THE EFFECT OF INDUSTRIAL EFFLUENTS ON CROP PLANTS: A REVIEW

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ABSTRACT:

Environmental pollution poses a great health hazard to human beings, animals and plants. Pollution has also adverse effects on the land, water and its living and nonliving components. Industrial effluents, containing organic and inorganic compounds have strong influence on the development of growth of crop plants. When the concentration of the pollutants in the effluents are low, the agriculture reuse of the treated effluents serve goals such as promoting sustainable agriculture and conservation of the scarce water resources. While, high concentration of the effluents causes many plant growth related problems. Industrial wastewater causes accumulation of heavy metals that are toxic in plants and thus affect the plant growth, seed germination, lower crop yield and human health. The adequate dilution of effluents treatment is therefore needed before the disposal and reuse of wastewaters for irrigation purposes.

Keywords: Pollution, Effluent, Heavy metals, Seed germination.
INTRODUCTION:

Industrialization plays a very important role for developing nations. But the disposal of wastewaters has become a global concern as the industries are associated with the generation of high volumes of effluents, limited space for land needed for the treatment including high cost of treatment technologies. In India, wastewaters from almost all the industries are being discharged untreated either on land or into the watercourses. Even at the places where some treatment facilities exist, these are not being operated properly. Resultantly these waste waters pollute the water resources and ultimately the agriculture land (Arjun et al. 2013). Effluents from industries which are normally considered as the main industrial pollutants containing organic and inorganic compounds are discharged into the nearby water bodies. It makes the water bodies toxic as various industries discharge the suspended solids, toxic chemicals, oils, greases, dyes, radioactive wastes and thermal pollutants. As a result the high level of pollutants mainly organic matter in river water causes an increase in BOD, COD, TDS TSS etc. It makes the water unsuitable for drinking, irrigation or for other uses. It has been found that the growth, yield and soil health get reduced when the farmers use the effluents for irrigation of the cultivated land (Nandy and Kaul. 1994). Heavy metals are being released from various sectors of industries like electroplating, fertilizer, leather, paint, pesticide, pharmaceuticals, pulp & paper, mining, oil refinery etc. The accumulation of these heavy metals in plants causes physiological and biochemical changes (Singh et al. 1981, Fisher et al. 1981). Out of the metals classified as toxic, lead(Pb), chromium(Cr), mercury(Hg), uranium(U), selenium(Se), zinc(Zn), arsenic (As), Cadmium(Cd), cobalt(Co), copper(Cu), Nickel(Ni) are emitted into environment in quantities that pose risks to human health (Johnson et al. 2007) and plant’s lives.

Effect of industrial effluents on crop plants:

Ramana et al. (2002) studied the effect of distillery effluent on seed germination in some vegetable crops. A laboratory experiment was conducted to study the effect of different concentrations (0, 5, 10, 15, 20, 25, 50, 75, and 100 %) of distillery effluent (raw spent wash) on seed germination %, speed of germination, peak value and germination value in some vegetable crops namely tomato, chilli, bottle gourd, cucumber and onion. The distillery effluent did not
show any inhibitory effect on seed germination at low concentration except in tomato. But in onion the germination was significantly higher (84%) at 10% concentration as against 63% in the control. Irrespective of the crop species, at higher concentration (75% and 100%), complete failure of the germination was observed. Among the five crops tomato recorded the lowest (29%) and onion the highest (48%) germination. The germination was inhibited in all five crops studied with concentrations exceeding 50%. In contrast the effluent at 10% concentration showed a positive effect on seed germination in onion.

Pandey et al. (2008) studied the pollution level in distillery effluent of lucknow based distillery which showed high acidity (pH~5.5), TS (3450mg/L), alkalinity(1500 mg/L), BOD (1649 ppm), Ni concentration (0.029 ppm) and its phytotoxic effect on seed germination and early growth of maize and rice. It inhibited germination and early seedling growth of maize and rice in relation to germination % of seeds, length of radical and plumule, fresh & dry weight of seedlings.

Siva and Suja. (2012) studied the effect of untreated sugar mill effluent at various concentrations (0, 25, 50, 75 and 100 %) on germination, speed of germination, peak value and germination value of two selected seeds i.e. peanut (Arachis hypogea) and green gram (Vigna radiata). As reported the germination percentage decreased with the increasing concentration of effluent in all the tested seeds, while the germination speed (%), peak value and germination value increased from control to 25 % & 50 % concentration and decreased from 50 % to 75% and 100 % effluent.

Narain et al. (2012) reported the impact of different concentrations (10%, 25%, 50%, 75% and 100%) of distillery effluent on seed germination (%), germination index, plumule and radicle length, fresh and dry weight of plumule and radicle, chlorophyll and carotenoid contents of Cicer arietinum. The germination percentage of seed, seedling growth and chlorophyll contents showed a gradual decline with the increase in the effluent concentration. The distillery effluent did not show any inhibitory effect on seed germination at low concentration (25%). Though the seeds germinated at 100% effluent concentration but they did not survive for longer periods. The better growth was recorded at 25% effluent concentration.

Doke et al. (2011) assessed physico-chemical parameters of treated waste water effluents from a sugar industry and studied the effect of various concentrations (0%, 20%, 40%, 60%, 80 % and
100%) of effluent on seed germination, germination speed (%), peak value and the germination value of *Vigna angularis* (Mung), *Vigna cylindrica* (Chavali) and *Sorghum cernum* (Jowar) seeds. The low effluent pH (4.35), high values of total dissolved solids (720 mg/L) and chemical oxygen demand (1330 mg/L) indicated the presence of high inorganic and organic contents with an acidic load. Germination percentage and germination value decreased with the increasing concentration of effluent in all the seeds tested.

Nath et al. (2007) reported the combinatorial effects of distillery and sugar factory effluents in crop plants. Mixed effluents were used in petridish culture experiments to investigate its effect on seed germination and seedling growth in wheat, garden pea, black gram and mustard. The seed germination and seedling growth significantly reduced with the increase in concentration of the effluent. The fresh matter was found significantly increased in barley (1.16 g per seedling in 25% dilution level of effluents in comparison to 0.93g in control), while other higher dilution levels reduced it. Wheat, garden pea, black gram, mustard invariably showed inhibition in fresh weight. Dry weight was found consistently reduced or unchanged in different treatments. Total chlorophyll contents in barley significantly increased for different treatments (2.351 and 2.721 mg/g fresh weight of tissue at 25, 50% dilution levels in comparison to 1.781 mg/g for control) while for other crops it got reduced all over the treatments. Amylase activity in wheat, garden pea, black gram and mustard reduced during all treatments. Only in barley its level was enhanced from 0.76 to 0.85, 0.96, 0.81 in 25, 50, 75% dilution levels of the effluent mixture respectively. Barley was found to be highly tolerant at 25 and 50% dilution levels for treatment with the combined effluent. It showed no change in germination %, while seedling growth increased for lower dilution levels of combined effluent as compared to control. The level of sensitivity was shown as follows, Barley>garden pea>wheat>black gram>mustard. Most detrimental effects were seen in mustard. The higher concentration of mixed effluent was not advisable for irrigation purposes. It could however be used for irrigation purposes after proper treatment and dilution (one part treated effluent and five parts of available irrigation water), as this dilution level was found growth and yield promotory.

Chum-xi et al. (2007) investigated the effect of Arsenic on seed germination and physiological activities of wheat seedlings. They reported that the lower concentration of Arsenic(0-1 mg/kg)
stimulated seed germination and the growth of root and shoot. All these factors, however
decreased gradually at higher concentrations (5-20 mg/kg).

Aydinalp and Marinova. (2009) reported the effect of heavy metals on seed germination and
plant growth of alfalfa plant (Medicago sativa). The effects of Cd, Cr, Cu, Ni, and Zn (0, 5, 10,
20, and 40 ppm) were studied. The results showed that the seed germination and plant growth
were significantly affected by Cd\(^{2+}\) and Cr\(^{6+}\) at 10 ppm, as well as by Cu\(^{2+}\) and Ni\(^{2+}\) at 20 ppm
and higher concentrations. The root and shoot growth were stimulated by 5 ppm of Cr\(^{6+}\), Cu\(^{2+}\),
Ni\(^{2+}\) and Zn\(^{2+}\). The study indicated that alfalfa plant might be grown directly in soils individually
contaminated with moderate amounts of Cd\(^{6+}\), Cr\(^{6+}\), & Cu\(^{2+}\).

Mami et al. (2011) investigated the influence of different concentration of heavy metals i.e Fe,
Pb, & Cu, on the seed germination and growth of two varieties of tomato. They found that heavy
metals in higher doses might cause metabolic disorders and growth inhibition for both the plant
species. Five doses (0, 0.001, 0.01, 0.1 and 1%) of Fe, Pb and Cu were investigated on two
tomato varieties namely barakat and local tomato. When compared with Fe and Pb, Cu had less
inhibitive effect on germination and growth indices. All the indices showed the decreasing order
as the doses of heavy metals were increased. However barkat variety showed better resistance.

Kaushik et al. (2005) reported the effect of different concentrations (0-100%) of textile effluent
on growth performance of wheat cultivars (WH-147, PBW-343 and PBX- 373). They found that
the textile effluents affected the growth of wheat crop. The textile effluent did not show any
inhibitory effect on seed germination at low concentration (6.25%). Based on the tolerance to
textile effluent the wheat cultivars were arranged as PBW-343< PBW-373< WH-147). It had
also been concluded that the effect of textile effluent was cultivar specific and due care should be
taken before using the textile effluent for irrigation purposes.

Raia and Khan. (2010) studied the effect of different concentration of industrial effluents
containing Fe, Cu, Zn, and Mn on seed germination and seedling growth of *Hordeum vulgare L.*
(Barley). It was observed that the accumulation of these pollutants occurred in the edible part of
plants and through food chain these pollutants reached the consumers and caused several harmful
effects.
Jadoon et al. (2013) studied the effect of irrigation using waste waters released from different industries on the vegetables grown in the vicinity of Faisalabad, Pakistan. The study showed that the waste water released from the textile, ghee and various industries contained heavy metals that accumulated in vegetables and had negative impacts on the vegetables grown. Heavy metals such as Ni, Cr, Zn, Cd, As and Pb resulted in inhibition of root growth, reduced plant growth and yield due to less uptake of water and nutrients.

Abraham et al. (2013) reported the effect of heavy metals (Cd, Pb, Cu) on seed germination of *Arachis hypogaeae L.* and found that Cd, Pb, and Cu significantly decreased seed germination of *Arachis hypogaeae L.* as compared to control. Increased concentration of Cd at 75 and 100 mg/l affected the groundnut seed germination extremely. While Lead treatment at 75 and 100 mg/l significantly reduced seed germination of groundnut as compared with control. Copper treatment at 100 mg/l also condensed seed germination of *Arachis hypogaeae L.* as compared with control.

Bhabindra Niroula. (2003) studied the Comparative effect of effluents from six major industries of Birat Nagar viz. Diesel Power House, Hetaunda Iron and Steel, Hulas Wire, Himalaya Soap and Chemicals, Leather Industry, Shah Udyog and Sub-Metropolitan Sewage, on the germination and seedling growth of rice and black gram. Effluent released from Himalaya Soap and Chemicals showed toxic lethal effect on both the test crops. On germination front, rice remained more sensitive and susceptible to the toxic effect of industrial effluents but black gram proved to be more tolerant. Effluent released from Diesel Power House and Shah Udyog remained toxic for seedling growth of black gram. While Leather Industry effluent showed toxic effect on the germination as well as seedling growth of rice.

Aswathi et al. (2013) studied the impact of different quantities of dyeing industry effluent on the growth, biochemical characteristics and yield of *Abelmoschus esculentus* (Bhindi). Germination percentage, root length, shoot length, the total fresh weight, total dry weight and vigour index of Bhindi were reported higher in sample T1 (200 mg of residue). The chlorophyll a, total chlorophyll, carotenoid contents and total soluble sugar of Bhindi were found higher in sample T3 (600 mg). The anthocyanin, free amino acids L- proline, leaf nitrate, peroxidase and catalase of Bhindi were observed higher in sample T6 (1200 mg ).The total soluble protein of Bhindi was reported higher in sample T2 ( 400mg). The nitrate reductase content of Bhindi was found higher
in sample T1. The length, weight and numbers of fruits of Bhindi were reported higher in sample T3 with 600 mg of dyeing industry effluent residue. From the results it had been inferred that the growth parameters and yield performance were higher in T1 (200 mg) and T3 (600 mg) respectively.

Wins et al. (2010) studied the effect of textile effluent on germination and growth of Vigna mungo L. (Black gram). At lower concentrations, the germination ratio and growth were relatively higher than the control, but with the increase in the effluent concentration these parameters were decreased. The best germination and seedling growth was observed at 25% concentration along with the growth promoting effect, significantly better than control. Beyond 25% effluent, root and shoot length decreased. The textile mill effluent was reported safe for irrigation purposes with proper treatment and dilution at 25%.

Garg. et al. (2008) evaluated the suitability of textile mill wastewater (treated and untreated) at different concentrations (0, 6.25, 12.5, 25, 50, 75, and 100%) for irrigation purposes. Effect of textile mill wastewater on germination, delay index, physiological growth parameters and plant pigments of two cultivars of sorghum was studied. The textile effluent did not show any inhibitory effect on seed germination at lower concentration (6.25%). The other reported plant parameters also followed the similar trend. Seeds germinated in 100% effluents did not survive for longer period. It was been concluded that the effect of the textile effluent was cultivar specific and due care should be taken before using the textile mill wastewater for irrigation purposes.

Rehman et al. (2009) reported that the textile effluent affected seed germination and early growth of some winter vegetable crops. The textile effluent reduced seed germination and early growth of all vegetables. Turnip was observed most susceptible while radish was tolerant to textile effluent treatments.

Sasikala et al. (2013) studied the impact of dye effluent at various concentrations (4%, 8%, 10%, 12% &16%) on seed germination of black gram for a period of fifteen days. She reported gradual decrease in the shoot and root length of the seedlings with the increase in the dye effluent concentrations.
Uaboi-Egbeni et al. (2009) investigated the impact of industrial effluents collected from five different industrial concerns of Lagos Nigeria, on *Abelmoschus esculentus* (Okra). During the study, they observed that these effluents induced detrimental effects on the flowering, fruiting, stem length, leaf width and leaf length of okra. Effluent from toiletries which had the highest concentration of oil (0.121) and the lowest pH (2.75) affected the time of flowering and fruiting of okra when compared with the control. The mean number and mean weight of fruits produced were also affected, although the extent varied with the nature of effluents. The effect was more pronounced in toiletries and plastic effluents where the mean values for fruit numbers was 3 and mean weight was of the order of 17.4 g. However, the mean weight for paint was reported higher than toiletries. Cross-sections of the experimental okra plants showed that the effluent affected the anatomical structures of the plant; the effect being more pronounced on okra grown on main drain. The anatomy of the control grown okra was not affected. The leaves of okra grown on toiletries’ effluent had a less mean leaf length than those grown on other effluents. The same trend was recorded for the mean leaf width. The stem length of okra grown on paint effluent had the least mean value and hence the most affected. The highest values for all parameters studied, was recorded for the control. There was a significant difference between the means of length of leaf, stem and leaf width and those of the control, signifying the effect which industrial effluents could have on the growth and productivity of plants.

Lenin et al. (2014) reported the effect of effluent of sago factory, salem, Tamil Nadu on the seed germination and seedling growth of eight varieties of *Sesamum indicum* L.(Gingelly) such as TMV 3, TMV 4, TMV 5, TMV 6, VRI 1, VRI 2, CO 1 and SVPR 1. At lower concentrations of sago factory effluent the germination percentage and growth were reported moderately higher than the control, but the gradual decrease in the germination of seedlings and seedling growth was reported with the increase in effluent concentration. The best germination of seedling growth, root length, shoot length, fresh weight and dry weight and tolerant variety were observed with 20% effluent concentration of sago factory effluent with growth promoting effect significantly better than control. Beyond 20% effluent concentration, root and shoot length were reportedly decreased.
Mehdi et al. (2008) studied the effect of pulp and paper mill effluents on seed germination and seedling growth of mustard, pea and rice seeds and observed that the lower concentration of effluent with 40%, 50% and 30% were suitable for germination and seedling growth of mustard, pea and rice respectively. The study had also revealed that the germination of seeds and seedling growth gradually declined with the increasing concentration of the effluent. However, rate of inhibition was reported different for different seeds. The study suggested that the effluent could be used safely for agricultural purpose, if used with proper dilution.

Begum et al. (2010) studied the effect of industrial effluents on the germination and seedling growth of three leafy vegetables. They collected effluents from natural gas fertilizer industry and investigated the effect of effluents on leafy vegetables. The study showed that the different concentration of the extract caused significant inhibitory effect on germination and root elongation but benefited the shoot elongation. Bioassays indicated that the effects were proportionate to the concentration of effluents and higher concentration showed stronger inhibitory effect.

**CONCLUSION:**

These study reveal that irrespective of the nature, the industrial effluents could be well utilized for agricultural crops on proper dilution, so as to reduce the lethality of the pollutants. Untreated/Undiluted industrial wastewaters create serious hazards to plants and eventually to human health. In water scarce countries, reuse of wastewaters for irrigation of various crops is very effective method to meet the demand of proper water and food supply. It may be further concluded that the higher concentration of released industrial effluent causes many types of inhibitory effects on the germination speed, peak value, germination value, plant growth, crop yield, accumulation of heavy metals in plants and poor human health. The proper treatment and dilution of the effluent is therefore needed before the disposal and usage of wastewater for irrigation purposes.

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