Physico-chemical effluent characteristic of the various industries depend on the type of the industry, raw material used and the manufacturing process involved (Somashaker et al., 1984). The physico-chemical characteristic of the effluents of the various industries have been analysed in the different parts of the country. The distillery effluents produced by about one hundred and forty five molasses based industries, yielding annually about one thousand million litres of alcohol in India alone contain not only sodium and organic matter but also essential macro and micro-nutrient elements. (Chakrabarty, 1964; NEERI 1970-71; Chatterji, 1978; Rao, 1978; Bhandari et al; 1976; Aslam and Khan, 1979; Samvels, 1980; Singh et al, 1980; Joshi et al, 1980; Kulkarni, 1982 and Khundanpur, 1984). Distillery effluents also called spent wash when used for irrigation purposes have been found to influence plants beneficially (Silva et al, 1980; Anon, 1979; Sheehan and Green field, 1980; Sorbal et al, 1981 and Rodella et al, 1983). Pande (1985) reported that distillery effluents not only influenced the growth, metabolism and composition of sugar cane plants but also increased their sugar contents.

A field experiment was conducted at Sakthi Sugars limited, during 1992-93, to assess the effect of distillery effluent on soil properties, yield
and quality of sugarcane variety Co. 853. The crop was irrigated with sugar factory waste water (irrigation) for establishments, then it was irrigated with treated effluent at 50, 40, 30, 20 and 10 times dilutions. Post harvested soil sample were analysed. The pH of soil was significantly increased from 6.95 to 7.83; the soil E.C. from 0.22 to 0.57 M.mhs/cm, and organic carbon from 0.67 to 1.10% with effluent irrigation. A significant increase in available Ca, Mg and exchangeable Na contents of the soils was noticed with effluent irrigations. The sugarcane variety Co. 853 is tolerant to saline conditions and show higher yield at 50, 40, 30 and 20 times dilution (182.8, 172.8, 166.8 and 162.0 t/ha respectively) than water (159.5 t/ha). The cane yield was increased by 14.6 and 8.3 per cent at 50 and 40 times dilutions respectively when compared with water; the 10 times dilution reduced the cane yield by 6.6 per cent (Devarajan and Oblisami, 1995).

Distillery effluents contain high percentage of organic and inorganic matter which effects the ground water, soil properties and vegetable plants grown in the area. Distillery effluents were acidic in nature (pH 3.5-4.5) and thus affects the growth of plants. It tends to create negative osmotic pressure in the medium thus retarding plant growth. It appear that at higher concentration of effluent the pH of soil is altered leasing the changes in plant uptake (Shrivastava et al, 1995, 1996a, 1996). The effluent ‘spent wash’ discharged from the liquor factory was highly acidic with a pH 3.9 and B.O.D. 31,000 mg/l. The
effect of distillery effluent on growth of Fenugreek (*Trigonella foenumgraecum* L Var Desi) and gram (*Cicer arietinum* Var. Desai) were studied. In fenugreek percentage germination of seeds and crop growth showed significant variation with the concentration of the effluent treatment. Root and shoot growth were retarded at higher concentration of the distillery effluent treatment beyond 10 percent. However, increased dry matter production and pot yield was observed at 1 percent dilute effluent treatment. Moreover, there existed a significant positive relationship between total chlorophyll content and effluent treatment at lower concentrations. Undiluted distillery effluent had a toxic effect on germination and growth, whereas 0.1 to 1% effluent concentration had a growth promoting effect which was significantly better than control. The seeds of gram (*Cicer arietinum* Var. Desai) were treated with high (100-1%) and low (0.1-0.0001%) concentrations of the effluent after proper dilution. A control with distilled water was maintained at the same time. It was observed that the gram seeds were more susceptible to the toxic effect of the effluent. Decrease in the speed of germination, shoot and root elongation, number of leaves and leaf length were observed. An attempt is made to draw a relationship between the pH of the effluent treated seedling extract and the ascorbic acid content of the seedling which showed significant results. However, there existed a significant negative relationship between the effluent concentration and the chlorophyll content of the gram seedlings.
Consequently, it was proved that liquor factory effluent was not useful for the germination and growth of gram seedlings (Raza and Vijay Kumari; 1986 a,b).

The impart of coimbatore based alcohol and chemical factory effluents were studied by Nirmala Rani and Janardhanan (1988, 1989) on seed germination and early seedling growth of maize, soybean, cowpea, rice and sorghum. The results indicate that the distillery contain excess amount of dissolved solids, high B.O.D. and C.O.D. values, chlorides, sulphides and ammoniacal nitrogen which when employed as such or at higher concentrations elicited deletrious effects on the overall growth of the crop plant studied. The effluents can be utilized for irrigation of maize fields successfully at 2.5% dilution level. The study revealed that lower concentrations of the effluent promoted seed germination and early seedling growth in cowpea, rice and Jawar while the higher concentrations retarded not only seed germination but also the early seedling growth in all the crop plants investigated. In soybean the germination percentage and early seedling growth were markedly suppressed with the increasing concentration. It was suggested that the distillery effluent may be used as a liquid fertilizer only for certain crops after proper dilution with water (Rajaram & Janardhanan, 1988). The effect of distillery effluent on seed germination and early seedling growth in fingermillet, pearlmillet, blackgram and green gram were studied by Vijay Kumari and Kumudha (1990). It was observed that
effluents up to 2.5% concentration were beneficial for the overall growth of plants. The seed germination and early seedling growth was retarded with increase in effluent concentration. The effluent in diluted form can be used as liquid fertilizer.

Goyal et al (1995) while working on the effect of distillery waste water (Hissar) application on soil microbiological properties and plant growth of *Vigna radiata* reported that the soil pH and E.C. increased with the effluent irrigation. The distillery waterwaste to a field soil at rates equivalent to 40, 80 and 160m³/hectare of irrigation led to increase in soil microbial biomass and dehydrogenase activity. The application of distillery waste water up to 160m³/hectare on mungbean (*Vigna radiata*) revealed to increase in dry matter production and N and P uptake. However at 640m³/hectare application rate and dry matter decline drastically. Electrical conductivity increased from 1.22 to 3.36 dsm⁻¹ with application of equivalent to 320m³/hectare irrigation. Therefore, it is warned that long term, continuous use of distillery wastewater may develop soil salinity which could adversely affect the soil fertility and crop production.

The effects of different concentration of distillery waste on seed germination, seedling growth and pigment content have been studied on rice, sugar beet and black gram. Rice (*Oryza Sativa*) seeds kept for germination in petri dishes containing equal amount of soil treated with different concentration of distillery effluent (Gorakhpur) (0, 5, 10, 25,
50, 75, 100%). At higher concentration (25% and above) both the speed of germination and seedling growth were retarded. Root growth was more adversely affected than the shoot growth. At 5% concentration overall growth of seedling was better than in control. The values of chlorophyll-a and -b decreased with increase in the effluent concentration. However, chlorophyll-b content was higher at 5% concentration than that in control. The carotenoid content continued to increase up to 50% effluent concentration. (Shahai et al; 1983). In another study, rice variety Co.43 was treated with the different dilution of Appapudal distillery, Paiyar district. The main plat treatments included sugar factory waste water and treated distillery effluent at 50, 40, 30, 20 and 10 times dilutions. The soil pH was significantly increased from 7.15 to 7.95, the soil E.C from 0.29 to 0.89 m. mhos/cm and organic carbon from 1.12 to 1.70% with effluent irrigation. The highest grain yield at 7.73 t/ha was registered by the control (water). Even the 50 times diluted effluent irrigations significantly reduced the grain yield (7.30 t/ha). The lower dilutions were found to be unsuitable for rice (Devarajan and Oblisami; 1995).

Bioassay studies were carried out to assess the toxicity of effluents discharged from Sri Ganganagar Sugar Mill cum distillery Ltd. On seed germination, seedlingling growth and pigment content of sugar beet (Beta Vulgaris). The seeds were kept moist either in different dilutions (1, 5, 10, 20 and 30%) of effluent solution and in double distilled
water, which served as control. At higher concentration (75%), there was complete inhibition of seed germination. It means that upto 5% level the seedling are getting some nutrients. However, beyond 5% concentration of effluent, there is progressive inhibition of germination due to the toxicity of effluent. The inhibitory effect was more pronounced on radicle in comparison to hypocotyle. The green, dry, organic and inorganic weights of seedlings also exhibited a similar tendency. (Sharma et al, 2001).

The impact of distillery effluent on the germination percentage, growth and yield of black gram (*Phaseolus Mungo*) were tested at varying concentrations of effluent ranging from 0.1 to 10 percent. 5 percent concentration promoted growth of root and shoot by 52.28 percent and 2.54 to 18.47 respectively whereas 10% effluent treatment retarded root and shoot growth of black gram by nearly 37 percent and 48 per cent respectively in comparison to control. Root and shoot biomass was reduced by 63.8 per cent and 40.05 percent respectively at 10 percent effluent treatment. However, at 5 per cent concentration root and shoot biomass showed an increase by 29.24 per cent and 25 per cent respectively. The number of fruits per plant increased by 35 per cent at 5 per cent effluent concentrations, whereas 10 per cent treatment the number of fruits per plant decreased by 55.88 per cent. Therefore 5 per cent concentration was found beneficial for the growth of blackgram (Shrikant and Rao 1993). Maize, rice, mustard, blackgram,
pigeonpea, soybean and Chickpea seeds germinated normally in 20% effluent, whereas green gram seeds germinated normally even in 50% effluent. Wheat seeds were more sensitive and did not germinate in 50 percent effluent. Seed germination of lentil and rice was drastically reduced in 50% effluent. In pure effluent (100% concentration) seeds of any crop did not germinate (Singh and Bahadur, 1995).

The impact of metals present in distillery effluents on surrounding ground water and plant tissues revealed higher concentration range in the effluent water. The concentration range of Cu, Zn, Cd, Pb, Ni and Fe was 0.3-2.66, 0.79 to 3.98, 0.01-1.0, 0.14-0.43, 0.1-0.61 and 215-220 mg/l respectively. In the ground water samples the concentration of Cu, Zn, Cd, Pb and Fe was found to be in the ranges of 0.1-0.92, 1.12-9.0, 1.12-9.0, 0.01-1.0, 0.01-1 and 0.75-1.5mg/l, respectively. The heavy metal concentration in ground water was above the permissible limit prescribed by WHO. The metallic analysis of different parts of tomato plant irrigated by distillery effluent showed the higher concentration of Cu, Cd, Pb and Ni in comparison to control. People living in such type of areas will be discourage by using the ground water for drinking and irrigation purposes. (Nemade and Shrivastava, 1996). Industrial effluent of different industries have been found to be both beneficial and toxic to the soil, plants and microbial activity. Certain industrial effluents such as those of fertilizers and chemicals, tanneries,
paper and pulp, sugar, milk plant and steel have potential of reutilization and may be harnessed for human welfare.

The data of chemical properties of Gorakhpur fertilizer factory shows that it contain high concentration of total N (1,600 mg/l), major constituents of which were ammonicial N and urea-N which appear to be the cause of effluventy toxicity. The concentrations of nitrate and nitrate-N were comparatively low. Other chemicals potassium, phosphate, chloride, calcium, heavy metals were found to be in low concentrations. Eight concentrations (1, 2.5, 5, 10, 25, 50 and 100% V/v) of this effluent were used to assess their effect on germination and seedling growth of Zea mays Linn L, var. 'Ganga 2'. The maximum percentage germination was observed in 5% concentration and minimum in 25% concentration of the effluent. The best seedling growth was observed in 2.5% concentration of the effluent. The root and shoot lengths, the first leaf area and the dry weight increased upto 2.5% concentration and then decreased gradually reaching their minimum in 25% concentration. The maximum chlorophyll-a content was obtained in 2.5% concentration of the effluent and maximum chlorophyll-b content in 5% concentrations. Both the chlorophyll-a and chlorophyll-b contents decreased as effluent concentration increased; the minimum being in 25% concentration. The decrease in chlorophyll content was more marked from 5 to 10% effluent concentration in chlorophyll-b
The effect of Kota, Rajasthan Nitrogenous fertilizer factory effluents on seedling growth and biochemical characteristics of *Brassica campestris* var taria and *Cicer arietinum* var C-235 has been studied. The germination energy index showed a gradual decline from 0.966 in control to 0.107 in 100% effluent treatment. In seedling growth the inhibitory effect was more on the radicle rather than that of hypocotyl. The effluent caused marked decrease in pigment concentration of seedlings, chlorophyll-a, chlorophyll-b, total chlorophyll and carotenoids were negatively correlated with concentration of effluents. On a comparative basis the inhibition of seedling growth was more pronounced in *C. arietinum* then that in *B. campestris* (Agarwal and Gupta, 1992).

Influence of chemical effluents discharged from a chemical and fertilizer factory on physico-chemical properties of soil and germination and mineral composition of wheat was studied at Varanasi, India. Forty times higher concentration of Na was observed in the effluent than that of the nearby well water. It showed a positive and significant correlation ($r=+0.795$) with the Na of the soil and a negative correlation with K ($r=-0.852$) and Ca ($r=-0.882$) of the soil. Cation exchange capacity, porosity and water holding capacity were reduced by effluent affected soil. Wheat plants grown in effluent affected soil showed higher percentage
of Na (1.62%) than that of the control plants (0.7%). Sodium effluent show positive and significant correlated with the Na of the soil and Na percentage of the plants, respectively, \( (r = +0.795) \) and \( r = +0.952 \).

Calcium of the plants grown in soil affected with Na rich effluent was less (0.72%) than that of the plants grown in control soil (0.897%). Calcium percentage of plants did not show significant correlation \( (r = -0.85) \) with the Na of the effluents. Na+Mg/Ca of soil showed negative correlation \( (r = -0.85) \). (Tripathi et al, 1990).

The effect of Neyveli fertilizer factory effluent on seed germination, seedling growth and dry weight of greengram (Vigna radiata), blackgram (Vigna mungo), ground nut (Arachis hypogaea), soyabean (Glycine max), Paddy (Oryza sativa) and sorghum (Sorghum bicolor) was investigated. The effluent was alkaline in nature. It was dark brownish in colour with ammonia odour and contained large amount of suspended and dissolved solids, nitrogen, sodium chlorides, bicarbonate, sulphate, calcium etc. and other elements also.

Germination studies was conducted with the field crop seeds treated with different concentrations (1, 2.5, 5, 10, 25, 50, 75 and 100 percent) of effluent. The percentage of germination of seeds, seedling growth and dry weight showed a gradual decline with increase in effluent concentration. The best germination, seedling growth and dry weight was observed at 10 percent concentration. Undiluted effluent elicited an inhibitory effect whereas the 10 percent effluent concentration had a
growth promoting effect which was significantly better than control. Beyond 10 percent effluent concentration, seedling growth decreased positively. The effluent can be used safely for irrigation purpose after proper dilution for beneficial cultivation of crops. (Sundermorthy et al, 2000).

In an another study, the effect of different concentrations (0, 1, 2.5, 5, 10, 25, 50, 75 and 100%) of neyveli fertilizer factory effluent on seed germination and seedling growth of four varieties of groundnut (Arachis hypogaea L). var. Co-2, ICG-FDR1, TMV-7 and URI-2) was studied. The percentage of germination and the seedling growth increased from one to ten percent concentration of the effluent and the other higher concentration decreased the germination percentage and also the seedling growth in all the varieties studied. The control seedlings showed highest fresh and dry weight than the effluent treated plants in all the varieties tested. (Sundaramoorthy et al, 2001).

The effluent of Titanium oxide chemical industry was collected from tuticorin city in south India. The effect of the effluent was studied on seed germination, growth chlorophyll and protein content of Vigna radiata and vigna mungo. The treated effluent of the factory was rich in chlorides (553mg.L⁻¹) sulphates (389 mg.L⁻¹), fluorides (1.2mgL⁻¹) and sodium 56mg.L⁻¹). The pH of the effluent was 5.03 at the time of collection. The 100% seed germination was observed upto 10 and 25% of effluent treated Vigna radiata and V. mungo respectively. Increased
growth, chlorophyll and protein content were observed up to 10% effluent concentration in both the species. The study suggests that this effluent may be used for irrigation after suitable dilution. (Chidambaram Pillai et al, 1996).

Water samples were collected from three sites of chemical industrial complex, Baroda and impact of effluent released by the chemical industries on seed germination and early growth performance of wheat crop have been studied. The chemical industries such as Indian Petrochemical limited, Gujarat Refinery, Gujarat Phenolics, Gujarat state Fertilizer Co., Petrofil, Universal dye stuffs and many more in Nandesari Industrial Estate are located on the northwestern side of Baroda. Besides, a large number of small and medium chemical industries are located within the corporation limits of the city. Water samples were collected from three sites – site I (150m upstream of river Vishvamitri, before the effluent channel from chemical industry meets the river), site II (from the effluent channel, just before it meets the river), and site III (100m after the effluent channel meets the river). Samples were diluted to 0, 10, 20, 40 and 60%. With the samples from site II, germination was completely inhibited up to 20% dilution, whereas, it was delayed with 40 and 60% dilution and only 30 and 60% germination was observed after third day. Root length was greatly inhibited with water samples diluted up to 20%, whereas shoot length was completely inhibited with those diluted up to 60%. The diluted
samples from site I and III had no significant effect on germination, but they retarded the root and shoot growth. Water samples from site III showed relatively more detrimental effect on germination and early growth performance of wheat than those from site I. (Sisodia and Bedi, 1985).

The effect of electroplating effluent on cultivated soil of Punjab was studied by Singh et al (1995). The electroplating effluent rich in toxic heavy metals particularly trivalent and hexavalent chromium and divalent nickle ions is used for cultivation regularly. The results reveal that these toxic metal ions get accumulated gradually and assimilation capacity of soil decreased day by day. The presence of such a significant amount of these metal ion particularly chromium upto 30$\mu$g and nickle upto 48$\mu$g in soil is alarming.

The photofilm factory effluent collected from Tamil Nadu have been analysed for its effect on seed germination and seedling development of Arachis hypogea and Zea mays. The photofilm factory effluent contained solids and metallic ions (cyanides, sulphides, chromium, copper, lead and mercury) along with biochemical and chemical oxygen demands. All the components of the effluent were within the admissible concentration except COD, TDS. The seed germination studies shows that the effluent was not much toxic upto 75% concentration both for groundnut and maize seeds. Whereas their was slight reduction in chlorophyll pigments, carbohydrates and protein.
contents. Only the pure effluent could exhibit significant toxicity over these plants. Among plants tested Z. mays was more tolerant (Manonmani et al, 1992).

The effect of cardboard factory effluent on germination and early seedling growth of rice (Oryza sativa) seeds have been investigated. The seeds presoaked in 25, 50, 75 and 100 per cent concentrations of the effluent for 15 and 24 hours, were germinated in distilled water. In another set, seeds were germinated under continuous moisture application of various concentrations of effluent. An inhibition in germination was recorded with the increasing concentration of effluents as well as pre-soaked period. Early seedling growth and dry biomass were found to be better in 25% concentration of effluent than those of control and higher concentrations in continuous application. The seedling raised from pre-soaked seeds showed better growth in 50% concentration. In this case the best growth was recorded in seeds pre-soaked for 15hr than rest of the treatments (Dixit et al, 1988).

A study was undertaken to assess the physico-chemical characteristics of rice mill effluent and the effect of various concentrations (0, 25, 50, 75 and 100%) on seed germination of three cereal crops (rice, maize and wheat). The effluent was alkaline in nature (pH 8.0). The high value of TSS (530 mg/l) and BOD (450mg/l) indicates presence of large amount of organic matter. In 25 and 50% concentration, the germination percentage was more or less at par with
that of control (0%). The effluent at higher concentrations (75 and 100%) exhibiting inhibitory effect. Thus, the effluent can be used for irrigation only after proper dilution (50%) (Abanti Padhan and Sahu, 1999). Physico-chemical characteristics of the effluents from rayon industry (Kota) have been studied which indicate low pH, suspended solids and zinc, biochemical oxygen demand and chemical oxygen demand show greater cause of pollution. The observations revealed that the effluent inhibited the germination energy index of *B. compestris* from 1.00 to 0.95 and that of *C. arietinum* from 0.966 to 0.475. The gradual decrease in germination energy index might be due to high osmotic pressure caused due to the high salt concentration in the effluent. There was overall decrease in roots, shoots and dry weight of seedlings when treated with effluent. The root length decreased from 6.91 to 5.1 cm in *B. campestris* and 15.68 to 11.93 cm in *C. arietinum*. The shoot length from 4.16 to 3.16 in *B. compestris* while from 13.13 to 9.06 cm in *C. arietinum*. The decrease in seedling growth was maximum at 100 percent concentration. Chlorophyll -a, chlorophyll -b, total chlorophyll and carotenoid content in the seedlings decreased from 20-100 percent effluent pretreatment of seeds over that of control. (Gupta and Agarwal 1992).

A field study was conducted at the experimental farm of Mathura Refinery, Indian Oil Corporation, Mathura (India) to evaluate the irrigational utility of treated refinery effluent in comparison with ground
water. Growth and yield parameters, including grain yield of three cultivators of *triticale* and one of wheat were studied. The effluent, ground water, and soil samples were analysed for various physico-chemical properties and noted that effluent increased all the growth and yield parameters. Soil irrigated with effluent showed no significant change in pH, total organic carbon, calcium, water soluble salts, cation exchange capacity and SAR. Treated refinery effluent met the irrigational quality requirements as its physico-chemical characteristics with in the permissible limits. *Triticale* performed better than wheat.

The samples of saree printing industry effluent from Kota were collected and various physico-chemical parameters were analysed by (Agrawal and Agrawal, 1990) to study its impact on seed germination and seedling growth of *C.tetragonoloba*. The effluent was alkaline (pH 8.2 – 11.2), TSS (185-248 mg/l), TDS (8451-9868 mg/l), Chloride (175-205 mg/l), BOD (140-285 mg/l) and COD (232-295 mg/l). The value of germination decreased from 100 per cent (control) to 5.53 per cent with 100 per cent effluent pretreatment. The root length decrease from 3.63 to 0.73 cm, the shoot length from 10.16 – 5.4 cm and dry weight of seedlings from 16.03 to 8.2 gm/seedling. Chlorophyll-a, chlorophyll-b, total chlorophyll and carotenoid content in seedling decreased from 0-100 per cent effluent pretreatment of seeds over that of control. The decrease was 14.79, 3.72, 34.55 and 49 fold in 100 per cent effluent concentration. The pigment values showed a decreased of 54.07,
14.47, 65.12 and 44.95 per cent respectively over control. Similar results have been observed by (Jain and Kumari, 1990) while working on the effect of different concentration (2.5, 5, 10, 25, 50, 75 and 100%) of saree printing industry effluent (Mathura) on germination, seedling growth and biomass in *Spinacea oleracea*. The increasing concentration of the effluent induced a gradual decrease in germination percentage and speed of germination. The best seedling growth took place in 2.5% and 5% concentration of the effluent. Above 2.5% concentration, the response declined up to 75% concentration. The effluent above 75% was lethal. The study reveals that the low concentration of the effluent may be used for irrigation purpose.

Effect of soaps and detergents factory effluent (Karnataka) on soil and crop plants like *Pennisetum typhoides* and *Pisum sativum* was studied by Somashekar and Siddaramaiah (1993). The physico-chemical analysis of effluents show that the effluent is alkaline and contain high amount of fluorides, chlorides, sulphates, sodium and zinc. It contained 36.0mg/l zinc and was deficient in nitrates and potassium. It was concluded that *Pisum sativum* treated with 10 per cent effluents showed 84 per cent germination while only 57 per cent of seeds germinate at 100% concentration. The length of the shoot and root was 9.79 and 4.79 cm respectively at 100 per cent concentration as against 17.16 and 7.06 cm of control. The percentage shoot inhibition varied from 1.86 to 42.95 as compared with control. The shoot and root
growth, the wet and dry weight at 75 per cent and 100 percent concentration remained significantly different from control. In P. typhoides exposed to raw effluents, 64 per cent seeds germinated while 98 per cent germinated in the control series. The percentage shoot inhibition ranged from 7.32 to 38.73 at different concentrations. The wet and dry weight at this concentration was comparatively low. In this case also, the data remained significant at 75 per cent and 100 per cent concentration. The values of vigour index support the view that P. Sativum is more susceptible. Following application of effluents to soil no appreciable change in the chemical composition of soil occurred. The effluents at higher concentration suppressed germination of seeds, root length, shoot length as well as reduce the fresh weight and dry weight.

Bhirawa Murthy and Appala Raju (1982) studied the effect of the alum factory (Visakhapatnam) effluents on seed germination and growth of seedlings of rice, green gram and mustard. The sludge contained high amounts of dissolved salts, aluminium (35.5), iron (5.5) and sulfate ions and was highly acidic (3.12). In rice, at 25% and 50% concentrations, shoot inhibition was comparatively less than root inhibition. At 75% and 100% concentration more inhibition was observed. In green gram at 25% concentrations, shoot inhibition was more than root inhibition. At 50%, 75% and 100% concentration further inhibition of root and shoot was observed. In mustard, even at 25% concentration there was a serve inhibition in both shoot and root
growth. At 75% and 100% concentration complete inhibition was observed.

The work of Srivastava and Mathur (1987) on chlor alkali plant located in Amlai (MP) reveals that the effluent was very toxic in terms of pH, suspended solids, residual chlorine and mercury. Mercury was the most toxic compound present in the effluent. The seeds *Raphanus sativus* was adversely effected by the CAP waste water. The germination rate was more in lower concentration of effluent (10, 30 and 50%) compared to higher concentrations though quite low when compared to control. Coefficient of correlation $r$ was calculated between increasing concentration of effluent and growth parameters. These values showed negative correlations, as the concentration of effluent increases there is decrease in the mean root length, mean shoot length and mean number of secondary roots. Evidently, to reduce the lethal impact, recovery of mercury and reduction of pH and residual chlorine should be made from the effluents before discharging them into the river.

The effect of domestic waste waters with various BOD levels on the germination and early seedling growth of some crops have been studied by Nashikkar (1994) Studies on irrigation with five levels of BOD of domestic waste water in the range of 0-1000 mg/l were conducted with the seeds of cabbage, brinzal, ladyfinger and cauliflower. Percent seed germination decreased at higher level of BOD of irrigation water
especially at the initial stages of growth. Inhibition of seed germination involved organic compounds as severe inhibition was found at high levels of BOD of irrigation water (5). This was due to the reduced oxygen levels and release of germination inhibitors such as ammonia and ethylene. As compared to the control the seedling growth of all the four crops were high than irrigated with high BOD waste waters. Cabbage, lady's finger and cauliflower shows optimum growth response at BOD level of 50 and 150mg/l. Whereas brinjal was found to be tolerant and continued to respond well to the irrigation with wastewater of BOD upto 1000mg/l.

The effect of pulp and paper mill effluents have been studied on seed germination and seedling growth of many seeds and tree crops Oryza, Sativa, Cicer arietinum, Arachis, hypogaea, Triticum aestivum L, Soybean etc. The physico-chemical properties of pulp and paper mill effluents show alkaline pH, dark brown in colour, with high suspended solids, dissolved solids, sodium, calcium and magnesium, salts viz. Chloride and sulphate, and was rich in lignin and cellulose.

Impact of Sanjay paper factory (Khalilabad, U.P.) effluent on the soil characteristic of neighbouring areas showed that the pH value was not very much affected i.e. 7.2, pronounced changes were observed in case of parameters like water holding capacity 34.5%, conductivity 0.44, umho, organic carbon 0.90%, copper 1.40µg/gm, cadmium 0.33 µg/g and magnesium 383µg/g in comparison to unaffected soils pH 7.0,
water holding capacity 45.0, conductivity 0.05 umho/cm, organic carbon 0.40%, copper 0.54μg/g, Cadmium 0.028 μg/g and magnesium 14.0 μg/g. The other parameters like particle density, nitrogen, phosphorous and potassium were not so much affected. Such conclusions were based on comparison of values between effluent affected and effluent unaffected soils. (Srivastava and Singh 1996).

Effect of pulp and paper mill effluent collected from M/s Seshaseyee paper and Boards Ltd. Periyar District, Tamilnadu was studied on germination and growth behaviour of tree seeds namely neem (*Azadiracta indica*), Pungam (*Pongamia glabra*) and Tamarind (*Tamarindus indica*). The seeds were treated with different concentrations of effluent, viz 25, 50, 75 and 100%. Tap water was used as control. The germination percentage decreased at 100% concentration of the effluent; only 75 percent of the seeds germinated as compared to control i.e. 100%. At 25 and 50 per cent concentrations, the effluent had no inhibitory effect on germination. The length of the root, shoot and vigour index of the tree species decreased at the higher concentrations. The 25 percent effluent was equal to that of normal water for irrigation (Gomathi and Oblisami, 1992).

Effect of paper mill effluent on seed germination and early growth performance of Radish and onion have been studied. The effluent from Orient Paper Mills, Amlai, M.P. India at the discharge point were collected. Grade II, Grade III and chlor-alkali plant waste were collected
separately and analysed for physico-chemical characteristic. Grade-II effluent consist of pale water from paper machine, cholorination and hypochlorite washing from bleach plant, wash water from chippr house and supernatant of lime from causticizer plant. Grade-III comprises digester house leakages, wash liquor from pulp mills and caustic extraction effluent from the bleach plant. It is dark brown in colour. Chlor alkali plant waste was turbid white and highly alkaline. The seeds of *Raphanus sativus* and *Allium cepa* were treated with different dilutions (10, 30, 50, 70 and 100%) of all the three effluents. The seeds were pre-soaked in different concentrations for an hour and in control the seeds were pre-soaked in distilled water for the same duration of time. The percent germination was more with the lower concentrations of the three effluents when seeds were treated with one to five days each. There were only 15 and 10% of germination as compared to 55, 35 and 25% for GR-II and GR-III effluent of paper mill for R. Sativus and A. cepa seeds respectively for the fifth day of treatment. Percent germination revealed significant differences at 10% for all treatment comparisons. In the case of *R. Sativus* seeds, at 10% concentration of all the three effluents, there was significant decrease in values of mean root length, mean shoot length and mean number of secondary roots as compared to control. No secondary root could emerge out in 100% concentration of Gr-III and CAP effluent. In case of *A. Cepa* seeds, only the mean radical length was observed as early growth performance of
the seed and here also the CAP effluent showed highly deleterious effect when compared to other two effluents. There is only 45, 64 and 38 cm of mean length in 100% concentration of Gr-III and Gr-II of paper mill and CAP influent, respectively as compared to 2.86 cm in control. (Srivastava 1991).

Effect of Nagaon paper mill effluent (Assam) on the germination of crop plant seed *oryza sativa* L. was studied in laboratory condition and compared with that of control. The study revealed marked delay in germination in effluent irrigated soil and decline in the germination percentage by 12.5% as compared to control. Possibly due to the presence of high concentration of salts and other chemicals in paper mill effluent that altered the soil salinity and disturbed the seed water relationship affecting the germination process. (Barauh 1997).

Effect of pulp and paper mill effluent situated at Kolhapur on germination of gram (*Cicer arietinum*) have been studied. The seeds were soaked for 24 hrs. in various concentrations of the wastes (10, 25, 50, 75 and 100%) and control (Tap Water). In the control the per cent germination rate increased gradually from 65% to 80% in 148 hrs., but got stabilized at 90% afterwards. In 10 to 75% concentrations the germination percentage was very high in the beginning and stabilized at 90%. However, a clear inhibition was visible in 100% concentration where the germination was 55 to 60% only between from 120 to 192 hrs. Considerable reduction in the radicle length was observed in 100%,
75%, 50% and 10% concentration of the pulp mill waste, but marginal increase was noted in 25% concentration. The plumule did not come out in 192 hours in the concentration above 10% except a small growth in 50%. Thus and overall basis wastewater significantly affected the growth of the seedlings (Shinde et al, 1988).

Maize, (Zea Mays L.) seeds were kept for germination in petridishes containing equal amount of soil treated with different concentrations of paper mill effluent of Darbhanga, Bihar (0, 5, 10, 25, 50, 75, 100%). Upto 25% concentration, both the percent of germination and seedling growth were increased but it decreased at higher concentrations. At 25% concentration the values of Root length, shoot length, fresh weight, dry weight were higher (7.32 cm, 8.10 cm; 2.78g, 0.28g) than control (5.85 cm, 6.90 cm; 1.97g, 0.19g respectively). The values of total chlorophyll, chlorophyll-a and chlorophyll-b increased upto 50% effluent concentration in comparison to control. However, the chlorophyll contents were higher in 75% than the control. Thus the paper mill effluent can be favorably use for irrigation purpose after proper dilution (25%) for better growth of the crop plants (Choudhary et al 1987).

Yash paper mill effluent (Faizabad) induced toxicity in Eichhornia crassipes and Spirodea polyrrhiza have been studied. Four concentrations (25%, 50%, 75% and 100%) of the effluent were used for treatment. The control was maintained separately. The plants were
harvested at 24, 72, 120 and 168h of exposure. Chlorophyll-a content and biomass of both the macrophytes decreased when exposed to different concentration of effluent and duration of exposure time (24 to 168h). The inhibition of chlorophyll content was 2.17% and 21.23% and that of biomass was 0.45% and 3.28% at 25% and 100% effluent concentration, respectively at 24h in E. crassipes while the inhibition of chlorophyll was 1.58% and 7.93% and that of biomass was 0.15% and 2.42% in S. polyrrhiza at the same effluent concentrations and duration of exposure. Whereas the inhibition of chlorophyll content was 3.86% and 57.72% and that of biomass was 3.20% and 9.72% at 25% and 100% effluent concentration, respectively at 168h in E. crassipes while the inhibition of chlorophyll was 8.59% and 28.50% and that of biomass was 5.88% and 9.53% in S. polyrrhiza at the same effluent concentrations and duration of exposure in comparision to control 100% chlorophyll content and biomass content at 24 hr and 168 hr. The metal (Cu, Fe, Zn and Mn) content of effluent decreased with exposure to these macrophytes for 168h. Reduction in metal contents of the effluent is probably due to the uptake of these metals by the aquatic macrophytes. (Srivastava and Pandey 1999).

Effect of paper mill effluent on seed germination and seedling growth of six varities of groundnut (Arachis hypogaea) have been studied. The six varities of groundnut (JC. 24, Co. 2, TMU. 7, ICG-CDRI, URI-2 and Girnar) have been treated with different concentration
The percentage of germination was 100, 100, 98, 98, 100 and 100% for JL 24, Co. 2, TMU 7, ICG-CDRI, VRI, 2 and Girmar varieties respectively at the germination percentage was 80, 75, 70, 65, 75 and 81% for different varieties at 100% effluent treatment. The seedling growth and their dry weight were also considered for varietal screening experiment. These parameters were found to decreased with the increase of effluent concentration. On the basis of data obtained from germination studies, the variety Co. 2 was more tolerant than the other varieties tested for paper mill effluent treatment (Sundaramoorthy and Kunjithapatham 2000).

Assessment of agropotentially of the effluent coming out from century pulp and paper mill, Ghanshyamdham, Lalkua (Uttaranchal) has been made on wheat (Triticum aestivum var. UP-2329) crop grown in two soils textures (i.e. pure soil and soil mined with equal amount of sand) with different effluent concentrations (0%, 50% and 1000%). Plant height increased by 2.91% and grain yield by 19.57% on irrigation with 50% diluted effluent and at 100% effluent irrigation, both decreased by 13.04% and 56.94% respectively as compared to no treatment. Harvest index in pure soil at 50% and 100% effluent irrigation was 65.12% and 38.29% respectively, while in control was 59.43%. Nutrient contents of wheat decreased under undiluted effluent and found maximum in normal soil with dilute effluent. Protein content in wheat grains
increased from 10.21% to 11.17% upon diluted effluent irrigation. Carbohydrate content increased from 71.65% to 73.42% and lipid content increased from 1.61% to 1.74% at 50% diluted effluent irrigation in normal soil and these soil parameters decreased upto 7.83%, 65.12% and 1.43% respectively at 100% effluent irrigation in sand mixed soil. Chlorophyll and protein contents in wheat leaves were more at 50% effluent irrigation over control, while 100% effluent irrigation resulted into reduction of the same. On the basis of the above result it was concluded that the effluent after proper dilution is beneficial for crop growth and yields even more than the normal water irrigation. (Singh et al 2002).

The effluent discharged from Lahat Sugar Factory in Madhubani district of Bihar and analysed after collection from six equidistant sites (200m apart) showed gradual decrease in value of all parameters from source to the sixth site 1 Km away. Physical parameters analysed: temperature 39-28°C; pH 4.2-5.2. Chemical parameters (mg/litre) were: alkalinity 410-235; free Co$_2$ 184.8 – 132.6; chemical oxygen demand 5200-2900; chloride 61-39.2; Ca 248.4-128.4; Mg 43.8-14.6; Na 24-16.2; K 84-33; P 3.7-1.9; total nitrogen 16.7-12.9; oil and grease 74-32; dissolved solids 568-404; suspended solids 1102-892; and dissolved oxygen absent. The presence of oil and grease, high levels of COD, solids, total alkalinity and calcium, and absence of dissolved oxygen
indicate high toxic nature of the effluent, which produces stinking smell and pollutes soil and water beyond permissible limits (Sinha 1993).

The physico-chemical properties of effluents of Kisan Sahkari Chini Mills Limited (KSCML), Satha, Aligarh (U.P.) and Panniji Sugar and General Mills (PSGM), Bulandshar (U.P.), and the effects of PSGM effluent on soil and crop plants have been studied. The effluents were high in various solids, COD, BODS, chlorides, sulphates, and had low dissolved oxygen and moderately alkaline pH. The effluents disturbed the pH, N, P, CaCO₃ and organic matter the greatest perturbance being observed in the potassium of the soil when effluent was used for irrigation. The effluent was applied to kidney bean Phaseolus aureus and millet, Pennisetum typhoides seeds in four concentrations (25%, 50%, 75% and 100%). Germination in the water-irrigated soil was 100% whereas it ranged between 91% and 99% in the other concentrations of the effluent. Shoot length of plants was highest in the control and 25% effluent and least in the soil treated with undiluted effluent. There was no correlation between root length and nature of irrigating fluid. The pH of soil increased gradually with increase in the concentration of the effluent. Hence, this alkaline effluent may be used for fields having acidic solids. For best results it is suggested that sugar factory effluent must be diluted before use (Ajmal and Khan (1983)).

The seeds of Oryza sativa L. var. ratha were pre-soaked for 24 hours in the different concentrations of mixed effluent collected from the
Baleshwar Khand Udyog (Sugar factory), Kadinar. The hundred percent germination was observed in control, 5, 10 and 20% effluent treated seeds. Root length of seedlings were increased upto 60% effluent-soaked seeds but decreased in 80% effluent. The shoot length was increased upto 20% effluent treated seedlings but decreased at higher concentrations. The chlorophyll a and b were observed more in 40 and 60% effluent treated seedlings also compared to the control (Bhatnagar et al; 1986).

A field experiment was conducted to study the effect of sugar factory effluent on growth, yield and quality of Bhindi-var PKMI in the premises of a sugar factory in Aundipatti, Madurai district, Tamil Nadu. The crop quality was not affected. Increased yields were obtained with 50% (11.43 t ha⁻¹) and 75% (12.50 t ha⁻¹) dilutions when compared to zero per cent dilution i.e. (9.72 t ha⁻¹). There was no adverse effect on the soil physical properties. The effluent can be used for irrigation bhindi crop with proper dilution. (Rathinasamy and Lakshmi Narashimhan (1998)).

The study on the physico-chemical properties of Saraya Sugar factory (Gorakhpur) was conducted by (Srivastava et al (1993)). The results reveals that the major by product of sugar factory were bagasse and presmud. Bagasse was used as fuel for steam production whereas presumed was used as manure. Sugar factory, however does not
contribute to pollution load and if there is any, it can be considerably reduced by proper operation and maintenance of the plant.

Effect of E.I.D. Parry & Co. sugar mill effluent, Nelli Kuppam on seed germination and early seedling growth of Blackgram (*Vigna mungo* (L) *Hepper* Var. ADT-3) had been studied. Blackgram seeds were raised in petriplates irrigated with various concentration of sugar mill effluent (0, 5, 10, 25, 50, 75 and 100%). The seedlings showed better growth at 5 and 10% effluent concentration when compared with control. The higher concentrations of the effluent produced harmful effects on germination and seedling growth of blackgram. (Chandrasekar et al (1998)).

An attempt has been made to study the effect of sugar factory effluent on germination and enzyme activities of seven improved gram (*Cicer arietinum* L.) varieties (namely K-468, H-208, JG-62, Annigiri, BDN-93, BG-209 and Chafa). The seeds were treated with different dilution of sugar factory effluent (5%, 10%, 15%, 20%, 25% & 50%). The overall germination percentage was not affected by effluent upto 15% concentration. However, the emergence was delayed by the effluent treatment. This effect was more pronounced in gram varieties K-468, H-208, JG-62 and Annigiri. The process of germination was found to be completely inhibited by effluent concentrations above 20%. The effluents at lower concentration (5%) stimulate dehydrogenase activity at all stages of germination. The higher concentrations of
effluent (10%) bring about a small decrease in dehydrogenase, especially at peak hours (72 and 96) of germination. The activity of enzyme catalase was stimulated by the effluents during most phases of germination. The peroxidase activity in chickpea seeds was suppressed by lower dose of effluent (5%) while higher dose (10%) brings about marked stimulation. The activity of enzyme acid phosphatase was inhibited due to pollution stress. (Murumakar and Chavan 1985).

Field experiments were conducted to study the effect of two levels of sugarcane trash incorporation an nodulation and yield of Kharif mung and its residual effect on rabi wheat. The trash was applied at the rate of 2.5 and 5.0 tonnes in combination with 12.5 and 25 Kg N/ha to Kharif Mung and common recommended dose of NPK was given to rabi wheat. The pooled data on nodulation, grain and dry matter yield in mung showed that the highest nodule number (177/5 plants) and nodule weight (272mg/5 plants) were recorded in the treatment of 5 tonnes trash with 25Kg N/ha, which was 40 and 31 per cent more than the control. An addition of trash and nitrogen at graded level significantly increased the grain and dry matter yield of mung over control. The highest grain yield (12.85 q/ha) and dry matter yield (12.99 q/ha) was obtained due to the application of 5 tonnes trash and 25 Kg N/ha, which was 27 and 43% more than the control. Whereas in wheat the highest grain (40.97 a/ha) and dry matter (51.67 q/ha) yield were obtained from plots where 5.0 t/ha sugarcane trash was applied to kharif mung. The
lowest grain (37.0 q/ha) and dry matter (42.70 q/ha) yields were produced by the treatment where only nitrogenous fertilizer was applied to kharif mung. The sugarcane trash not only increased the yield parameters of the first crop (mung) but also left soil more fertile after its harvest which ultimately influenced the grain and dry matter yield of wheat. (Rasal et al 1989).

The studies on the effect of sugar factory waste on germination of gram (Cicer aritinum) shows that the higher concentration of the waste suppressed the germination to a great extent. The radical growth was adversely affected by all the dilutions. On the other hand, initially there was hardly any significant difference in the plumule length, but later the 25% and 50% dilutions of the waste showed a promotary effect. In the 100% waste plumule growth was suppressed greatly (Goel and Kulkarni 1994).

Germination, seedling growth, concentrations of photosynthetic pigments and nutrient uptake in Triticum vulgare L. (var W-H-147) were studied in response to sugar mill effluent (Rohtak, India) application. 10% concentration in aqueous Vs. soil of Triticum vulgare has been observed at 10% effluent concentration. Effluent treatment caused 61 to 71% reduction in root and shoot length in aqueous medium, whereas the inhibitory effect was less in soil, showing a reduction of 21 to 24%, as compared to control. Likewise, the reduction in plant biomass due to effluent treatment was more (31 to 38%) in aqueous medium than that
in soil (16 to 25%). The effluent treatment increased the concentrations of various pigments, however, the pigment ratios got changed in the aqueous medium only. The uptake of calcium and sodium was very high in effluent treated seedlings both in aqueous medium (0.22 and 2.92 mg/plant) and in the soil (0.42 and 3.0 mg/plant), showing relatively greater uptake in aqueous effluent medium. The increase in phosphorus uptake due to the effluent on the other hand, more marked when applied to soil. The effluent treated plants showed 7% increase in potassium and 68% increase in chloride uptake, their uptake was decreased by 47 and 16% respectively, in soil. (Kaushik et al 1994).

Steel industries and gun factories are no less important for developing world. In fact the percentage itself is called steel age. The discharge of large quantities of effluents from these industries is not beyond imagination. The effluents of steel industries and gun factories are expected to contain sufficient quantities of Mg, Fe and other essential and non essential mineral elements in addition to contaminants draw from raw materials, burning coal and polishing etc. Which can cause pollution and influences our soils, water and growth as plants to a great extent.

The effect of Bhailai steel plant effluent on Kanhar soil and crops such as Cyamopsis titragenoloba, Abelmoschus esculentus, Linum usitatissimum, Sesamum indicum L, Phaseolus vulgaris L, Cicer
arie tinum, Phaseolus mungo, Zea mays and Oryza sativa have been
tested. Physico-chemical characteristic of Kanhar soil, not being
irrigated or being irrigated with a steel mill effluent, for one or many
years have been investigated. The physico-chemical characteristic of
Bhilai steel plant effluent were with a mean pH value of 7.92, osmotic
pressure and residual sodium carbonate had very low mean values of
0.25 atm and 2.81 m.e.l respectively. BOD values with a range of 0.67 to
1.21 mg/l and an average of 0.82 mg/l was very low as compared to the
range (113-137 mg/l) and mean (655 mg/l) values for COD. The mean
values for sulphate (4406 mg/l), nitrate nitrogen (2804 mg/l) calcium
(172.70 mg/l) magnesium (98.19 mg/l) and iron (5351 mg/l) indicated
their higher concentrations. The concentration of phenol was 47.44 mg/l.

pH of the soil was not affected significantly by irrigation. E.C. shows
higher value (2.67 m mhoms/cm) in long term irrigated and cultivated
soil as compared to unirrigated soil (0.16 am mhos/cm). Water holding
capacity for long term irrigated oil was high 164.03%. Available and
total phosphate concentrations shows maximum concentration of
0.08 mg/g and 1.23 mg/g respectively were obtained for irrigated and
cultivated fields while their minimum concentrations of 0.0019 mg/g and
0.0572 mg/g respectively were obtained for unirrigated non-cultivated
soils. Total nitrogen concentrations was found to be both maximum
(5.67 mg/g) as well as minimum (0.36 mg/g) for long term irrigated and
cultivated fields. Acid soluble as well as water soluble iron were found to
be maximum (9.63 mg/g and 2.70 μg/g respectively) for irrigated and cultivated fields, but maximum values for ferric and ferrous iron 1.10mg/g and 67.74mg/g respectively were obtained for a many year irrigated and uncultivated soil (Sharma Naik, 1990, 1991 a, b, c).

The effect of BSP effluent on “Kanhar” soil and Linum usitatissimum L. in field condition, and Sesamum indicum L. and Phaseolus vulgaris L. under pot conditions were analysed, leaf pigments like chlorophyll a, chlorophyll b and total chlorophyll were increased with effluent irrigation in the leaves of S. indicum and P. vulgaris i.e. (6.86% and 18.589; 5.24; and 26.57%;’ 6.24 and 21.76 respectively) but decreased in the leaves of L. usitatissimum 6.26%-11.35%; -6.95% respectively. Pheophytin concentration increased by about 27 per cent in S. indicum (27.31%) but decreased in other two species (-8.54%, -17.51 respectively, while protein concentration exhibited a decrease of about 8 per cent in the leaves of S. indicum but increased about 11 and 34 per cent in the leaves of effluent irrigated plants of P. vulgaris and L. usitatissimum respectively. Concentrations of calcium and magnesium decreased in the leaf, stem and root of almost all the effluent-irrigated plants of all the three species. Contrarily, the concentration of phsophate increased in all the plant parts of all the species, with effluent irrigation, with more than 200 per cent increase in the roots of S. indicum and P. vulgaris. Concentraton of iron, however, decreased with effluent irrigation, in the leaf and stem (-11.65, -5.16)
respectively of *S. indicum* and leaf, stem and root of *P. vulgaris* (-15.31, -47.04, -3.35) respectively but in *L. usitatissimum* it increased in all the plant parts with about 40 per cent increase in the leaves. Soil properties also exhibited different types of changes. pH slightly decrease in soil planted with *P. vulgaris*. Organic matter increased in soil planted with *S. indicum* and *P. vulgaris* (0.50% and 2.24%) respectively but decreased in *L. usitatissimum* (-5.15%) planted soil. Available phosphate concentration, in the effluent irrigated soil decreased with *S. indicum* and *P. vulgaris* (0.50% and 2.24%) respectively but decreased in *L. usitatissimum* (-5.15%) planted soil. Available phosphate concentration in the effluent irrigated soil decreased with *S. indicum* & *P. vulgaris* (-45.45%, -22.22%) respectively and increased with *L. usitatissimum* 52.32%. Total phosphate as well as calcium concentrations in the effluent-irrigated soil increased with *S. indicum* 16.13%, 1.26% respectively but decreased with other two species. Total nitrogen concentration was very high in the effluent irrigated soil planted with *S. indicum* (174.98%) but increase was minimum in the soil planted with legume species *P. vulgaris* (8.05%) and also found minimum in *L. usitatissimum* (35.65%). Magnesium increased in the effluent irrigated soil planted only with *L. usitatissimum* but decreased in the soil planted with other two species. Chloride concentration, in effluent irrigated soil, increased very significantly, planted with *S. indicum* 312.55% but decreased with *P. vulgaris* (-23.41%) and *L. usitatissimum* (-88.11%)
while alkalinity increased very significantly with *P. vulgaris* but
decreased in the soil planted with other two species. The results, thus
indicated that it is not safe to continue the use of steel mill effluent

Bhilai steel mill effluent irrigation increased pigments and protein
concentration in the leaves, as well as ash and nutrient content in
almost all the parts of *C. tetrafonolaba*. However, treatment decreased
the germination percentage as well as other germination parameters of
seeds. In the effluent germinated seedlings, fresh weight, moisture
percentage and calcium concentration were decreased, but dry weight,
Mg, PO$_4$ and Fe concentrations were increased, as compared to the
values in seedlings under control conditions. Effluent irrigation to the
soil resulted in very significant increase with respect to nitrogen
concentration, and with it, several other parameters of the soil also
experienced significant effects, due to effluent irrigation.

In the Bhilai effluent irrigated soil, only readily oxidizable organic
matter and sulfate concentration increased, but total nitrogen decreased
significantly, while remaining 14 parameters exhibited insignificant
effect. Germination percentage of *Abelmoschus esculentus* seeds
decreased from 87 under control to 82 under treated condition,
amounting to 6.10 per cent decrease. Germination value, speed of
germination index and germination relative index also decreased under
the treatment condition by 5.00, 11.21, 30.30 and 32.42 per cent.
respectively with respect to control. The fresh weight, dry weight and moisture percentage of seedlings decrease by 32.42%, 11.16% and 11.79% per cent respectively. Seedlings treated with tap water show significant increase in calcium and phosphate concentration from 19.37 to 26.58mg/100g (37.22%) for calcium and 3.268 to 3.718mg/g (13.77%) for phosphate, while iron concentration significantly increased from 0.469 to 0.742 mg/g (36.79%) with effluent treatment but concentration of magnesium was slightly higher in tap water emerged seedlings by about 2.10 per cent over the treated seedlings. The presently observed significant effects of effluent on soil and seedlings, even with short term irrigation indicate that when the effluent comes in direct contact, its effects, both on soil and plants were more significant.

Effect of integrated steel plant Bhilai, M.P. effluent on germination percentage and seedling height of selected pluses and cereals have been studied. The seeds/grains of bengal (Cicer arietinum), mung (Phaseolus mungo), maize (Zea mays) and paddy (Oryza sativa) were soaked separately in 25%, 50%, 75% and 100% concentration of the effluent and in distilled water (control) for 24 hr. The physico-chemical characteristics of the waste water suggest that the sulphides, cyanides, ammonia, phenolics, nitrites, iron and oil are present in high concentrations. The germination percentage of seeds decreased with increase in the effluent concentration; seedling growth was also found to be retarded in higher effluent concentrations. The maize variety has
shown the lowest tolerance for the waste water followed by paddy, bengal gram and mung. If the waste water is treated adequately or at least diluted before discharge from the plant premises it can be suitably used by the farmers for irrigation. (Shukla and Moitra 1995).

Some physico-chemical and metal pollutants of the steel plant effluent located in Rourkela have been studied. The pH of the effluent was found to be alkaline throughout the year ranging from 8.3 to 9.56. The values of conductivity, COD, total alkalinity, total dissolved solids, total suspended solids were all above permissible limit. The values of solids found above critical limits was confirmed by the complete absence of phytoplankton in the effluent. The annual averages of the metals tested were in the order of Ca>k>mg>Cu>Fe>Cr>Zn>Cd. (Mohanty et al 1991).

The Impact of effluents from textile industry of Pali (Rajasthan) on Bandi river and nearby wells was investigated. The effluents were highly saline, coloured and rich in sodium resulting in significantly higher values of sodium adsorption ratio (SAR) and residual sodium carbonate (RSC). The content of heavy metals such as cadmium, lead, chromium, nickel, cobalt etc. were in traces. The results of water samples from the river and adjoining wells collected during December 1991 indicate that salinity, SAR and RSC of the river water near the discharge point were very high. This makes the river water as well as waters from adjoining wells were not suitable for irrigation. The river water have very low
bacterial count indicating the toxic effect of the industrial effluents. But
the population of bacteria in the nearby wells was more as compared to
the river water. Productivity of soils around Bandi river decreased as a
result of irrigation by the well waters polluted with the discharged of
industrial effluents in the river. The micro-organisms in soil irrigated with
polluted water decrease from 29 percent to 90 percent as compared to
the soil irrigated with ordinary water. The inhibitory effect was more
significant in respect of free living nitrogen bacteria. (Rao et al 1993).

The waste water from “The Orissa Weaver’s Co-operative
Spinning Mills”, was collected and its effect on germination and growth
of maize have been studied. Seeds were soaked in waste water of
different concentration such as 25%, 50%, 75% and 100% for specific
hours (3 hr, 6 hr, 12 hr, 24 hr, 36 hr and 48 h). Textile mill waste water
did not inhibit the germination in maize. Soaking of seeds in waste
water resulted in early germination. At lower dilutions, the maize
showed favourable growth and increase in biochemical characteristics
like protein, sugar, aminoacid and pigment content in laboratory
experiments over control. Application of textile mills waste water in
agriculture without adequate dilution is not recommended. (Panda and
Mishra 1997).

Effect of Sanganer, Jaipur Textile industry waste water on growth
and some biochemical parameters of *Triticum aestivum* Var. Raj 3077
has been studied. The seeds were exposed with five different dilutions
of textile industry waste made with distilled water i.e. DW : WW levels 1:0, 3:1, 1:1, 1:3, 0:1. The growth of *T.aestivum* was adversely affected with the increase in DW : WW concentration from 1:0 to DW : WW concentration 0:1. The reduction in root and shoot lengths were 59.3 & 38.2 percent respectively as the concentration of waste water increased from 0 to 75% similarly root and shoot dry weights decreased to about 36.8 and 28.5 percent respectively. The amount of chlorophyll-a, chlorophyll-b and total chlorophyll in DW:WW ratio of 1:0 was 6.8280, 1.8660 and 8.6940 mg/g respectively which respectively decreased to 3.9640 mg/g, 1.1940mg/g and 5.1580 mg/g in DW:WW ratio of 0:1. The carbohydrate content decreased from 200mg/g in control level of 240mg/g in DW : WW ratio of 0:1 whereas the protein content reduced from 4.32mg/g to 3.12mg/g in DW:WW level of 0:1 (Khan and Jain 1995).

The effluent of the Modi Textile Factory Ltd., Modinagar, U.P. (MTF) was analysed and its effects in various concentrations (25, 50, 75 and 100%) on certain physicochemical properties of soil and germination and growth of kidney bean, *Phaseolus aureus* and lady's finger, *Abelmoschus exulentus* crops were studied. The effluent was found to be rich in various types of solids, BOD, COD, Cl⁻, So₄²⁻, Na⁺, K⁺, Ca²⁺ and Mg²⁺, deficient in dissolved oxygen and highly alkaline in nature. At all the dilutions tested there was an increase in the water soluble salts, electrical conductivity, cation-exchange capacity, pH, NH₃-
N, phosphorus, organic matter and NH₄OHC-extractable Na⁺, K⁺, Ca²⁺ and Mg²⁺ of the soil. The greatest changes were recorded with 100% effluent, the most marked increase being in the organic matter of soil, followed by NH₃-N K⁺, Na⁺, P, Ca²⁺ and Mg²⁺. The other effluent concentrations also changed soil composition accordingly. The top soil supplemented with different dilutions of the effluent had higher concentration of water-soluble salts and extractable nutrients than the subsoils. The soils supporting crops were found to have lower concentrations of nutrients than those without crops.

The plants grown in different effluent concentrations were analysed for Na⁺, K⁺, Ca²⁺ and Mg²⁺. Na⁺ showed a constant and gradual increase with increase in the effluent concentration, whereas K⁺, Ca²⁺ and Mg²⁺ concentrations were found to be highest in the plants grown in 50% effluent followed by 25, 75 and 100% effluent. Germination was inhibited and delayed by 100 and 75% effluent, whereas it was normal with other effluent concentrations as compared to water control. Undiluted and 75% effluent retarded the growth of plants whereas 50% effluent enhanced the growth. (Ajmal and Khan 1985).

Much contribution has been made by Ajmal et al (1984); Gautam & Bishnoi (1990) and Gautam et al (1992) in the field of effect of Dairy effluent on soil and crop plants.

The physico-chemical properties of the effluents of Hindustan lever (India) Ltd, Ghazibad, UP (HLF) and its soap splitting unit (SSU)
were determined. The effects of HLF effluent in four different concentrations (i.e. 25%, 50%, 75% and 100%) on certain physico-chemical properties of fertile soil and on the germination and growth of two common crop plants have been studied. The values of total solids, NH$_3$-N, NO$_3$-N, COD, BOD, chlorides and sulphates were found to be high in both effluents. Considerable amounts of phosphorous, potassium, magnesium and calcium were also present, as well as traces of heavy metals (Fe, Mn, Cr, Cd, Zn, Cu, Co, Pb and Ni). The effluent (HLF) at all dilutions raised the concentrations of water-soluble salts, CaCO$_3$, NH$_3$-N, potassium, phosphorus and organic matter of the soil. The greatest changes were, however, caused by the undiluted effluent.

The upper layers of soils receiving effluent had higher values of available nutrients than the lower layers. The highest perturbance was noted in the organic matter content of the soil when it was irrigated with 100% effluent, with successively lower effects on NH$_3$-N, potassium, phosphorus and CaCO$_3$. Seventy-five per cent, 50% and 25% effluent also disturbed the soil composition accordingly. No significant change was noted in the soil pH. The germination of pea and mustard seeds was delayed and restricted to 90% of normal when undiluted effluent was used for irrigation, whereas germination was normal with other effluent concentration. Undiluted effluent inhibited the growth of plants whilst 75% effluent enhanced it. The growth of crops substantially reduced the nutrient content of the soils, as was established by
comparing the crop-supporting soils with irrigated, uncropped soils (Ajmal and Khan 1984).

The physico-chemical characteristics of dairy Glaxo Laboratories (India) Ltd. effluent (GLLE), and the effects of its discharge directly on fertile soil and indirectly on kidney bean *Phaseolus aureus* and pearl millet *Pennisetum typhoides* crops for 6 weeks, were evaluated. The GLLE was slightly alkaline and had high BOD and COD due to the presence of large amounts of solids. It was rich in bicarbonates and calcium. GLLE was found to be responsible for altering the chemical composition of the soil. Soil irrigated with GLLF showed an increase in pH, organic matter, calcium carbonate content, water soluble salts, cation exchange capacity, electrical conductivity, nitrogen and phosphorus. Potassium decreased, probably due to it being leached to the lower layers of soil. The effects of undiluted effluent and of effluent diluted to 75%, 50% and 25%, using water irrigation as a control, on the germination and growth of kidney bean and pearl millet were monitored. The undiluted GLLE restricted the germination of kidney bean to some extent while that of pearl millet was enhanced. 100% GLLE retarded the height of plants of both crops whilst 25% effluent in kidney bean, and 75% effluent in pearl millet, enhanced it considerably (Ajmal et al 1984).

Effect of Amul dairy, Bikaner effluent on soil characteristics and plant growth have been studied in *Avena sativa Linn*. The dairy effluent was slightly alkaline and medium saline with pH 8.14 and E.C. 4.47
mmhos/cm. The ionic concentrations of Na, Cl, CO₃ and SO₄ of the effluent were observed to be 44.02, 30.0, 3.76 and 6.84mg/litre, respectively. HCO₃ concentration of the effluent was lesser than tap water. The concentrations of nitrate nitrogen and phosphate were 0.14 and 0.20 mg/litre, respectively. The germination was 97.5% in the diluted effluent (1:1) concentration i.e. at par with control and the germination was decreased to 83.790 in undiluted effluent. The length of root and (4.1cm) and shoot (38.8cm) were observed to be relatively more in diluted effluent than the undiluted (23.7cm/root and 32.1cm/shoot). Similarly the fresh/dry biomass of above ground (AG) plant parts increased (2.420/0.55g) in diluted one, as compared to that of control (2.081/0.505g), whereas the biomass of the underground parts in diluted effluent was at par with that of control and lesser in undiluted. Sandy soil was observed to be saline, medium alkaline with organic carbon (0.09), phosphorus (9.0), and potash (325/Kg/h). The plant growth changed the alkalinity and salinity of the soil after treatment with effluent. The E.C. value of the soil increased upto 2.00-2.47 mmhos/cm, in effluent treated soil. There was no change in basic nutrients (organic carbon = 0.12% and P₂O₅ = 10.25Kg/h) of the soil, treated with diluted and undiluted effluents as compared to that of control. K₂O was slightly raised in undiluted treated soil. The oat plant was moderately tolerant and exhibited better growth in diluted effluent. (Gautam and Bishnoi 1990).
In an another study conducted by (Gautam et al 1992) on effect of Amul Dairy effluent, on seed germination of some Rabi and Kharif crop plants observed that the percentage germination was inhibited in all test crop plants except wheat when treated with 75 and 100% effluent. The germination was 100% in wheat at all levels of concentration. In 50% treatment the germination was at par with that of control in all test crop plants. However percentage germination was increases in 25% effluent treated seeds. The maximum germination percentage inhibition was observed in gram, oat, rizka and jowar when treated with 100% effluent. Wheat was the most tolerant crop and germination in different concentration of effluent was at par with that of control (100%).

The effect of Bhavnagar, Gujarat dairy effluent was studied on seed germination, seedling growth and pigment contents of *Pennisetum typhoides* Barm (Bajra) and *Sorghum bicolor* L. (Jawar). The seeds were soaked in different concentration 25%, 50%, 75% and 100% of the effluent. A gradual decrease in the germination of seeds, seedling growth and pigment contents with increase in effluents concentration was observed. The best germination, seedling growth and pigment content was observed in 25% effluent concentration. Undiluted effluent had a inhibitory effect. Whereas 25% effluent concentration had a growth promoting effect which was significantly better than control. Beyond 25% effluent shoot and root length decrease positively. Thus
effluent can be used safely for irrigation purposes at proper dilution (25%) for beneficial cultivation (Pandit et al 1996).

A study was carried out in laboratory to find out the feasibility of utilization of Koyana dairy waste, Karad, India (the dairy processing milk and manufacturing butter and producing 1.2 lac litres of waste water). Growth studies on Glycine max (Soyabean) and Phaseolus mungo were conducted in earthen pots with 10, 25, 50, 75 and 100% concentration of dairy waste (original dairy waste had mean BOD-48 mg/l, mean COD 630.5mg/L, mean TSS 206.5mg/L, mean TDS 378mg/l. Total kjedhal nitrogen 89.95mg/l, Total phosphorous 10.84mg/l and sodium 72mg/l, potassium content was 12.8 mg/l). The effect on the germination of seeds of these two crops was studied in petriplates. An evaluation of the dairy waste for their suitability as irrigants showed that 75% and 100% came under moderate to high salinity class. The dairy waste was not found to effect the germination percentage and length of the seedlings in Phaseolus mungo. In Glycine max it caused early germination and was promotory for the growth of the seedlings. However, in the growth experiments in earthen pots, the waste was found to improve the plant growth in Glycine max but proved to be inhibitory for the growth of Phaseolus mungo. Seventy five percent concentration gave the best results with Glycine max. The dairy waste appreciably increased the ash, calcium nitrogen and phosphorus content of both the crops. The dairy waste irrigation slightly increased
the pH, organic matter and conductivity of the soils. In case of *Glycine max*, the phosphorus content increased in 10%, 25% and 50% but actually declined in 100%. This situation was opposite in *Phaseous mungo*. Potassium content increased considerably in the higher concentrations (Trivedy and Kirpekar, 1991).

A pot culture experiment was conducted for two seasons using mother dairy, Yelahanka, Bangalore effluent at various concentrations. The experiment consisted of six treatments such as Irrigation with borewell water (control) (T₁), irrigation with 1:1 (T₂), 2:1 (T₃) and 3:1 (T₄) ratio of effluent and water, alternate irrigation with undiluted effluent and boewell water (T₅) and irrigation with undiluted effluent (T₆). The pH of the effluent was 8.12 and EC 0.74. The sodium content was found to be high (6.22 me/L) and Ca+Mg content was found to be low (3.45mg/L). The effluent contain maximum suspended solids (126mg/L). The germination percentage decreased with increase in the quantity of effluent in both French bean and *Amaranthus*. It was maximum (8.75 and 95.50 percent, in French bean and Amaranthus respectively) in T₁ control and minimum 71.87 and 36.50 per cent in French bean and *Amaranthus*, respectively in T₆ (raw effluent). Dry matter yield of both the crops was highest in T₁ (Control) treatment and lowest in T₆ (raw effluent) treatment. The plant nutrient elements decreased due to effluents compared to control (T₁). The nitrogen content varied from 1.88 to 1.93 per cent in French bean and 1.60 to 2.66 per cent in
Amaranthus. The phosphorus content ranged from 0.20 to 0.27 and 0.30 to 0.54 per cent and potassium from 1.31 to 1.53 and 2.84 to 3.83 per cent in French bean and Amaranthus respectively. Sodium concentration increase with increase concentration of effluent. Sodium varied form 0.35 per cent ($T_1$) to 0.41 per cent ($T_6$) and 0.85 ($T_6$) to 1.09 percent ($T_6$) in French bean and Amaranthus respectively Ca and Mg content of the both French bean and Amaranthus were decreased with increase in effluent concentration. The Ca content varies from 1.40 to 1.71 per cent and 1.37 to 3.13 per cent and Mg varied from 0.82 to 0.92 per cent and 0.56 to 0.96 per cent in French bean and Amaranthus respectively. The effluent is less harmful to the crops if it used in 1:1 dilutions (Srikantha et al 1998). Combined effect of waste of different industries on the seed germination, seedling growth, pigment content and Biomass of many crops and vegetable plants such as Phaseolus radiatus, Okra, Gram, Maize, Paddy, Foxtail Millet, Wheat and Pisum sativuum have been studied. The effect of the various concentrations (0,1,2.5, 5, 10, 15, 30, 50, 75 and 100 per cent v/v) of the mixed fertilizer factory and distillery effluent on the germination of the seeds Phaseolus radiatus (Linn.) was studied. The results have shown that the percentage germination and speed of germination Index (SGI) increased correspondingly with increase in the effluent concentration up to 5 per cent and the growth and biomass of seedlings and their pigment content up to 10 per cent. The carotenoid content, however
increased up to 30 per cent concentration. The mixture of fertilizer factory and distillery effluents was found beneficial up to 15 per cent for the overall growth of the plants. Thus, its use for irrigation would not only solve the disposal problem of the two effluents but will also serve as an additional fertilizer (Sahai and Neelam 1987).

The influence of dyeing and textile water pollution on nodulation and germination of *Cicer arietinum* L. have been studied. The effluent was rich in chloride, bicarbonate and total dissolved salts. The BOD value was quite high. The seeds were treated with different dilutions (5%, 10%, 20%, 25% and 50%). A control set with distilled water was maintained. The investigation showed that increasing concentration of effluent induced a general decrease in the germination percentage, hypocotyl length, radicle length, nodule number and its fresh weight as well as the dry weight of the root and shoot i.e. 24.96% 3.12cm, 1.45cm, 23, 183mg/plant, 30mg and 20mg respectively at 50% concentration in comparison to the control i.e. 100%, 13.42cm, 11.30cm, 68, 628mg/plant, 124mg and 78mg respectively. Lower concentrations of effluent were not so toxic. The study showed that dyeing and textile waste had a toxic effect on the overall growth of the *Cicer arietinum* L (Dayama 1987).

The study was undertaken to investigate the combined effect of effluent of distillery and sugar mill at different concentrations Viz 5, 15, 25, 50, 75 and 100 per cent on seed *Abelmoschus esculentus* (L)
Moench. Germination percentage (90%), fresh & dry weight of shoot (0.30751g/ml 0.02067gm), fresh and dry weight of root (0.04404gm; 0.00307gm) and biomass (0.351.55mg/plant) increased upto 25 percent effluent concentration in comparison to control were germination percentage was 75%, fresh and dry weight of shoot 0.172/5gm; 0.02015gm, fresh and dry weight of rot (0.02452gm; 0.00182gm) and biomass 0.19667gm/plant. Germination was completely inhibited in at 100% effluent. Germination was noted at 75 percent effluent, but seedling did not survived. However, the waste water of distillery and sugar mill may be used for irrigation after diluting the effluent to 75 percent (Om et al 1994).

An attempt has been made to evaluate the water pollution caused by existing industries in parts of Cochin. A systematic study of the chemical nature of the surface water bodies from Eloor to Cochin harbour has been made with a view to assess the extent of pollution of various trace elements. The study revealed that the concentration of trace elements around Eloor industrial belt was higher than the Vembanad lake, which may be attributed to steady discharge of effluents in Eloor region. In most of the samples, concentration of trace elements exceed the maximum permissible limit prescribed by W.H.O. (1984). Such as Pb (0.05mg/l), Cd (0.005mg/l), Cr (0.05mg/l), Cu (1.0mg/l), Zn (5-15mg/l), Fe (1.0mg/l). Range of toxic metals in the samples are such as lead range from 0.302 to 0.960mg/l with on
average of 0.479 mg/l. Cadmium was high ranging from 0.166 mg/l to 0.487 ppm. The value of chromium ranges from 0.90 to 1.95 mg/l averaging 1.343 mg/l. The concentration of manganese and nickel ranges from 0.376 and 0.695 mg/l; 0.031 to 0.43 mg/l respectively. Average concentrations of zinc and cobalt in the area are 2.167 and 0.128 mg/l, respectively. The copper value ranges between 0.96 and 1.98 mg/l with an average value of 1.277 mg/l. This reveals that the concentration of toxic heavy metals in the area particularly in Eloor region is much higher than the permissible limits (Khurshid et al 1998).

Investigations were carried out to assess the accumulation of plant nutrients and heavy metals in soils of the lands adjoining few industrial establishments in Kochi, Kerala. Three locations, site A, B and C having a total area of 110 acres neighbouring the fertilizer and chemicals Travancore Ltd (FACT) were selected for the investigation. The studies indicated high salinity, organic carbon and enrichment of major nutrients like nitrogen and phosphorus in the soil. The electrical conductivity of the soils indicated high level of salts, the conductivity increasing up to a level of 1.48 ds/m in site A and 4.28 and 2.00 ds/m in site B and C respectively. The mean organic carbon content of the surface soils in the area is 1.1% in site A. At site B and C, it is 2.4 and 3.2% respectively. Among major nutrients, available nitrogen level in the soil ranges between 3800 to 8000, 5000 to 74000 and 6400 to 6600 Kg/ha in site A, B and C respectively. Similarly, the level of available
phosphorus of the soils varies from 600-1000 in site A and B, 920-1000 Kg/ha in site C. High levels of DTPA extractable micronutrients such as Zn, Cu, Mn and Fe were also observed in the soil samples collected from different locations and three depths in site A, B and C. The value of zinc varied from 3.8 to 5.5 mg/Kg in surface soils to lower layers at site A. The value of copper varies from 0.8 to 2.6mg/Kg, 2.2 to 3.5 mg/Kg and 1.4 to 2.9 mg/kg in the surface, middle and the deeper layers of the three sites of the study area. Manganese is round to be much higher in the surface soil in all the three sites ranging from 8.9 to 14.6 mg/kg followed by 2.0 to 9.1 in the middle and 2.1 to 10.9 mg/Kg in the deeper layers respectively. Available iron in the soils ranged from 73 to 239, 91 to 182 and 115 to 175 mg/kg in the surface, middle and lower layers respectively. (Vasu et al 1998).

Studies were conducted to evaluate the effects of industrial effluents and polluted water on seed germination of crops. Two effluent samples and two waste water (polluted) samples were collected from Hattedan industrial development area, Hyderabad and a bioassay test was conducted using seeds of paddy, maize, greengram and foxtail millet. The germination percentage and dry mater yields of all the crops tested were lower than control. The effluents and waste waters were unsuitable for irrigation and there is a need to treat and dispose of them scientifically. (Prashanthi and Rao 1998).
Seven water samples have been taken from three factories namely, camphor and Allied Products Limited (Camphor), Western Indian Match company Limited and Indian Turpentine and Resin Company Limited, Bareilly. Their physico-chemical parameters were quantified to see their impacts on grazing animals and cereals. pH was found in the range of 7.73 to 8.65 and showing an inverse relationship with dissolved oxygen content and direct relationship with TDS in most of the water samples. TDS values varied from 628.20 to 838.30mg/l; while variation in EC values was observed from 0.59 to 0.87µmhos. Growth of plumules of wheat grains was found retarded when treated with water samples than that of grains treated with normal tap water. (Singh et al 1998). The combined effluent from three industries, viz. Indian Turpentine and Rosin Co. Ltd., Western India Match Co. Ltd. and Camphor and Allied Products Ltd. was collected and subjected to physicochemical analysis. The effluent was found to contain total suspended solids, total dissolved solids, oil and grease, Na, Pb and Cr beyond their respective maximum recommended permissible limits. The effects of effluent on growth performance of Pisum sativum L. (var T-163) and Triticum aestivum (var. U.P.-115) have been studied. All the growth attributes exhibited on overall decrease in effluent irrigated plants of P. sativum and Triticum aestivum as compared with control, harvested after 30, 75 and 135 days of sowing. In the P. sativum case, the reduction in number of leaves (19.35%) and leaf area (28.08%) was
not significant at late vegetative stage (after 74 days). Maximum decrease in leaf area (31.09%) was observed at early vegetative stage. However, maximum reduction in root length (22.0%), number of branches (46.08%) and root dry weight (44.2%) was obtained at the age of 75 days. The decrease was maximum in shoot length (34.54%), number of leaves 26.60%, shoot dry weight (37.64%), biomass/plant (38.03%) number of inflorescence/plant (41.61%) and dry weight of seeds (38.88%) after 135 days. Whereas in case of *Triticum aestivum* shoot length, root length, leaf area per plant, shoot dry weight, root dry weight and biomass per plant exhibited maximum decrease in treated plants at 75 days, being 31.21, 37.82, 43.77, 40.16, 45.56 and 42.40% respectively. However, the decrease in number of leaves for plant and number of tillers/plant in the treated plants was maximum at fruiting stage (after 135 days), being 34.89 and 37.50% respectively. Percentage decrease in number of inflorescence and total seed dry weight in *Triticum aestivum* was 34.72 and 38.05% respectively. (Bahadur and Sharma 1989 a,b).

Effect of some heavy metals on seed germination and early seedlings growth of groundnut, sunflower and gingery have been studied. The seeds of *Arachis hypogaea* Linn. Vars. Co. 2 and Suf. 4) and *Sesamum indium* L. vars. Co. 1 and TMU-4 were treated with different concentrations (0, 20, 50, 100 and 200 μg/ml) of mercuric chloride, cadmium acetate and zinc sulphate. The results showed that
the 200% increase in concentration of HgCl₂ suppressed seed germination to the extent of 12-20% in groundnut, 20-27% in sunflower and 42-48% in gingelly. The growth rate of root shoot and the formation of lateral roots were found to be retarded with increasing concentrations of HgCl₂ in all the three crops. Even lower concentrations (20 & 50 μg/ml) of HgCl₂ markedly inhibited lateral root formation in sunflower. Decrease in fresh weight of seedlings ranged from 29-37% in groundnut, 33-40% in sunflower, and 20% in gingery treated with 200% increased in concentration of HgCl₂. The increase in concentration of Cd to the extent of 200% inhibited seed germination ranging from 25-28% in groundnut, 45-55% in sunflower and 26-55% in gingery. Relatively, higher concentrations of Cd (100% and 200%) significantly reduced shoot and root lengths in all the three oil seed crops. Even increase in concentration of Cd upto 20% and 50% inhibited root growth 12-16% and lateral root formation 10-13% in groundnut var Co. 1 and 6-12% root growth and 40% lateral root formation in gingery var. Co.1. The increase in concentration of Zn (100% and 200%) inhibited both seed germination and seedling growth in all the oil seed crops. Nonetheless, increase in concentration of Zn to the extent of 20% did not effect seed germination and seedling growth in sunflower and gingery significantly. In groundnut the seedlings attained maximum growth treated with Zn at 20% concentration (Renjini and Jahardhanan 1989).
In order to assess the effect of metal interactions on plant growth, a greenhouse experiment was conducted, in which spring barley was grown for 48 days in a soil to which cadmium, copper, lead and zinc were added singly and in combination. Plant growth was measured as shoot and root dry matter production. At the end of the experiment the plant material was analysed for metal uptake and the soil was extracted with CaCl$_2$ solution, to measure the plant-available metal content. The most effect on plant growth was an interaction between copper and zinc, which was also important in determining uptake of these metals and the amounts extractable with CaCl$_2$ solution. An analysis of the underlying mechanism led to the conclusion that the growth of barley was controlled principally by the amount of plant-available zinc, which depended on the amounts of both added zinc and added copper. The effect of the added copper was to increase the toxicity of the added zinc. (Luo and Rimmer, 1995).

The accumulation of Cd by wheat (*Triticum aestivum* L.) grain grown at nine sites across south Australia was investigated. Application of low rates of Zn fertilizer (up to 5.0 Kg Zn/ha$^{-1}$) were found to markedly decrease the Cd concentration in wheat grain grown in areas of marginal to severe in deficiency. No further significant decreases in Cd concentration in grain occurred at higher rates of applied Zn. Effectiveness of applied Zn on grain Cd concentration decreased with time since application. Grain Cd concentrations decreased with fresh
An attempt has been made to investigate the acute toxicity of five metals \((\text{Cr}^{6+}, \text{Cd}^{2+}, \text{Hg}^{2+}, \text{Pb}^{2+}, \text{As}^{5+})\) which are widely spread in the environment and are widely recognized as highly toxic and dangerous. As the testing subject, mustard seeds \((\text{Sinapis alba})\) were used and their LC50, EC50 values and their 95% confidence limits on germination and root growth have been tested. The results demonstrated that after 72hr the most toxic metal for seed germination was \(\text{As}^{5+}\) and the least toxic was \(\text{Pb}^{2+}\). The resulting rank order of toxicity for metal ions on germination was \(\text{As}^{5+} > \text{Cr}^{5+}(2) > \text{Cr}^{5+}(1) = \text{Hg}^{2+} > \text{Cd}^{2+} \cdot \text{Pb}^{2+}\). The LC50 (Cr) values were in some cases extremely high \((\text{Pb}^{2+}, \text{Cd}^{2+})\). The greatest inhibition of root growth was with \(\text{Cr}^{6+}(1)\) and \(\text{As}^{5+}\) and the least with \(\text{Pb}^{2+}\). The rank order of toxicity for root-growth inhibition was \(\text{Cr}^{6+}(1) = \text{As}^{5+} > \text{Hg}^{2+} > \text{Cr}^{6+}(2) = \text{Cd}^{2+} > \text{Pb}^{2+}\). From both rank orders of toxicity the results indicate that the most toxic metal ion for plant seeds (their germination and root growth) was \(\text{As}^{5+}\) and the least toxic was \(\text{Pb}^{2+}\) \((\text{Fargasova, 1994})\).

Effluent collected from three industries such as Hindustan Aeronautics Limited (HAL), Hindustan Machine Tool (HMT) and UB-Mec Batteries (UB-Mef) rich in heavy metals were applied to the soil and...
crop plants. The treatment of effluent with different plants was made such as HAL industry effluent was used to treat (*Dolichos biflorus* and *Vigna sinensis*), HMT industry was used for *Zea mays* and *Dolichos biflorus*, UB-Mec industry effluent used for *Brasica Juncea* and *Phaseolus aureus*. The different concentrations of 10, 25, 50 and 75% effluent concentration were used. The pH of the raw effluent and the soil amended with effluent remained alkaline in respect of HMT. Following application, the soil also showed higher levels of sodium, potassium calcium and magnesium. In this case comparatively *Zea mays* absorbed more phosphates, magnesium and iron, and exhibited better growth than *Dolichous biflorus*. The concentration of phosphates in the soil fed with raw HAL effluent was 4.60 mg/Kg, while 4.41 mg/Kg was observed in case of HMT and in UB-Mec 1.80 mg/Kg. After amending the soil with acidic UB-mec effluent there as gradual rise in pH, the concentration of organic carbon, phosphates, potassium, sodium, calcium, magnesium, iron and magnese also increased. *Brassica juncea* absorbed more phsophorus, calcium and magnesium from the effluent of UB-Mec than *Phaseolus aureus*. The plant tissue from *Dolichos biflorus* yielded 7.5 mg/Kg of lead, 36.4 mg/Hg Zinc, 44.4 mg/Kg copper and 47.9 mg/Kg chromium, in the case of 100% HAL efluents, the same effluent in *Vigna sinesis*, yielded slightly higher concentrations of zinc, copper and chromium. Similarly higher concentration of zinc and lead were noticed in *Phaseolus aureus* fed
with UB Mee water. *Brassia juncea* treated with the same waste water yielded slightly higher concentrations of lead, zinc and copper. The suppression of root growth in *Zea mays* treated with HMT and *Vigna sinesis* treated with HAL waste water is attributed to inhibitory action of copper and chromium. The rate of accumulation of metals depended on the available metal present in the soil, viz, zinc, lead and cobalt (UB-Mec), copper, chromium and zinc (HAL) and copper, chromium and nickel (HMT). Further, the moderately acidic soil in the case of UB-Mec favoured greater accumulation of metal ions. (Somashekar and Siddaramiah 1997).

Heavy metal pollution of air, soil and plants around zinc smelter have been studied. Findings reveal that in ambient air dust (Suspended particulate matter) and Zn fraction dominated (0.835 to 2.7 μm³) over other metals. While in soil Fe content (5940 to 13150 ppm on dry weight basis) was most predominant because of areas being rich in iron or content, although addition enrichment in the near by areas was seen Cd with lowest emission rate ranged from 0.037 to 0.127 μg/m³ in ambient air and 1.5 to 14.0 ppm in soil. Overall impact of various toxic metal emission was seen even upto 7.0 kms from plant site and zone of influence was governed by micrometeorological and tropographical conditions of the area. (Agrawal et al 1988).

The study on heavy metal uptake and accumulation strategies of two absolute metallophyte species (*America maritima* ssp. *halleri* and
cardominopsis halleri) and one pseudometallophyte (*Agrostis tenuis*) growing near a farmer metal smelter have been conducted. Samples of plant parts and soil were analysed for Zn, Cd, Pb and Cu. In soil, there were two dominant types of metal concentration gradient with depth. Under the absolute metallophytes, extremely high metal contents were measured in the surficial Ah horizon, followed by a strong decrease gradient with depth. Under the absolute metallophytes, extremely high metal contents were measured in the surficial Ah horizon, followed by a strong decrease in the underlying soil horizons (L$_{11}$ and L$_{12}$). Under the pseudometallophyte, metal concentration in the Ah horizon were much lower and fewer differences were observed in metal concentrations among the Ah, L$_{11}$ and L$_{12}$ horizons. The concentrations of Zn, Cd, Pb and Cu in *Agrostis tenuis* roots were greater than concentration in leaves, indicating significant metal immobilisation by the roots. For C. halleri, Zn and Cd concentrations in leaves were >20000 and >100mgKg$^{-1}$, respectively, indicating hyperaccumulation of these element. *Armeria maritima ssp.* halleri exhibited root concentrations of Pb and Cu that were 20 and 88 times greater, respectively, than these in green leaves, suggesting an exclusion strategy by metal immobilisation in roots. However, Zn, Cd, Pb and Cu concentration in brown leaves of *Armeria maritima ssp.* halleri were 3-8 times greater than in green leaves, suggesting a second strategy, i.e. detoxification mechanism by leaf fall. (Muller et al 2000). A study on Inter-
relationships between soil properties and uptake of cadmium, copper, lead and zinc from contaminated soils by Raddish (*Raphanus sativi*L.) have been conducted. Raddish was grown in 46 garden plots in England and Wales. Some of the gardens had been contaminated by heavy metals from lead mining. The soils were analysed for pH, organic content and cation exchange capacity; also for Cd, Cu, Pb and Zn (total, organic bound, exchangeable and specifically sorbed). Acetic acid-soluble P and exchangeable K, Mg and Zn were also determined. Raddish bulbs and leaves were analysed for heavy metals. The results were interpreted using linear and multiple linear correlation and regression analysis. Acetic acid satisfactorily predicted Cd uptake and Pb uptake was best predicted by total soil Pb. These regressions were not improved by including other soils properties. Zinc uptake was best modeled using exchangeable Zn and the predictive power of the regression was improved by including pH. However, the pH term was positive suggesting that raising soil pH would increase uptake. A poor relationship between total and exchangeable Zn was changed to a highly significant relationship by including cation exchange capacity and pH. The latter term was strongly negative uptake of Cu was not satisfactorily predicted. (Davies, 1992).

A field experiment was conducted at the experimental faculty of The Institute of Soil Science and Plant Cultivation (IUNG), Pulawy, Poland to study the transfer of Cd, Pb and Zn from soil contaminated by
smelter flue dust to crop plants grown in a rotation. The soil was amended with Pb-Zn smelter flue-dust (2-66.8Kg per 10m$^2$ plot) to stimulate the long-term effect that the smelting of non-ferrous metal ore has on arable soils. The treated soil became strongly contaminated with metals (Cd 3.2-106Mg/Kg, Pb 146-3452 Mg/Kg, Zn 465-11375 mg/kg). Concentrations of Cd, Pb and Zn in barely grain, barely straw, meadow blue grass, red clover and potatoes were generally low. The highest metal concentration were found in potato tubers (intact), meadow bluegrass, and barley straw. The observed reduction in crop yield was probably the result of possible nutrient imbalances rather than of metal (Zn, Cu) phytotoxicities. Zn and Cd uptake by the plants can be described by the saturation (plateau) model ($y=9\mu$, $b<1$). The relationship between Pb in the soil and plants was linear with an extremely low slope (0.0001-0.003). No excessive dietary intake of Cd is expected when Cd concentrations in barley grain and potato tubers grown on the contaminated soil are not higher than 0.6 and 1.0 mg/kg, respectively. Based on the risk analysis and taking into account the saturation model of the soil-plant metal relationship, it was concluded that, under the conditions of this experiment (neutral soil pH), soil with Cd concentrations of up to 30mg/kg is still safe for production of these crop plants (Dudka, 1996).

Distribution of different fractions of cadmium, Zinc, Lead, and copper in unpolluted and polluted soils have been studied. The source
of pollution was the Kamioka mine and Smelter, Japan. McLaren and Crawford’s method for fractionating soil Cu was modified, and used to fractionate soil Cd, Zn, Pb and Cu in 38 soil samples from 11 soil profiles from industrially polluted and nearby unpolluted areas. Pollutant metals, especially Cd and Zn, were soluble than the native soil metals. On average, approximately 45% of Cd was present in the CaCl$_2$ soluble (CA) fraction, whereas corresponding values for the other metals were below 10%. The percentages of each metal in the CA fraction followed the order Cd$>$Zn $>$ Pb$>$Cu. The same order was observed for the acetic acid soluble (AAC) fraction. Approximately 30% of total Pb and Cu were present in the pyrophosphate soluble (PYR) fraction, and only 10% of total Cd and Zn. Approximately 20% of total Zn or Pb and 10% of Cd or Cu were present in the free oxide (OX) fraction. Only 20% of Cd and between 40-50% of the other 3 metals were present in the residual (RES) fraction. The results show that Cd is more labile than the other 3 metals (Asami et al; 1995).

A pot culture experiment was conducted to study the effect of 0, 15, 30, 45, 60, 75, 90, 105, 120 and 135 mg/Kg trivalent and hexavalent chromium on yield and accumulation of chromium by spinach (Spinacea oleracea L.). Chromium content in spinach leaves increased from nil in control to 2.8 and 3.14 mg/Kg due to 135 mg/kg Cr (III) and Cr (VI) respectively at 25 days of growth. The control plants contained highest amount of N and P and both decreased with
increasing levels of Cr (III) and Cr (VI) application. The amount of chromium in spinach leaves decreased with progressive cuttings. Chromium (VI) applied at 30mg/Kg reduced the spinach yield to a greater extent that Cr (III). Chromium induced reduced leaf size, burning and firing of leaf tips or margin and slower growth were observed. (Singh 2001).

Effect of lead on Phaseolus mungo and Phaseolus radiatus have been studied. The seeds were treated with different concentrations of Pb \((\text{NO}_3)_2\) solution (viz 1.5, 3.0, 4.5, 6.0, 7.5 and 9.0mM/litre). Percentage germination height of plant and survivability, pods per plant treated seeds was always less than the control. Minimum percentage germination of 25 and 47% were observed in \(P.\ mungo\) and \(P.\ radiatus\) in 9mM/litre solution treated for 30 hours. Survivability of \(P.\ radiatus\) was comparatively greater than \(P.\ mungo\). The highest of 66 and 80% in 1.5mM/liter solution treated for 6 hours and lowest of 13 and 18% in 9.0mM/liter solution treated for 6 hours was recorded in \(P.\ mungo\) and \(P.\ radiatus\) respectively.

While minimum of 160mm in 9.0mM/liter and 300mm in 4.5 mM/liter solution treated for 30 hours were observed in these tow plant respectively. The number of leaves was quite uneven. P.Mungo had leaves equal or greater in number than control at all concentrations treated for 6, 24 and 30 hours. In \(P.\ radiatus\) the number of leaves was always less, though lowest number of leaves was observed at all
concentrations in a 24 hour treatment period. In general, the reduction in the number of pods in *P. mungo* was more than *P. radiatus*. POD length varied between 48-71mm and 43-14mm compared to 62 and 42mm of control in *P. mungo* and *P. radiatus* respectively. As a whole lead proves to be toxic and inhibitory to the plants and produces adverse effect on it. (Prasad and Devi 1990).

A study was conducted on the effect of chromium on wheat (*Triticum aestivum* L. (V. HO 2204). Chromium was supplied as sodium dichromate (A.R.). Superimposed on basal nutrient solution at six graded levels (viz. 0.00, 0.05, 0.1, 0.25, 0.5 and 1mM). As compared to control plants, a marked decline in inflorescence biomass was observed at 0.05mM Cr. The dry weight of leaves of wheat decreased at 0.05mM Cr supply level of 60% in comparison to control plants. With an increase in chromium supply to 0.1mM there was further depression of 12 percent. The dry weight of stem depressed by 49% at 0.05mM Cr as compared to the plants grown without chromium; with further increase in Cr supply upto 0.1mM the depression increased by about 33 percent over the yield obtained at 0.05mM Cr. The depression in grain yields as a result of differential chromium supply was very high and ranged between 82% to 92% from 0.05 to 1.0mM Cr. (Sharma and Mehrotra 1993).

Performance of wheat (*Triticum aestivum* Linn. Var. RR-21), Barley (*Hordium vulgare* Linn.), Raddish (*Raphanus sativus* Linn.) and
spinach (*Spinacea oleracea* Linn.) Irrigated with Iron Foundry effluent. Performance of the four crop plants at the vegetative stage was recorded after harvesting when 50 day old. The dry weight of plants of wheat, barley and raddish got reduced due to treatment with the foundry waste water, whereas the spinach had increased from 1.97g/plant of control to 2.86 g/plant of the treated plants. This increase was found statistically non-significant. Dry matter production of effluent treated spinach had 71.41 g/m² as against 48.9g/m² of the control plants. This showed a significant increase (P=1%) in the plant dry matter. Other plant species had decreased dry matter production in relation to the waste water. Loss in Forage matter of barley was recorded to be 34.83% followed by Raddish with 25.91% and wheat with 25.35%. The spinach, on the other hand, had 46.03%.

Enhancement in the vegetable matter production. There was inhibition of growth due to the heavy metal accumulation which caused a loss in yield of 8.07% in wheat and 8.96% in barley. The iron level was, therefore, found toxic to wheat and barely both.

The above results show that spinach has better growth in relation to the level of iron of the effluent. It promoted yield of its vegetable matter upto 46.03% (Gupta and maury 1987).

The waste waters produced by tanneries industries contain harmful substances. The effluents produced by these industries were bluish green in colour saline and sodic, containing large amounts of

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organic and inorganic substances; chlorides, sodium, chromium, proteins, tannin and high BOD and COD values; in addition to important plant food like nitrogen, calcium and potassium etc. (Iyer et al 1957; Thabaraj et al, 1964, Charkarbarthy et al, 1966; Indian standard, 1977; Bharti et al, 1979; Gupta et al, 1981; Rao and Kumar, 1981, 1984; Srivastava, 1981; George, 1984). Mckee and Wolf (1963) observed that sulphides and tannins present in Tennery effluent reacted with iron and imparted colour and undesirable odour and taste to water. Tannery wastes contain valuable plant nutrients like nitrogen, potassium, calcium, phosphorus, sulphur etc., though their use needs proper dilution and elimination of toxicities for beneficial irrigation purposes (Thabaraj et al, 1964). Hariharan (1968) also observed changes in colour and dissolved solids in well waters in Polar basins.

The Tannery effluent has been collected from various tannery located at various place in the country by various authors and analysed for physico-chemical characteristics.

The physico-chemical characteristic of tannry effluents has been given below:

**Pioneer Tannery Kanpur** :- Colour Brown, pH-9.5, TSS-2550mg/l, TDS-1235mg/l, TS-14900mg/l, COD 4100mg/l, BOD-1810mg/l, chlorides-4200mg/l, Tannin-445mg/l, Chromium-Nil, Calcium Carbonate-1260mg/L
Dindigul Tannery ETP Tamilnadu : Colour-light brown, odour-unpleasant, pH-8.81, EC-15.61 (dsm\(^{-1}\)), Carbonate-400.0mg/l, Bicarbonate-1880.0mg/l, Chloride-3550.0mg/l, Calcium-287.0mg/l, Magnesium-141.0mg/l, Sodium-2785.0mg/l, Potassium-102.00mg/l, Sulphate-519.4mg/l, Total solids-15500.0mg/l, TDS-10075.0mg/l, organic carbonate(%) - 0.026mg/l, Total N-201.72mg/l, Amonical N-92.4mg/l, Total P-0.5mg/l, COD-3250mg/l, B.O.D.-1600.0mg/l, Mn-0.11mg/l, Zn-0.6mg/l, Cu-0.12mg/l, Fe-1.83mg/l, Cr-23.5mg/l, Biological properties-Bacteria-29x10\(^5\)/ml, Actinomycetes-Nil, Funji-8.1x10\(^3\)/ml.

Mouchong Tannery Calcutta : Colour-Dirty Grey, pH-9.2, Total solids-21.500mg/l, Dissolved solids-18.300mg/l, Suspended solids-3.200mg/l, BOD-2.300mg/l, COD-5.500mg/l, Total nitrogen-60mg/l, Phosphate 8mg/l, Potassium-2mg/l, Chloride-12.400mg/l, Sulfate-2.200 mg/l, Sulfide-120mg/l, Chromium-250mg/l.

Jayanti Nalla Kolhapur Tanneries : Colour Blakish, Temperature 29\(^0\)C, pH-8.3, E.C.-9.3mmhs/cm, Total solids-1950mg/l, DO-2.9mg/l, C.O.D. -116.2mg/l, B.O.D.-96.0mg, Chlorides-298.2mg/l, Alkalinity-340.0mg/l, total Nitrogen-710mg/l, total phosphorus-0.36g/l.

The effects of Tannery effluent have been studied on the various crops plants such as Bhindi, Ragi, Cicer arietinum (L), Soybean, Brassica compestris (L), Vigna radiata, Cajanus cajan (L) Millsp, Finger Millet.
Kamalam and Raj (1980 a, b) studied the effect of tannery effluent on Ragi and Bhindi. To ascertain the effect of tannery effluent on seed germination and nutrient uptake of Ragi, a Neubauer experiment was conducted. Germination, dry matter production and nutrient uptake of the crop were reduced significantly by increased concentration of the effluent. This effluent was more pronounced in black soil. The adverse effect of the effluent was mainly due to the high total soluble salt content. A pot culture experiment was conducted on red and alluvial soils with bhindi (Pusa Sawani) as test crop at two levels of tannery effluent application, mixing it with water in 25 and 50% proportions. The yield of bhindi was adversely affected by application of tannery effluent and the effect was more pronounced with increase in concentration. Impact of Tannery effluent on seed germination, seedling growth and chlorophyll content in *Cicer arietinum* L has been studied by Rao and Kumar 1983, Ansari and Bhattacharya 1988, Kadam 1995; Nandi et al 1995 and Saxena et al 1986. Raw and Kumar 1983 treated the seeds with six concentrations (5,10,25,50,75 and 100%) of the effluent. Seed germination was effected by 75 & 100% effluent. There was gradual decrease in root and growth (in length) with increase in concentrations of the effluent. 5 and 10% effluent treatment enhanced the total chlorophyll content though 'chlorophyll-a' has shown slight decrement. The remaining concentrations (25, 50, 75 and 100%) of the effluents resulted in the reduction in chlorophyll content. Ansari and
Bhattacharya 1988 studied the effect of Pioneer Tannery on the gram seeds found the same result. The overall growth of seedlings increased up to 25% level. Kadam, 1995 while studying on the effect of Tannery effluent from Jayanti Nalla Kolhapur on Cicer arietinum seeds found that the 25-50% diluted waste has promotional effects in chlorophyll content, reducing sugars, total sugars, starch, total carbohydrates, sodium and potassium. Nandi et al 1995 studied the different concentrations (1, 2.5, 5, 10, 25 and 50%) of Mou Chong Tannery effluent Calcutta on Vigna Mungo L. hepper. At lower concentrations particularly 2.5% the effluent promoted seed germination and early seedling growth while higher concentrations retarded these processes. Saxena et al 1986 found the complete retardation of gram seedling when treated with the undiluted tannery effluent of Agra city.

The seeds of Brassica compestris L. Var T-a were soaked in graded concentrations of 5, 10, 50 and 100 % of Pioneer tannery effluent. Results suggest an increase in germination percentage over control in lower concentrations with a decreased germination percentage in higher concentrations. As compared to conball all the treatments showed increased in length of root and shoot of seedlings significantly. Increase in presoaking time delayed germination but resulted in better seedling growth. Observations suggested possibilities of better prospective yield of mustard in treated plants. (Chadha 1988).
Tannery effluent induced changes in growth, yield and protein contents of *Vigna radiata* have been studied by Saxena et al., 1986; Anjum, 1990; Bera and Bokaria, 1999, Balashouri and Prameeladevi 1994.

Saxena et al.; 1986 found complete retardation of mung when treated with undiluted tannery effluent of Agra city. Sugarcane, rice, Wheat and mustard showed positive response to post-methanation effluents application with irrigation water. Even after the 20th consecutive irrigation with effluent, none of the crops showed any toxicity symptoms upto 30% post methanation effluents (PME) application (Chhonkar et al, 2000). Application of composite tannery effluent (25, 50, 75 and 100 %; were studied on growth and yield of *Vigna radiatia* (Mung). An overall increase in growth and yield of the crop was observed with 25 % effluent. However, with the increase in concentrations of effluents the plant growth marked concomitant decline. %age increase of 3.1, 3.33, 15.1, 2.0 in plant height, number of branches, leaf area per plant and dry weight per plant, respectively was observed. Dilution of 25 percent promoted biological and economic yield together with increased nodule formation and nitrogen content in leaves as compared to control. Increase of 6.8 and 1.4 % in biological and economic yield, respectively, coupled with 22.4 and 5.3 percent increase in number of root nodules and protein content of leaves, respectively with 25% effluent was witnessed against control in 35, 50
and 65 days aged plants. Observed promotion in growth and yield in statistically significant at 5% error probability (Anjum 1990). Effect of different of concentrations (1, 2.5, 5, 10, 25 and 50%) of Mou Chong Tannery effluent on seed germination, seedling growth and chloroplast pigments in mungbean (*Vigna radiata* L. Wil-Czek) CV Pusa Baisakhi was studied. In comparison to control, effluent concentration upto 10% did not significantly reduce seed germination; however with increase in the concentration of effluent, seed germination was affected. Early seedling growth, fresh and dry weight were found to be better at 2.5% concentration of effluent than control and higher concentrations. This stimulatory effect might be attributed to presence of optimum levels of nutrients at 2.5% concentration and inhibitory effect at much higher concentrations due to presence of excess amount of dissolved solids, chloride, sulfide, chromium and high BOD and COD values of the effluent. Irrespective of concentration, chlorophyll-a, chlorophyll-b and total chlorophyll were found to decrease in 6 days old Mung bean seedling as compared to control. This might be attributed to inhibition of enzyme concerned with chlorophyll biosynthesis. Therefore it is suggested that tannery effluent can never be employed in the field directly or at higher concentration but can be utilized as a liquid fertilizer only for certain crops at 2.5% dilution level (Bera & Bokaria 1999).

Balashouri and Prameela Devi 1994 studied the impact of tannery effluent at 2.5, 5.0, 7.5, 15.0, 25.0, 50.0, 75.0 and 100%. 85
Concentrations on seedling growth of *Vigna radiata* (L), *Caianus cajan* (L) and *Sorghum bicolor* (L) plants under laboratory conditions. There was a gradual increase in percent of germination, root and shoot lengths, chlorophyll content and phytomass of pulse and cereal crop seedlings with corresponding increase of effluents up to 7.5 and 5.0% concentrations respectively. The overall pulse seedling growth was better upto 15% of effluent concentrations over control and it was upto 7.5% for cereals, then the adverse affect was observed with corresponding increase of effluent concentrations. The effect of tannery effluent on pulse and cereal crops showed the difference in tolerant limits of the effluent upto 15% for pulses, *V. radiata* and *C. cajan* and upto 7.5% for cereal crop seedlings; *S. bicolor*. The results reveal that pulse crop plants are comparatively more tolerant than the cereal crop plants to tannery effluents. Therefore the tannery effluent, can be used for irrigation purpose only after proper diluting it to 7.5% concentration where it not only supplies nutrients to plant growth, but also reduces the usage of expensive inorganic chemical fertilizer. Yadav and Sukhla 1994 also have the similar observation for the cereal crop maize. Germination of Maize seeds is accelerated after treatment with tannery effluent in low concentrations i.e. 25 %.

The effect of crude effluent collected from Mou Chong Tannery, Calcutta on *Wheat* have been studied. The seeds were treated with different concentrations (1, 2.5, 5, 10, 25 and 50%) were prepared by
diluting with distilled water. The seed germination increase up to 5% concentration and thereafter decrease with increase in concentration of the effluent. Shoot length of wheat was found maximum in 5% concentration (5.42 cm) and then decrease with increase in effluent concentration. Root growth was severely affected by treatment with effluent of more than 25% concentration. Effluent concentrations of 25% and above markedly reduced dry weight of shoot and root. Therefore, it suggested that tanneries effluents should never be directly dispersed to the field for irrigation purposes but could be used with advantage for certain crop after proper dilution with water. (Mishra and Bera, 1995).

Investigations was carried out to study the effect of tannery effluent Dindigul, Tamilnadu on soil properties and growth of finger Millet in pot culture. Amendments like gypsum, pressmud, FVM, rice husk ash, cement dust and composted coirpith were tested in combination with raw and diluted effluent. The effluent irrigation increased the bulk density, pH, EC and organic content of soil. Raw effluent reduced the N,P and K uptake but the diluted effluent increased it. Among the amendments, gypsum, pressmud and composted coirpith recorded higher uptake of N,P and K respectively. The grain and straw yields were very much reduced due to effluent irrigation. The diluted effluent irrigation along with composted coirpith recorded higher yield. (Kumaravelu et al, 2000).