine the constituents present so as to assess the impact of these on the plants.

5.4.1. Physico-chemical Analysis of Vermiwash

The physico-chemical analysis of vermiwash revealed that high total dissolved solids were present in the vermiwash and it was in agreement with the reports of Bai and Vijayalakshmi (2000), Lalitha *et al*. (2000) and Ismail (2005) and this increased level is due to the presence of vermicast of the earthworm belonging to the species *Eisenia fetida* used in the vermiwash unit.

In the present study the high nitrogen content in the vermiwash may due to the fact that earthworms enhanced the nitrogen cycle. Tripathi and Bharadwaj (2004) reported that the losses of organic carbon might be responsible for nitrogen addition in the form of mucus, nitrogenous excretory substances, growth stimulatory hormones and enzymes from the gut of earthworms. Lee (1985) suggested that the phosphorous level in vermiwash may due to mineralization of phosphorous during vermicomposting. The total potassium present in vermiwash might be due to changes in the distribution of potassium between non-exchangeable and exchangeable forms. The results are in accordance with Suthar (2007) who suggested that due to enhanced microbial activity during the vermicomposting process, the earthworm processed waste material contains high concentration of exchangeable potassium, which consequently enhances the rate of mineralization. The calcium present in the vermiwash may be due to calciferous glands in earthworms that are involved in the production of calcium carbonate. Garg *et al.* (2006) reported that the gut process of earthworms is associated with calcium metabolism that is primarily responsible for enhanced calcium content in worm cast. Mall *et al.* (2005) reported that vermiwash contains micronutrients like iron. The present study also confirms this. The copper content in vermiwash might be due to the increased content of several copper containing oxidizing enzymes. The results are in accordance with Lee (1985) who reported that the copper was found to be increased in worm casts. The presence of manganese content in vermiwash might be due to the fact that earthworms enhanced the mineralization of this element due to microbial and enzymatic activity of earthworm intestine. This results are supported by Vasanthi and Kumaraswamy (1999) who stated that micronutrients like manganese are rich in vermiwash. The findings of the present study are in accordance with the study of Graff (1970) who reported that zinc content was increased in the vermiwash.

5.4.2. Physico-chemical Properties of Tannery Effluent

The values of TDS, COD, and BOD recorded in the tannery effluent were 5596 mg/L, 3114 mg/L and 1152 mg/L. The values are 2.8, 12.5, 11.5 times higher than the standards respectively for discharge of trade effluent as per Bureau of Indian Standards (BIS-10500-1991). From the above results it could be concluded that all the physico-chemical parameters were found to be relatively high in untreated tannery effluent. The electrical conductivity was high due to the presence of inorganic substances and salts which contributes to conductivity. The untreated tannery effluent had higher amount of suspended solids, which are responsible for the higher amount of BOD and COD. High amount of COD may be due to high amount of organic compounds which are not affected by the bacterial decomposition. These results are in agreement with the previous reports of Lakshmi and Sundaramoorthy (2003), Paneerselvam *et al*. (2003) and Alvarez-Bernal et *al*. (2006).

5.5. Germination Studies of *C. juncea* as Effected by Tannery Effluent and Growth-promoting Substances

The seed germination studies of *C. juncea* as effected by tannery effluent and growth-promoting substances were carried out to assess the impact of tannery effluent and probable remedial effects if any by the growth-promoting substances. The germination studies were done in terms of germination percentage, plumule and radicle growth, and these parameters were used to derive the seedling vigour index (SVI).

The time taken for seed germination to reach 100% is variable and in the present study it is observed that in V2 treatment (Water (d) + 20% Vermiwash (s)) 100% germination was attained after 48 h. in compared to control which reaches 100% germination at 96 h. But in 100% tannery effluent treatment the time taken for 100% seed germination was high when compared to other treatments. Among the treatments T2 related groups had a tendency for delayed germination where 100% germination was attained only at 96h. Thus reduction in the amount of water absorption takes place in T2 treatment, which results in retardation of seed germination due to enhanced salinity. The salt concentration, outside of the seed is known to act as limiting factor and it might be responsible for delay in germination (Adriano *et al*., 1973) and due to less water absorption by osmosis (Gomathi and

Oblisami, 1992). The present findings agree well with that of Vijayarangen and Lakshmanachary (1992), Kumar and Bharghava (1998), Shinde *et al*. (1998) and Niroula (2003). Similar results were reported in tannery effluent treated sunflower seedlings. The results are also in accordance with the previous study of Hossain *et al*. (2010) who reported that raw tannery effluent caused a reduction in seed germination of sunflower and other crops like wheat, maize and horse gram (Sangeetha *et al*., 2012; Rao *et al*., 2014). The application of tannery effluent at lower concentration did not show inhibitory effect on vegetable crop seeds such as Beet root (*Beta vulgaris* L.) and Cabbage (*Brassica oleracea* L.) as reported by Asfaw *et al*. (2012).

Gibberellin showed seed germination percentage (97%) similar to vermiwash which was higher than the control (93%) at 48 hours. The plumule length also showed a trend similar to seed germination. The result shows that the foliar spray of 100 ppm concentration of gibberellin and foliar spray of 10% and 20% vermiwash were ineffective in augmenting the growth of plumule and radicle when the seeds were fed with raw tannery effluent without dilution. But when the seeds were fed with tannery effluent of 50% dilution, the seeds show relatively higher plumule length and radicle length than the control. According to the results, the seeds treated with raw tannery effluent had significantly negative impact on the seedling growth and seedling vigour index of *C. juncea*, when compared to control treatment.

The lower concentration of tannery effluent was very effective, supporting seed germination and seedling growth. On the other hand, plumule length of seedlings showed a decreasing trend with increasing concentration of tannery effluent. The exposure of lower concentration of effluent to the seedling shows growth promotion, and over all development of the seedling. This may be due to the optimal level of the organic matter present in the 50% diluted tannery effluent that act as nutrients for the growth of the seeds. At lower concentration the tannery effluent stimulated the germination, radicle and plumule growth, hence it has potential as a liquid fertilizer.

As far as the radical length is concerned, vermiwash treatments (V1,V2, T1V1 and T1V2) brought about a higher radicle length followed by control and gibberellin treatments. The plumule and radicle length were minimum in plants treated with 100% tannery effluent (T2, T2V1,T2V2 and T2G) but maximum in plants drenched with 50% tannery effluent (T1, T1V1, T1V2) and G treatment (Water(d) + 100 ppm Gibberellin (s)) (Plate 43). Hence, seedling vigour index was found to be high in vermiwash, gibberellins and 50% tannery effluent with vermiwash combination. GA_3 plays an important role in increasing of amylolytic activity in seed germination (Ochoa *et al.*, 2015). Application of GA_3 with soil and vermicompost potting medium resulted in maximum seed germination and seedling vigour index in papaya (*Carica papaya*) as reported by Ramteke *et al.* 2016. Hence the results of the present study corroborate the previous reports.

Analysis of Chromium in Seedlings

The analysis of chromium in the seedlings of different treatment groups in the germination study has clearly shown that there was no detectable level of chromium in the seedlings. However, visible phytotoxic symptoms observed in the seed germination study, bring about necessity to investigate with separate studies the capacity of *C. juncea* to extract and accumulate chromium from soils contaminated with higher amounts of this metal. The previous reports of Agarwal *et al.* (2014) have shown that *C. juncea* is known accumulator of chromium but the present investigation in seedlings of *C. juncea* does not corroborate this report.

5.6. Study of Exo-morphological Variations as Effected by Tannery Effluent and Growth-promoting Substances

Exo-morphological studies were carried out to investigate the effects of growth-promoting substances on the external growth parameters of the experimental plant namely *C. juncea*. When analysing the external growth parameters, the easily observable and quantifiable aspects such as plant height, internodal diameter, number of leaves, leaf area, number of inflorescences, time to flowering, root length, survival rate and biomass were considered.

5.6.1. Plant Height

The reduction in plant height in T2 treatment (100% Tannery effluent (sd) + Deionised water (fs)) might be mainly due to the reduced root growth and consequent lesser nutrients and water transport to the aerial parts of the plant. In addition to this, chromium transport to the aerial parts of the plant can have a direct impact on cellular metabolism of shoots contributing to the reduction in plant height **(**Shanker *et al.*, 2005). In 50% tannery effluent soil drenched plants (T1, T1V1, T1V2 and T1G) growth is enhanced which shows that some organic matter present in polluted water may act like a liquid fertiliser and compensate the negative effect of toxic materials in it. Thus it shows that when the effluent is diluted it releases utilizable nutrients which enhance plant growth and development (Table 20; Figure 15A). Nutrients present in the waste water absorbed by the plants accelerates the crop production and it eventually leads to reclamation of effluent water in effluent-fed agriculture. Many crops utilize the major nutrients for their growth (Damodharan and Reddy, 2012).

The height in G (Water (sd) + 100 ppm Gibberellin (fs)) treatment is maximum among all the treatments. Feucht and Watson (1958), Kaufman *et al.* (1965), Aloni (1992), Aloni *et al.* (2000) and Aloni (2007) reported that growth substances like GA and NAA caused increase in height of the plant. Foliar spray of GA influenced growth of coriander (Verma and Sen, 2008; Das *et al*., 2018). Vermiwash contains several enzymes, plant growth hormones, vitamins along with micro and macronutrients which increases the resistance power of crops against various diseases to enhance the growth and productivity of crops (Anand *et al*., 1995; Suthar *et al*., 2005). All these reports support the findings of the present study.

5.6.2. Internodal Diameter

The internodal diameter is more in G treatment (Water (sd) + 100 ppm Gibberellin (fs)) followed by V2 treatment (Water (sd) + 20% Vermiwash (fs)) (Table 20; Figure 15A). These results are in agreement with the previous results of Leite *et al*. (2003) who has reported that foliar application of gibberellin increases the internal diameter on soybean and Chaurasiy *et al*. (2014) who studied the effect of GA on growth and yield of cabbage (*Brassica oleracea*) and noticed that GA significantly increases the stem diameter.

5.6.3. Number of Leaves

Maximum number of leaves are seen in V2 treatment (Water (sd) + 20% Vermiwash (fs)) which shows that vermiwash promotes the growth of the plant (Table 20; Figure 15A). The results corroborate with the earlier reports of Ansari (2008). Samadhiya *et al*. (2013) also reported that foliar spray of vermiwash in tomato, showed a significant increase in plant height and number of leaves. Muscolo *et al*. (1999) also reported an auxin-like effect of earthworm promoting cell growth and nitrogen metabolism in *Daucus carota*.

5.6.4. Leaf area

Maximum leaf area was observed in V2 treatment (Water (sd) + 20% Vermiwash (fs)) when compared to other treatments which shows that vermiwash promotes the growth of the plant (Table 20; Figure 15A). The results corroborate with the earlier reports of Ansari (2008) on the growth enhancing effects of vermiwash in the yield parameter of Spinach (*Spinacia oleracea*), and Onion (*Allium cepa*). The leaf area in plants grown in soil drenched with raw tannery effluent (T2V1, T2V2, T2G) shows decreased leaf area when compared to other treatment groups. Karunyal *et al*. (1994) also reported that the tannery effluent decreased leaf area and dry weight in *Oryza sativa, Leucaena leucocephala* and *Acacia holosericea.*

5.6.5. First Flowering

When compared to other treatments, the early flowering was observed in plants sprayed with gibberellin and soil drenched with water (G treatment) and plants grown in soil drenched with 50% tannery effluent (T1, T1V1, T1V2) treatment (Table 20; Figure 15A). High chlorophyll content may have progressed the flowering stage to peak (Preethi and Khan 2017) which is observed in V2 and T1V2 treatment. Delay in flowering is pronounced in T2G treatment (100% Tannery effluent (sd) + 100 ppm Gibberellin (fs)) and this may be due to antagonistic effect of raw effluent and gibberellins on the flowering stage (Jain, 2017).

5.6.6. Number of Inflorescence

The number of inflorescences are maximum in V1 treatment (Water (sd) + 10% Vermiwash (fs)), followed by gibberellin (G treatment) which indicates the growth-promoting substances in vermiwash and gibberellin augmented the flowering stage also (Table 20; Figure 15B). According to Lalitha *et al*. (2000) organic fertilizer application will have an emphatic effect on plant growth and production. According to Zambare *et al*. (2008) the vermiwash contains various enzymes like protease, amylase, urease and phosphatase and it would stimulate the growth and yield of crops. These results also corroborate the effects of GA that brings about bolting and flowering (Jain 2017). In this study raw tannery effluent proved deleterious to plant growth both at vegetative and reproductive stages.

5.6.7. Survival Percentage

In the present investigation it was observed that the control (C treatment) and the treatments with foliar spray of vermiwash (V1 and V2) and vermiwash in combination with 50% tannery effluent soil drench (T1V1 and T1V2) and gibberellin alone (G) showed a survival percentage of 100%, while the treatment with 100% tannery effluent even in combination with foliar spray of gibberellin showed a drastically reduced survival rate(Table 20; Figure 15B). This may be due to the presence of high level of sodium chloride, and chromium used in the tanning process that is let out as such in the untreated tannery effluent. Even the gibberellin when applied as foliar spray along with 100% tannery effluent in soil drench did not increase the survival rate. Chromium can cause wilting by affecting the root cells of plants (Bassi *et al.*, 1990; McGrath, 1995). In plants, chromium interferes with several metabolic processes causing phytotoxicity like reduced growth, chlorosis, swelling of mitochondria and finally leads to plant death as reported by Dazy *et al.*, 2008. This study corroborates the earlier report of Wei and Zhou (2008) who reported that growth of the plant is prohibited and leads to death due to excessive uptake of metals by plants.

5.6.8. Root Length

A lengthy root system was observed in T1V2 treatment (50% Tannery effluent (sd) + 20% Vermiwash (fs)), and a dense root system in V2 treatment (Water (sd) + 20% Vermiwash (fs)) (Table 20; Figure 15B). There were no lateral roots in plants grown in soil drenched with 100% tannery effluent (T2, T2V1, T2V2 and T2G). Chromium toxicity results in loss of growth of lateral roots, damaging of root cap and detached plasma membrane from the cell wall as per the reports of Mariappan *et al.* (2001). Liu *et al.* (2003) reported that the inhibition of root length may be due to heavy metal interference with cell division and inducement of chromosomal aberrations. The present study is in accordance with these reports.

5.6.9. Nature of Root Nodules

The variation in nature of root nodules was significantly influenced by the drenching of tannery effluent in the soil in raw and diluted forms and different treatment of foliar spray combination. Larger nodules were observed in vermiwash treatments as opposed to absence of nodules in raw effluent treatments (Plate 10). The results confirm the previous reports of Gopal *et al*. (2010) in cowpea who reported increased nodules in vermiwash treated plants.

5.6.10. Shoot Biomass

The shoot biomass was increased in V1 (Water (sd) + 10% Vermiwash (fs)) and T1V1 (50% Tannery effluent (sd) +10% Vermiwash (fs)) treatments. Hatti *et al.*, (2010) reported that biomass of the plant increases after spraying the vermiwash of *Perionyx excavatus.* A study conducted by Sinha *et al*., (2015) in two different varieties of paddy (*Oryza sativa*) and in redgram (*Cajanus cajan*) treated with different dilution of tannery effluent showed that fresh weight of root and shoot were severely affected and decreased with increasing concentration. In a study conducted on *Vallisneria spiralis* to evaluate the Cr(VI) accumulation and toxicity in relation to biomass production, it was found that dry matter production was severely affected by Cr(VI) concentrations (Vajpayee *et al*., 2001). Hence the results of the present study corroborate the earlier reports which is similar to result of Nath *et al.* (2005).

5.6.11. Root Biomass

The root biomass was high in the treatment group of V1 (Water (sd) + 10% Vermiwash (fs)) and V2 (Water (sd) + 20% Vermiwash (fs)) and this is also supported by the previous reports of Gopal *et al.* (2010) who reported increased biomass in vermiwash treated cowpea plants.

Thus, an overall impression of the effect caused by vermiwash and gibberellin on tannery effluent-fed *C. juncea* with regard to exo-morphological characters is that soil drenching of diluted tannery effluent and vermiwash at 10% concentration as foliar spray were able to bring about beneficial effects (Plate 44).

5.7. Study of Biochemical Variations as Effected by Tannery Effluent and Growth-promoting Substances

Biochemical studies in different treatment groups in the present investigation was carried out to assess the effect of growth-promoting substances on tannery effluent-fed *C. juncea*. In this context, biochemical parameters such as chlorophyll, protein, carbohydrates and protein content levels in leaf tissue have been estimated.

5.7.1. Chlorophyll

A high Chlorophyll content was observed in plants grown in diluted tannery effluent and treated with foliar spray of vermiwash (T1V2). These results were in agreement with the previous results of Kaushik *et al.*(2005) who reported that the chlorophyll and carotenoid contents of three different cultivars of wheat did not show any inhibitory effect at low concentration of textile effluent. All other treatments showed a similar level of chlorophyll in the leaves (Table 16; Figure 12). In *C. juncea* the tannery effluent did not pose an adverse threat to chlorophyll unlike the previous studies of Davies *et al*. (2002), Caravaca *et al*. (2003), Shanker *et al*. (2005), Choudhury and Panda (2005), Panda and Choudhury (2005) and Vernay *et al*. (2007) who reported that chromium blocks the photosynthetic electron transport, inhibits photophosphorylation and decreases membrane integrity. Preeti and Khan (2017) have reported that increase in chlorophyll with increase in vermicompost treatment and the total chlorophyll content shows variations in the different growth stages of the plant such as pre flowering, peak flowering and post flowering stages.

5.7.2. Protein

After comparing the protein content in all treatment groups, there was drastic variation in G (Water (sd) + 100 ppm Gibberellin (fs)) treatment, which shows low protein content (Table 17; Figure 13). Presence of high content of protein in all treatment groups except in control and gibberellin treated plants (G treatment) suggests the slowing down of protein degradation when compared to control. This may be due to loss of activity of proteases in the presence of heavy metals or induced by biofertilizer. The effect of soda ash industry effluent shows positive effect on the protein content in seaweed (*Ulva faciata* and *Chaetomorpha antennina*) due to uptake of polluted water (Jadeja and Tewari 2008).

5.7.3. Carbohydrate

Plants treated with 50% tannery effluent (T1, T1V1, T1V2 treatments) and gibberellin (G treatment) showed high carbohydrate content (Table 17; Figure 13). Najafian *et al*. (2012) showed that optimal presence of the nutrients and organic matter in waste water increases uptake and accumulation of elements in plant tissue enhancing photosynthetic and metabolic processes leading to increased carbohydrate, protein content.

5.7.4. Lipids

There is not much variations in lipid content in different treatment groups (Table 17; Figure 13), though low level of lipids than control were observed in treatments V1, V2, T1 and T2G (Karthikairaj and Isaiarasu, 2013).

5.8. Study of Anatomical Variations as Effected by Tannery Effluent and Growth-promoting Substances

The effects of gibberellin and vermiwash as growth-promoting substances on tannery effluent treated *C. juncea* in terms of internal anatomy have been investigated in the present study.

5.8.1. T.S. of Stem

The phloem zone along with bast fibres shows widening in V1 and T1V1 treatment. Gibberellin treated plants (G treatment) shows a widened zone of phloem with the increased fibre development. In T2 treatment there is obliteration of phloem zone. The histological results of stem revealed that chromium in tannery effluent causes stress which is manifested as increase in wall thickness of fibres and obliteration of pith cells. The anatomical variation in the various tissue of the plant could be due to ill effects of tannery effluent and are well corroborated with earlier reports on anatomical variations in aquatic plants exposed to pollutants (Gupta et al., 2011). These effects have been countered by growth-promoting substances such as vermiwash and gibberellin which in turn have caused increase in the diameter of internode (Plate 45 and 46). The wall thickness has been reduced with an increase in fiber cells and reduction in frequency of vessels as seen in diluted tannery effluent and vermiwash treatment. Gibberellin was able to induce gelatinous fibres with shrunken and withdrawn walls when combined with tannery effluent (Plate 47). Xylem gets much reduced and vessels becomes less frequent. These effects are similar to observations of Elumalai *et al.* 2013 in *Abelmoschus esculentus.* Further an increase in wall thickness is an indication of stress which is clearly visible in all the tannery effluent treated groups (Aloni 1979; Aloni 1987; Cutter 1978).

5.8.2. T.S. of Leaf

Control leaf shows thin lamina with small midrib. In vermiwash treatment, the lamina and midrib are thickened due to increase in cell size (Plate 48). The tannery effluent treatments leads to reduction of vertical rows of xylem in the vascular bundles of midrib. The size of parenchyma cells are reduced along with the reduction in the diameter of xylem vessels. The combination of 50% tannery effluent (sd) and 10% vermiwash (fs) brings about the reduction in abnormality of increase cell size and wall thickness and appears to be closer to control. Similar effect is observed in T1V2 treatment (50% Tannery effluent (sd) + 20% Vermiwash (fs)) treatment. In general vermiwash is able to counter the stress faced by the plants treated with the tannery effluent leading to the reversal of tissue damage and thus abnormality is reduced. Wall thickness is also normal so stress release is evident in these plants treated with 10% and 20% vermiwash as foliar spray.

In Gibberellin treatment, the overall view of lamina and midrib are similar to control, but diameter of xylem vessels had increased. This result corroborates the earlier report of Sachs and Lang (1957). The histology of leaf of plants treated with diluted tannery effluent and gibberellin appears similar to the control with well-developed xylem and phloem in the vascular bundle. But the histology of leaf of plants that are treated with 100% tannery effluent (sd) and 100 ppm gibberellin (fs) shows reduced xylem which is obliterated (Saikia *et al*., 2012) and vertical alignment is changed to cluster alignment. Thus, the high concentration of tannery effluent has nullified the effect of gibberellin. These results correspond to previous studies of Najafian *et al*. (2012).

5.9. Randomly Amplified Polymorphic DNA (RAPD) Analysis to study the genetic variations caused by Tannery effluent and Growth-promoting substances

Hierarchical clustering was done and the result showed that 100% tannery effluent treated seedlings showed difference in the banding pattern than the other treatment groups. This indicates that 100% tannery effluent has caused mutation in seedlings as well as the leaves. There was disappearance of some bands that were seen in the control and appearance of additional bands absent in the control. The leaves showed pronounced degradation of bands in the 100% tannery effluent treatments compared to the seedlings. These results are in accordance of previous reports of Raj *et al*. (2014) who have studied DNA damage induced by tannery effluent in Mung Bean by the use of RAPD markers. They have observed that untreated tannery effluent has genotoxic effects which is manifested as disappearance of control bands due to DNA damage. Enan (2006) has also made a similar observation regarding genotoxic effect of heavy metals on kidney bean. Swaileh *et al*. (2008) have studied the genotoxicity caused by waste water in *Avena sativa.* In seedlings, it is observed additional bands appeared in treatments involving 100% tannery effluent which can be attributed to DNA damage caused by formation of bulky adducts (Raj *et al*., 2014).

Hence the RAPD analysis revealed that 100% tannery effluent causes variations in morphology, histology and biochemistry which is the result of the variations in the DNA and use of growth regulators is able to create a setback in the manifestation of characteristics due to the damage caused and this is visible as an enhancement of growth parameters.