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Phyto-toxic effects of industrial effluents on Agricultural crops-A Review

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ABSTRACT

Industrial manors are established to fulfill the demand of the growing population in the country. The opening of industries on one hand manufactures useful products but at the same time generates waste products in the form of solid, liquid or gas that leads to the establishment of hazards, pollution and losses of energy. Most of the solid wastes and effluents are discharged into the soil and nearby water bodies and thus ultimately pretense a serious risk to human and routine functioning of all ecosystems. The effluent discharging industries are distilleries, sugar mills, pulp and paper mills, detergents, chemical factories, textile dyeing industries, tanneries, electroplating, pharmaceuticals and dairy industries. Among the industrial effluents are characterized by high load of pollutants. The effluent was different colours with unpleasant odours and also characterized with high value of total dissolved solids, electrical conductivity, BOD, COD and acidic pH. Both physical and chemical parameters are higher than that of the permissible limits set for irrigation except some heavy metals. Consequently, it shows that the effluents are not suitable for irrigation purpose. The reviewed deals with the phyto toxic effects of industrial effluents to dilute or recycle it as irrigation propose, for its possible nutritive value. The literature relating the effects of industrial effluents on seed germination and seedling growth, phytotoxcity, vigor index and biochemical content of some agricultural crops.

Key words: Industrial effluents,Seed germination, Phytotoxicity and Biochemical content.

INTRODUCTION

Enormous growth of industrialization and agriculture has resulted in serious environmental pollution there has been a substantial increase in generation of industrial effluents, which is discharged either into open land or nearby aquatic ecosystems. This action promotes unreliable level of environmental pollution. The problem of environmental pollution on account of compulsory industrial growth is, due to the problem dumping of industrial waste as well, whether solid, liquid or gaseous. Polluted water, in addition to other effects, directly affects soil not only in industrial areas but also in agricultural fields and river beds, thereby creating by secondary resource of pollution. Various industries have been continuously adding lot of effluents containing high level of nutrients, heavy metals and hazardous substances to the cultivable soil. These effluents not only increase the nutrient level, but also overload tolerance limits and cause toxicity (Misra and Pandey, 2002; Sangeetha *et al.,* 2012).

The water pollution caused by some industrial effluent has seriously affected the growth and yield of agricultural crops. They were found to be reduced plant growth when the effluent was used for irrigation. Many attempts were made by a number of workers to assess the nature of effluents and its effects on some agricultural crops (Vidya and Usha, 2007; Uaboi-Egbenni *et al.,* 2009; Chauhan and Tiwari, 2010; Medhi *et al.,* 2011; Al-Dulaimi *et al.,* 2012; Rohit and Ponmurugan 2013; Parvathi *et al.,* 2014; David Noel and Rajan 2015; Maucieri *et al.,* 2016; Al-Isawi *et al.,* 2016; Srivastava, *et al.,* 2017; Ijaz *et al.,* 2018 Ain *et al.,* 2019 and Khilari *et al.,* 2020).

Industrial effluent on crop plants

The physico-chemical characteristics of tannery effluents from chrome farming, vegetable tanning, and composite effluent and also for irrigation water were reported by (Indira et al., 2012). The effluent is associated with unhygienic acid and high risk in environment. The effluent from tanneries possess heavy load of oxygen demanding organics as well as potentially toxic inorganic. The polluted water from industrial effluent changes the microenvironment of the soil. Effluents make use of negative and positive effects on the seed germination, plant growth, physiology, productivity and nutritional value of some agricultural plants (Saravanamoorthy and Ranjithakumari, 2007;Mohan and Nehrukumar 2007; Ayyasamy *et al.,* 2008; Mala and Saravanababu, 2009; Hussain *et al.,* 2010; Medhi *et al.,* 2011; Kumar and Chopra, 2012; Barbera, *et al.,* 2013; Mahmood *et al.,* 2013; Reddy *et al.,* 2014; Selvakumar *et al.* 2014; Mandakini and Khillare 2016; Jadhav Umesh *et al.,* 2016; Vaithiyanathan and Sundaramoorthy 2017; Kumar *et al.,* 2017; Mythili and Mujeera Fathima 2018; Hailu *et al.,* 2019).

The dyeing factory effluent can be used for irrigation purposes at proper dilution for getting higher yield (Amte and Mahaska 2012; Lav and Jyoti 2012; Kathirvel 2012; Hira *et al.,* 2017) and The untreated dyeing industry effluent (50%) to reduce the germination percentage, growth parameters like plumule and radicle length, relative toxicity, percentage of phytotoxicity and tolerance index of Lady's finger (David Noel and Rajan 2015).

The practice of the use of sugar mill effluent for irrigation of various agricultural crops was reported by several workers (Mohan and Nehrukumar 2007; Mala and Saravanababu, 2009; Chauhan and Tiwari, 2010; Vijayaragavan *et al.,* 2011; Saurabh and Shailja 2014; Vinod 2014; Srivastava, *et al.,* 2017). The results of pot culture experiment showed that at low concentrations of sugar mill effluent proved to better to the morphological parameters of *Tagetes erecta* and *Capsicum annuum* and thereafter the growth may reduce over control (Rajesh *et al.,* 2015; Suresh *et al.,* 2014).

Effluents with seed germination (%)

Seed germination may be defined as a series of events which take place when dry quiescent seeds imbibe water resulting in an increase in metabolic activity and the initiation of a seedling from the embryo. Pollutants interfere with enzyme and hormonal systems. A modification of biological and reproduction functions due to this interference lead to the decrease in viability and germination of the seed materials. So, the germination studies were identified to find the germination and growth response of some agricultural crops grown in various concentration of different industrial effluents.

Pandey *et al.* (2007) reported that the lower concentration of distillery effluent promoted the seed germination and seedling growth of wheat, pea and ladies finger. Dixit, (2003) studied the toxicity of raw and diluted distillery effluent on seed germination, growth of seedling and pigment content of sugar beet. For that the seeds kept moist in different dilutions (1, 5, 10, 20 and 30%) of effluent solution, with double distilled water, which served as the control. The concentrations greater than>5% of effluent were found to be toxic. Kalaiselvi *et al.* (2009) reported that soap factory effluent was toxic to seed germination and seedling growth of finger and pearl millet, but when the effluent was diluted to 2.5 to 5.0%

it improved the seed germination and seedling growth. Sharma, *et al* (2002) studied the effect of fertilizer factory effluents (0, 1, 2, 5, 10, 25, 50 and 100%) on seed germination of three tomato varieties. Increasing the concentration of effluent leads decreased germination percentage. Germination improved with 25% effluent concentration and 50 and 100% showed negative impact on germination.

The irrigational utilization of treated tannery effluent and its impact on growth behavior of some agricultural crop plants were reported. Among the three crops tested, *Phaseolus mungo* and *Vigna radiata* are found to be tolerant than *Abelmoschus esculentus* (Mariappan *et al.,* 2001). Dhevagi and Oblisami (2000) reported that the influence of paper mill effluent on paddy, soybean, maize, greengram, sunflower, castor and gingelly. Kannan (2001) reported certain crop plants tolerance to distillery effluent irrigation. Ramana *et al.* (2002b) reported the germination of some vegetable crops under distillery effluent concentrations. Sundaramoorthy *et al.* (2006) reported that the growth behaviour of greengram and groundnut seedlings for dye industry effluent. Among the crops tested, greengram was more sensitive than groundnut under dye industry effluent concentrations.

The morphological parameters like germination percentage, seedling growth and dry weight of ten varieties of groundnut were recorded. Among the varieties studied, the variety TMV 4 showed better performance under tannery effluent treatment. On the basis of germination behaviour, TMV 4 was reported to be tolerant and VRI 4 was considered to be susceptible when compared to the other varieties tested (Sundaramoorthy and Lakshmi, 2000). Muthusamy and Jayabalan (2001) screened two varieties of cotton under sago and sugar industry effluents.

Kaushik *et al.* (2005) reported the textile effluent on growth performance of wheat cultivars. Based on the tolerance to textile effluent, the wheat cultivars have been arranged in the following order: PBW 343 < PBW 373 < WH 4. Six varieties of cowpea were screened for tolerance to dye industry effluent. Among the six varieties, CO 4 was reported to be the tolerant variety than the other varieties tested (Sumathi *et al.,* 2006). Dhanam (2009) reported that the higher concentration of dairy effluent reduced the seed germination and seedling growth of paddy plants. Kumar (2006) reported that the increasing concentration of steel factory effluent induced a gradual decrease in germination percentage. The maximum seedling growth of *Phaseolus mungo* was recorded in 25% concentration of effluent and minimum growth was observed at 100% effluent concentration.

The effect of flyash pond effluent on seed germination of two varieties of legumes was reported (Das *et al.,* 2000). The higher concentrations of the different industrial effluents inhibited germination percentage in *Vigna radiata* (Augusthy and Sherin, 2001), *Cicer arietinum* L. (Raina *et al.,* 2005) Mustard plants (Bharagava *et al.,* 2008), maize (Vinod 2014), *Vigna unguiculata* (Chopra and Srivastava 2011), *Brassica rapa* (Iqbal *et al.,* 2013), Sorghum (Maucieri *et al.,* 2016).

The higher concentrations of dairy effluent reduced seed germination percentage (Prasanna Kumar *et al.,* 1997) and also the germination of Agricultural crops, Soyabeans (Rajendra *et al.,* 2010), Wheat (Lav and Jyoti 2012), *Glycine max* varieties (Sharma and Sharma 2013). Kaushik *et al.* (2005) reported the textile effluents contain organic and inorganic chemicals which have adverse effects on different crops. Rajasekarapandian *et al.* (2005) have reported the germination percentage of *Lablab purpureus* in various concentrations of textile mill effluent, the value increased at lower concentration (25%) and it decreased continuously up to higher concentration (100%). The seed germination percentage showed a significant reduction at higher concentrations of paper mill effluent in maize, sunflower, greengram, blackgram, soybean and groundnut (Dhevagi and Oblisami, 2000; Sundaramoorthy and Kunjuthapatham, 2000) and *Trigonella foenum-graecum* (Reddy and Borse, 2001). The same results were absorbed in sugar mill effluents with *Arachis hypogaea, Vigna radiate* (Siva Santhi and Sujapandian 2012), paper mill effluent with *Abelmoschus esculentus* (Kumar and Chopra 2012).

Mustard showed highly significant reduction in germination percentage even at lowest concentration of the sugar factory effluent mixture (Nath *et al.,* 2007). However, the increase in the seed germination percentage due to the lower concentrations of sugar mill effluent was reported in paddy (Thamizhiniyan *et al.,* 2000; Ramakrishnan *et al.,* 2001; Krishna and

Leelavathi, 2002). The seed germination of *Eluesine coracana* increased at lower concentrations of sugar mill effluent when compared with control (Lakshmi and Sundaramoorthy, 2000). The higher concentrations of sugar mill effluent reduced the seed germination percentage in soybean (Rathore *et al.,* 2000). Nath and Sharma (2002) reported that the lower concentration of sugar factory effluent increases the germination in greengram.

Nagajyoti *et al.* (2008) reported that percentage of groundnut seed germination at low concentration of power plant effluent. Kannan (2001) reported that the germination percentage decreased in *Pennisetum typhoides* and *Phaseolus aureus* with increase of distillery effluent concentration. Indira and Ravi mycin (2009) reported that the germination percentage of five varieties of blackgram, with increased tannery effluent concentrations reduced the seed germination percentage.

The main reason to reduced germination percentage of crop plants when irrigated industrial effluents, due to the mechanism involved in delayed germination might be associated with the reduced activity of several enzymes and In addition to suppression of germination and early seedling growth at higher concentrations of industrial effluents may also be attributed to acidic pH associated with higher quantity of dissolved solids, chlorides and heavy metal compounds present in the effluent, They have also shown that excess amount of TDS is responsible for retardation of germination and subsequent growth of young seedlings because they would disturb the osmotic relation of the seeds with water and thus reduce the amount of water absorbed (Nigam *et al.,* 2003). The lower concentration of industrial effluent increased the germination percentage of some agricultural crops. The increase in germination percentage over control at lower concentrations indicates the stimulation of physiologically inactive seeds of the lot by the treatment as suggested by Lenin and Thamizhiniyan (2009). It may also be due to the reduction in level of toxic metabolites by dilution and better utilization of nutrients present in the effluent.

Industrial effluents on seedling growth

Seedling growth, which starts when germination is completed, signals a shift in priorities to a rapid growth of root and shoot and establishment of a photosynthetic seedling. In the process, reserve foods are hydrolyzed and provide fuel for energy and building blocks for new macromolecules. As a consequence of these alterations, there will be reduced production and metabolic changes which ultimately results in growth retardation. Acute, instant tissue degeneration affects plant ability to produce and store food in seeds. Oxidative stress is the most critical impedance for quality of plant growth.

Thorat and Chaudhari (2004) reported the dilution of tannery effluent in up to 50% was found to have better influence on growth of *Cyamopsis tetragonaloba* (L.). On the other hand, 25% effluent concentration was observed to impart overall beneficial influence on plant growth. Raut *et al.* (2007) reported that the average shoot and root length of *Vigna radiata* was more for raw pharmaceutical effluent compared to treated effluent but not more than control. There was slight and gradual reduction in plumule and radicle length from lower to higher concentrations of sugar and distillery effluent in seedlings of different plant species (Nath *et al.,* 2007). Kannan and Upreti (2008) reported that pre-soaking of *Vigna radiata* L. seeds with untreated distillery effluent for 6 h significantly reduced the length of embryonic axis and the root in a concentration dependent behavior.

Augusthy and Sherin (2001) reported that the higher concentrations of dye factory effluents decreased the seedling growth of *Vigna radiata* L. Higher degree of toxicity was noticed at higher concentration of factory effluents. Kumawat *et al.* (2001) reported that the South India viscose factory effluent significantly inhibit the plumule development in *Arachis hypogaea*. Dhanam (2009) reported that the growth of paddy seedling decreased with an increased of dairy effluent concentration.

However, the undiluted sugar mill effluent treatment was deleterious to the overall growth of all seedlings. Kumar (2000a and b) reported that the effect of higher concentrations of sugar mill effluent harmfully affected the seedling growth of *Hordeum vulgare*. The seedling growth of *Cicer arietinum* increased at lower concentration of the sugar mill effluent and they decreased with the increase of effluent concentrations (Singh *et al.,* 2005).

A better seedling growth of *Lablab purpureus* was recorded at 25% concentration of textile mill effluent in comparison to control

(Rajasekarapandian *et al.,* 2005). Vijayakumari (2003) have reported the same results in *Glycine max* L. Raina *et al.* (2005) reported that the irrigation of the crop with different concentrations of paper mill effluent has inhibited the root length and shoot length of *Cicer arietinum* L. The increase in root length with the increase in the concentrations of the effluent was recorded. The maximum reduction in shoot length and root length were recorded in 100% concentration of untreated effluent. Mehta and Bharadwaj (2012) reported that chickpea seeds treated with industrial effluents showed maximum levels of electrical conductivity, total dissolved solids and chlorides, so the root and shoot length were reduced due to the effluent treatments. They concluded that *Cicer* was more sensitive towards effluent application as compared to *Vigna.*

The seedling growth of some crops increased at low concentrations of effluents. The review obtained from the seeds grown in dilute or low concentrations effluents was invariably better as compared to the control in all the cases. However, the growth of the seedlings was drastically inhibited in higher concentrations of the industrial effluents. It indicates that the lower concentrations of effluents had a marked growth promoting effect on overall growth of seedlings (Sundaramoorthy *et al.,* 2006). The seed might have required some nutrients for their normal metabolic activities. The effluents also contain plant nutrients and trace elements, which are essential for plant growth (Dhanam, 2009; Saravanan *et al.,* 2012; Patel *et al.,* 2013; Kohli and Malaviya 2013; Lenin *et al.,* 2014; Kumar *et al.,* 2014; Odiyi and Abiya 2016).

Vigour index and tolerance index

The untreated dyeing industry effluent(50%) to reduce the germination percentage, growth parameters like plumule and radicle length, relative toxicity, percentage of phytotoxicity and tolerance index of Lady's finger (David Noel and Rajan 2015). Kaushik *et al.* (2005) reported the lower concentrations of textile effluent did not show any inhibitory effect on vigour index values. Krishna and Leelavathi (2002) reported that the lower concentration of sugar factory effluent increased the vigour index values when compared to the higher concentration of effluent. Dhevagi and Oblisami (2000) reported the vigour index values of neem, pungam, tamarind seedlings and also for maize, groundnut, soybean, sunflower, castor and gingelly seedlings treated with paper mill effluent.

Kumawat *et al.* (2001) reported the changes in vigour index values of groundnut grown under dye industry effluent. Pandey *et al.* (2009) reported that the increase of vigour index of pea and wheat plant was 25% of distillery effluent concentration when compared with the control. Kannan and Upreti (2008) reported that the vigour index values were higher in control plants than in increasing concentrations of distillery effluent. Similarly, the values gradually decreased with the increase of effluent concentrations. The vigour index values of rice, blackgram and tomato (Rajannan and Oblisami, 1979), jowar, bajra and paddy (Somasekhar *et al.,* 1984) seedlings were significantly poor in undiluted paper mill effluent when compared to control. These values were found to be increased with the decrease in the concentrations of the effluent. The increase of vigour index was reported at 10 and 20% of dye industry effluent concentrations when compared with the control (Swaminathan and Vaidheeswaran, 1991). The vigour index values of *Pisum sativum, Oryza sativa, Vigna sinensis, Trigonella foenum-graecum* L. and *Vigna radiata* seedlings were recorded due to tannery effluent (Anjum, 1990). The tolerance index value decreased with increase in the industrial effluents concentration. Low concentration of industrial effluents increased the vigour index values and remained inversely correlated with the concentration level of the effluents. Hence the vigour index values decreased with the increase of industrial effluents concentration.

Morphological parameters

The increase in root and shoot length of groundnut were increased at lower concentration of power plant effluent (Nagajyoti, 2008). Ukaegbu and Odeigah (2009) reported that the reduced in the root length of *Allium cepa* in high concentration of sewage effluent. The plant height of both control plants and effluent treated plants were recorded. No growth was noticed in the plant sample treated with the undiluted effluent (Vidya and Usha, 2007). The root length and shoot length of 15 days old *Vigna radiata* was higher in lower concentrations of raw pharmaceutical effluent (Raut *et al.,* 2007).

Wins and Murugan (2010) studied the effect of textile mill effluent on germination and growth of *Vinga*

Mungo L. and found that under lower concentration of effluent the germination and seedling growth(shoot and root length) was higher than the control but in higher concentration there is a gradual decrease in both germination and length of seedlings. Best germination and seedling growth was observed in (25%) concentration so they concluded that textile effluents can be safely used for irrigation after proper treatment and dilution at (25%).

The growth parameters such as number of secondary root and shoot and root length of *Cicer arietinum* registered either equal or lower values in all the treatments. The increase in the growth of *Cicer arietinum* was recorded at lower concentrations than in higher concentrations (Raina *et al.,* 2005). The reduction in plant height of *Hordeum vulgare* was observed due to the influence of periodic watering with sugar mill effluent (Kumar, 2000b).

Yousaf *et al.,* (2010) conducted a pot experiment with 5 varieties of *Glycine max* (soybean) viz., PSC-62, NARC- 2, NARC-5, NARC-7 and William-82 and accomplished that seedling lengths of PSC-62, NARC-2 and NARC-5 were longer with application of paper and board industry effluent as compared to the textile industry effluent application. At the same time, the total leaf area of soybean decreased with the further increase of some industrial effluent concentrations (Poonkodi and Raghupathy, 2002). The total leaf area of groundnut and finger millet reduced markedly due to paper mill effluent irrigation (Padmanabhan, 1986; Himabindu and Jaganmohan Reddy, 2008). The increase the total leaf area *Pisum sativum* and *Triticum aestivum* were observed at lower concentration of distillery effluent (Pandey *et al.,* 2007). The shoot and root length and other morphological parameters were increased at low concentration of tannery effluent on *Zea mays* L (Hailu *et al.,* 2019), Tomato (Mandakini and Khillare 2016), some selected agricultural crops (Reddy2014), *Crotalaria juncea* (Mythili and Mujeera Fathima 2018).

Fresh and dry weights

Vidya and Usha (2007) stated that the dry weight of *Ocimum basilicum* was lower in plants treated with tannery effluent than in control. Distillery effluents significantly increased the dry matter production of groundnut (Ramana *et al.,* 2002a). The total dry matter production varied significantly among the treatments. The treated pots are having significantly greater shoot dry matter with increasing effluent stress (Sarathchandra *et al.,* 2006). However, the dry weight of paddy decreased in the presence of high concentrations of the effluent (Ramakrishnan *et al.,* 2001). The reduction in dry weight of *Hordeum vulgare* at high concentrations of carbonaceous sugar mill effluent has been reported (Kumar, 2000b). Das *et al.* (2000) reported that the flyash pond effluent reduced the fresh weight and dry weight of leguminous plants.

Singh *et al.* (2005) reported the response in dry weight of *Lemna minor* due to sugar waste at 1 to 7 days time interval. *Lemna minor* plant has maximum change in biomass at 25% of sugar factory leachate concentration. The change in biomass was nearly 17 at 100% concentration when compared to initial biomass. Pragasam and Kannabiran (2001); Misra and Pandey (2002) reported that 10% concentration of distillery effluent increased the fresh weight and dry weight of *Vigna mungo* and *Cicer arietinum* seedlings while the higher concentrations reduced these parameters. Lower concentrations of biodiesel spentwash showed promoting effect on seed germination, seedling growth, and dry matter production in paddy and French bean crops. The germination, seedling growth, dry matter production and chlorophyll content of both the species are significantly differed in different concentrations of biodiesel spentwash. The maximum promoting effect was recorded at (25%) in paddy and at (50%) in French bean. In general the germination (%) and seedling growth decreased with increase in concentration of the biodiesel spentwash (Mohana *et al.,* 2011). Mehta and Bhardwaj (2012). Studied at the lower concentration of industrial effluents to increasing the fresh and dry weight of *Vigna radiata* and *Cicer arietinu.* Gupta *et al.,* 2016 recorded at the paper mill effluent were analyzed at different dilutions viz. 5%, 10%, 20%, 40%, 30%, 50%, & control, at more than 10% of effluent concentration decline was reported in biomass, of black gram plant. Maucieri *et al.,* 2016 recorded at low level concentration of urban wastewater to increasing the total biomass on Sorghum plants.

Vaithiyanathan *et al.* (2014) studied on response of black gram (*vigna mungo* L.) to sugar mill effluent treatment. Germination studies parameters such as germination percentage, germination index, shoot length, root length, fresh and dry weight of seedlings were found to be increased up to 10% concentration of effluent. Percentage of vigour index, tolerance index and phytotoxicity were also calculated and found germination parameters of black gram decreased at higher concentration (25, 50, 75 and 100%) of sugar mill effluent. It may also due to the presence of excessive amount of the trace elements; the major elements as well as other pollutants could possibly decrease the seedling growth and subsequently the weight of the seedlings. The industrial effluents also contain plant nutrients and trace elements, which are essential for plant growth. The presence of optimum level of nutrients in the lower concentrations of industrial effluent might have increased the growth as well as the fresh and dry weight of seedlings (Rath *et al.,* 2011).

Biochemical Studies

Chlorophyll is an integral component of plant pigments and plays a vital role in the process of photosynthesis. Suresh *et al.,* (2014) reported that the higher concentrations of sugar mill effluent (above 50%) were found to affect plant growth and decreased Chlorophyll-a, Chlorophyll-b and total Chlorophyll and Protein contents, but diluted effluent (up to 50%) favored the plant growth and biochemical content of *Capsicum annuum*. The same treading was observed on paper mill effluent with black gram (Gupta *et al.,* 2016), sugar mill effluent with *Brassica nigra* L, (Bharagava *et al.,* 2008). Parmila and Sanjeev (2010) reported that the reduction in chlorophyll content of was *Triticum aestivum* cv. PBW-226 due to high level of sugarcane industrial effluent.

Dhanam (2009) reported that the increase in dairy effluent concentration the chlorophyll 'a', chlorophyll 'b', total chlorophyll and carotenoid contents reduced of paddy plants. Dhanam and Arulbalachandran (2009) reported that the increased the briquetting and carbonization plant effluent reduced the chlorophyll 'a', chlorophyll 'b', total chlorophyll and carotenoid contents of groundnut. Nagajyoti *et al.* (2008) reported that the chlorophyll 'a', chlorophyll 'b', total chlorophyll contents of groundnut increased at 25% concentration and decreased at higher concentration of power plant effluents.

The total chlorophyll contents were found to decrease from lower to higher concentration of treated combined effluent in wheat, barley, garden pea and blackgram (Nath *et al.,* 2007). Chlorophyll 'a', chlorophyll 'b' and carotenoid content of *Lablab purpureus* were gradually increased at 25% effluent concentration and declined at higher concentrations of textile mill effluent (Rajasekarapandian *et al.,* 2005). The decreases in chlorophyll content of different crops due to paper mill effluent (Baskar and Usharani, 2002).

Lakshmi and Sundaramoorthy (2001) studied the effect of tannery effluent on total chlorophyll content of selected pulses and cereal crops. Sinha *et al.* (2002) reported that the effect of tannery effluent on the chlorophyll content of *Alternanthera sesillis* showed a decrease in total chlorophyll and carotenoid in the leaves when compared to control plants. Baskaran *et al.* (2009a) reported that the best chlorophyll content was observed at 10% concentration of sugar mill effluent. Osuagwu *et al.,* (2013) detail studied that the crude oil pollution to decrease the chlorophyll a b and total chlorophyll content of *Dioscorea bulbifera* L.

Lal (2009) reported that the higher concentration of tannery effluent caused the reduction in total sugars and starch content of *Lemna minor* L. The total reducing sugars and total soluble sugar content of *Ocimum basilicum* was higher in control plants when compared to plants treated with tannery effluent (Vidya and Usha,2007).The carbohydrate content of groundnut and greengram seedlings increased under lower concentration and decreased under higher concentrations of dyeing factory effluent (Swaminathan and Vaidheeswaran, 1991).

The carbohydrate content of *Phaseolus mungo*, *Vigna radiata* and *Abelmoschus esculentus* were decreased with the increase of tannery effluent irrigation (Mariappan *et al.,* 2001). Raut *et al.* (2007) reported that the carbohydrate content of *Vigna radiata* was higher in control plants than the plants treated with higher concentrations of pharmaceutical effluent. The higher carbohydrate content of mungbean was higher in distillery effluent treatment when compared with control (Kannan and Upreti, 2008). Vidya and Usha (2007) reported that the starch content of *Ocimum basilicum* was higher in lower concentrations of tannery effluent when compared with control.

Baskaran *et al.* (2009b) details that the increase in protein content of greengram at lower concentration of sugar mill effluent. Raut *et al.* (2007) reported that the protein content of *Vigna* *radiata* was higher in pharmaceutical effluent treatment than in control plants. The distillery effluents showed a marked influence on protein content of groundnut (Ramana *et al.,* 2002a). A significant concentration dependent increase in protein contents of mungbean was reported by Kannan and Upreti (2008). The highest amount of protein content was recorded in blackgram at 10% concentrations tannery effluent. The lowest content was recorded at 75% concentration of sago factory effluent (Sivaraman and Thamizhiniyan, 2005). Sinha *et al*. (2002) states that the effects of tannery effluent on the protein content of *Alternanthera sesillis* leaves. It showed a decreasing trend in protein content at higher concentrations of effluent. Dhanam and Arulbalachandran (2009) reported that the lower concentration of briquetting and carbonization plant effluent increasing the protein content of groundnut plants.

It has been reported that the lower concentrations of tannery effluent increased the amino acid content while the higher concentrations decreased the amino acid content (Muthusamy and Jayabalan, 2001). The lower concentration of sugar mill effluent increased the amino acid content in *Hordeum vulgare* and *Eleusine coracana* (Lakshmi and Sundaramoorthy, 2000). The highest concentrations of sugar mill effluent reduced the amino acid content of ragi and paddy (Lakshmi and Sundaramoorthy, 2001). The same results showed that the higher concentrations of sugar mill effluent (above 40%) were found to affect plant growth and decreased chlorophyll-a, chlorophyll-b and total chlorophyll, caroteinoids, total sugar, amino acids and protein contents, but diluted sugar mill effluent (up to 40%) favored the plant growth and biochemical content of *Raphanus sativus* L. var. Pusha Chetki (Vijayaragavan *et al*., 2011).

Gupta *et al.,* (2016) recorded that the paper mill effluent were analyzed at different dilutions viz. 5%, 10%, 20%, 40%,30%, 50%, & control, at more than 10% of effluent concentration decline was reported in biomass, protein and chlorophyll content of black gram plant. The chlorophyll and carotenoid content in the leaves of the *Brassica juncea* was decreased when grown in diluted textile effluent, which was increased with increase in dilution. The decrease in pigment content was relatively less on 30th day and it increased on 90th day (Smrithi *et al.,* 2012). Sivaraman *et al*., (2013) studied impact of different concentration (control, 5, 10, 25, 50, 75 & 100 %) of sugar mill effluent on pigment content like chlorophyll 'a', chlorophyll 'b' and carotenoid were increased while decreased at higher (25- 100%) concentration changes of blackgram (*Vigna mungo*, var.co-5). Malook *et al.,* (2018) reported that the effect of wastewater (municipal sewage water (MSW) and sugar Mill effluent (SME) with different treatments the significant increase occurred in chlorophyll content (chl 'a', 'b' and carotenoids) at (25 %) than the control.

Jayakumar *et al*., (2014) recorded the impact of sugar mill effluent on photosynthetic pigment content and biochemical constituents variance of Cluster Bean (*Cyamopsis tetragonaloba* (L) Taub) and found all the photosynthetic pigment content, such as chlorophyll-a, chlorophyll-b, total chlorophyll, carotenoid content and biochemical constituents, such as, starch, amino acid, protein, reducing and non-reducing sugar content were increased at 10% sugar mill effluent concentration while decreased at higher (25, 50, 75 and 100 %.) concentrations of sugar mill effluent.

The chlorophyll is one of the important biochemical content which is used as a capacity of the plant growth. The pigments content of chlorophyll 'a', 'b', total chlorophyll and carotenoid contents of experimental crops showed increasing trends at lower concentrations of industrial effluents. Reduction of pigment contents induced by higher concentration of industrial effluents may be associated with high level of mineral ions. Some of the possible reasons for the decrease in pigment content may be the formation of enzyme such as chlorophyllase which is responsible for chlorophyll degradation, the increase in carotenoid content might due to enhanced influence of nitrogen and other organic elements present in the diluted industrial effluents (Anniepritima, 2002; Rath *et al.,* 2011). The sugar content showed decreased trend at higher concentrations of the industrial effluents. The effect may be due to transportation of most of the nitrogen absorbed by the plants. The another view for the decrease of sugar content at higher concentration of the effluents might be due to the excessive nutrient uptake that caused imbalance and eventually cut to depletion of carbohydrate reserve, the reduced sugar content in the plants treatment with higher concentrations of the effluents might be due to the utilization of the sugars in metabolic activity in order meet stress conditions. Decrease in free amino acids at high salinity decrease in amino acid at higher concentrations can be attributed to the inhibitory effect of the effluents on protease activity.

The protein content it might also be attributed to greater absorption and assimilation of potassium and nitrogen, which play a vital role in protein synthesis the higher concentration of industrial effluents, decreased the protein content of all crops. The reduction in the rate of nitrogen absorption and amount of nitrogen present in the plants, the total physiological activities were found to decrease resulting in gradual reduction in protein content of the plants treated with higher concentrations of the industrial effluents. The significant increase in the protein content, the plant might be due to the potassium and nitrate in their optimum quantity present in the lower concentration of the industrial effluents.

CONCLUSION

The review conclusion that the new technology raised man's standard and made life more comfortable but with increasing industrial development, safe disposal of industrial effluents has become a more ecological challenge. As the problem of effluents has now attained complex dimensions, it becomes essential either to find suitable ways for the safe disposal of these wastes or to suggest novel use, considering them as by-products. Finding a beneficial use for these industrial effluents could further benefit the economics of the industry. Among the industrial effluents (diluted and recycling methods) low concentration such as (5%, 10%, 20%and 25%) may act as a good liquid fertilizer in the all crop plants this kind of approach will prevent and reduce the water and soil pollution in all ecosystems.

Conflict of interest

The author declares that there is no conflict of interest.

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