A REVIEW :

Impact of effluents from different industries on growth of plants

R.K. SHARMA

Asian Journal of Environmental Science, (June, 2011) Vol. 6 No. 1 : 96-104

Sharma, R.K. (2011). Impact of effluents from different industries on growth of plants. *Asian J. Environ. Sci.*, **6**(1) : 96-104.

Correspondence to :
R.K. SHARMA
Department of Botany,
G.G.M. Science College,
JAMMU (J&K)
INDIA
raj66a@gmail.com

Key words :
Plant growth,
Effluents,
Biomass

Received:
December, 2010
Accepted :
January, 2011

Due to explosion of population, change in attitude of life and development of high degree of scientific researches have yielded rapid growth of industrialization to fulfill the human needs in the last two decades of twentieth century. This phenomenon has generated laterally most serious problem concerned with human health and other welfare. Albeit water consumption in the industries has third rank, but many industries are generating effluent not only of high amount but they contain high level of organic components which act as suitable media for growth and multiplication of both virulent and avirulent micro-organisms. They are concerned in reducing oxygen level resulting adverse effect on aquatic biota. Pathogenic organisms present in the effluent may cause epidemics if surface water is contaminated with these effluents. Besides this, several industries are concerned with such type of products having high toxicity level in the effluent to existence of chemical or heavy metal salts. Even after proper treatment, effluent should not be discharged in an aquatic system or near by recreation point in order to control the outbreak of any kind of epidemic. But as in our conditions where maximum number of cities and industries do not possess adequate treatment plants, it is customary to discharge untreated raw sewage either in aquatic reservoir or a land surface. Since this raw sewage contains high amount of organic components and even treated effluent also possess certain amount of organic components, both may serve the need of nutritional requirement to the plants as a fertilizer. Therefore, in order to find out alternative suitable means of safer sewage disposal as well as minimizing the investment in agricultural cost, various studies have reported that waste discharged from industries is capable of inhibiting seed germination and seedling growth.

Chemical industry:

The effect of chemical industry effluent was studied by Swaminathan *et al.* (1989) on germination, plants growth, foliage and chlorophyll content, flowering and fruiting in case of *Hibiscus esculentus* L. They reported that in 5% effluent, germination, seedling development, plants growth, foliage and chlorophyll content increased where as flowering and fruiting days were observed to be reduced. Kumar *et al.* (1990) studied the effect of chemical industry effluent on germination, root-shoot length, dry matter accumulation, crop productivity in *Cyamopsis tetragonoloba* L. and it was observed that at 5%, 10% and 15% concentrations, there was increase in crop productivity, root and shoot length and dry matter accumulation. However, at higher concentrations of effluents (25%) growth retardation was observed and no seed germination was observed on cent per cent effluent.

Diary effluent:

The impact of dairy effluents on germination, seedling growth and pigment content in *Phaseolus aureus* were studied by Kumar *et al.* (1990). It was seen that with the increase in effluent concentration, there was decrease in seed germination, seedling growth and pigment content. Prasanna *et al.* (1997) also found similar results in case of *Phaseolus aureus* and *Phaseolus mungo*. Kulkarni and Dharwadkar (1998) studied the effect of dairy effluents on germination and biomass in wheat and it was seen that with increase in dilutions, rate of germination increased. Gautam and Bishnoi (1990) studied the effect of dairy effluents on germination

and growth behaviour in wheat. They found that seed germination was slow in pure effluent as compared to that of diluted and control.

Dying and textile effluent:

Dayama (1987) studied the impact of dyeing and textile effluent on germination, seedling growth and biomass in *Cicer arietinum*. He observed that high concentration of effluent were toxic while lower concentration were not toxic. Swaminathan and Vaidheeswaran (1991) also studied the effect of dyeing and textile effluent on germination and seeding development in case of *Arachis hypogaea*. They observed that diluted effluent increase the chlorophyll carbohydrates and protein contents of the seedling while pure effluent decreased the amount of physiological parameters. Siyatha *et al*. (1992) found that in *Vigna radiatus*, the germination energy index showed a gradual decline from 0.966 in control to 0.107 in 100% effluent treatment. Gupta and Nathawat (1992) found that in *Pisum sativum*, with increasing concentration of effluents there was decrease in root and shoot length and total biomass. Rao *et al*. (1993) observed that increased concentration of effluent affects the biological activity of soil. Vijayaregam and Lakshmanacharya (1994) found that in green gram, effluents at low concentrations enhanced the growth and dry weight of seedlings whereas higher concentrations carried deleterious effect on seedling growth. Aggarwal *et al.* (1994) studied the effect on tree species and soil properties. They observed that highly sodic textile effluents can be used for growing the tree species and its deleterious effect can be mitigated by the addition of gypsum in the soil.

Distillery effluent:

The increased concentration of distillery effluents causes gradual decrease in the germination percentage and seed germination index in *Cajanus cajan*. Naidu and Raman (1995) studied the effect of distillery effluents on *Arachis hypogaea* and reported that higher concentrations inhibited germination and seedling growth.

Similarly, Sharma *et al*. (2002) studied the effect of distillery effluent in *Beta vulgaris* and noticed that higher concentrations (>5%) of effluent were found to be toxic.

Fertilzer factory effluent:

The impact of fertilizer factory effluent was studied by Sahai (1998) in *Sesamum indicum* L. It was observed that upto 5% concentration, germination percentage and seed of germination increased. Upto 10% , length of radicle and plumule, seedling biomass and pigment content considerably increased. Sahai (1988) also observed that in *Oryza sativa* upto 5% concentration, positive results were observed in germination and seed of germination index. Sahai and Srivastava (1998) observed that in *Phaseolus vulgaris* and *Momorodica charantia*, with increase in effluent concentration, there was corresponding decrease in the parameters like germination, seedling growth and pigment content.

Sahai and Srivastava (1998) also studied the effect of fertilizer factory effluent on germination and seedling growth in *Brassica oleracea*. They noticed that with the increase in effluent concentrations, there was corresponding decrease in percentage germination and speed of germination index. Aggarwal and Gupta (1992) studied the effect of effluent in *Brassica campestris* and found that germination energy index showed a gradual decline from 0.966 in control to 0.107 in 100% effluent concentration and decreased pigment concentration with increased concentration of effluent.

Raza *et al.* (1987) studied the effect of industrial effluent on soil and natural vegetation and noticed that physiological parameters showed negative correlations with chlorides, sulphates and total salinity of soil. Soils become highly saline in nature. Rampal and Dorjey (2000) also studied the effect of industrial effluent in *Lens esculenta* and found that maximum growth occurred at 50% effluent concentration.

Iron foundary effluent:

The impact of iron foundry effluent was studied on the growth and yield in cereal and vegetable crops by Gupta and Maury (1987). They reported that only spinach showed a significant increase in the yield and growth. Rest of the crops showed reduction in growth and yield.

Paper effluent:

The effect of newsprint factory effluent on germination and seedling growth in *Vigna sinensis*, *Vicia foba*, *Cassia tora, Cassia occidentales* was studied by Jabeen and Abraham (1997). No adverse affects were observed.

Chaudhary *et al.* (1987) studied the effect of paper industry effluent on germination seedling growth and chlorophyll content in *Zea mays* L. It was noticed that highest overall growth was found upto 25% concentration of effluent but chlorophyll content was higher at 75%. Chaudhary *et al*. (1989) also studied the effect of effluent on germination, seedling growth and pigment content in *Hordeum vulgare*. They observed that best seedling growth occurred at 25% effluent concentration, gradual decrease in germination was observed above 25%

concentration. Das and Behara (1993) studied the impact of paper industry effluent on the physiological parameterss in *Helianthus annuus* and observed that with increased effluent concentration and time, decreasing trends were observed in physiological parameterss. Dutta and Boissya (1996) studied the effect of paper industry effluent on germination in *Oryza sativa* L and found that in effluent affected areas, germination percentage and yield were comparatively less. In *Eichhorria crassipis* and *Spirodela polyrhiza*, Srivastava (1988) found that with the corresponding increase in concentration of effluent and duration of exposure, chlorophyll a and biomass decreased.

The impact of pulp and paper industry effluent on germination and seedling growth in jowar and bajra was studied by Karande *et al.* (1993). It was observed that untreated effluents of paper mill when employed as such or diluted showed negligible adverse effect on growth and seedling germination. Sundari and Kanakarni (2001) studied the effect of the effluent on ground water resources, soil fertility, crop production in agricultural crops and found that untreated effluent was not adequate to safeguard the environment and showed negative correlation with the parameters. Reddy and Borse (2001) studied the effect of the effluent on germination and seedling growth in *Trigonella foenumgraceum* L. and found that there was increase in germination and seedling growth upto 25% concentration and above it, there was decline in parameters. Singh *et al.* (2002) studied the effect of effluent in *Triticum aestivum* L. and noticed that diluted effluent showed increase in chlorophyll content, plant height, shoot and root biomass, grain yield etc. whereas concentrated effluent showed a decrease in parameters.

Pharmaceutical industry effluent:

Patel *et al.* (1990) studied the effect of pharmaceutical industry effluent on germination, dry matter accumulation and yield in *Brassica juncia* L. They found that there was increase in parameters upto 40% of effluent concentration and with the further increase in concentration, there was decrease in given parameters.

Rubber factory:

The impact of effluent rubber factory effluent on germination and seedling growth in *Vigna radiatus* was studied by Augusthy and Mani (2001). They observed that at concentration >50%, seed germination percentage was retarded, upto 50% concentration seedling growth enhanced.

Rice mill effluent:

Padhan and Sahu (1999) studied the effect of rice mill effluent on germination percentage in cereal crops. They found that upto 50% concentration, germination percentage increased, >50% concentration inhibitory effect was observed.

Singh *et al.* (1999) studied the effect of sewage water on biomass, morphology and productivity in *Vicia faba* and found that plants irrigated with treated sewage showed increase in parameters than plants irrigated with raw sewage.

Sugar industry effluent:

The impact of sugar industry effluent on the activity of enzymes in *Cicer arietinum*. It was observed that the activity of peroxidase and catalase was stimulated by effluent while the activity of dehydrogenase was enhanced at lower doses of effluent. The activity of enzyme acid phosphatase was inhibited. Srivastava (1988) studied the effect of effluent on flora and fauna and found that sugar factory effluent caused deterioration of water quality and flora and fauna in local water bodies. Singh *et al*. (1992) studied the effect in tomato and *Meliodogyne incognita* and found that there was beneficial effect of effluent on plants and the root knot disease caused by *Meliodogyne* sp. was inhibited. The effect of sugar industry effluent was studied in *Abelmoschus esculentus* by Hari Om *et al*. (1994). It was observed that upto 25% concentration of effluent, the germination, seedling growth, and biomass showed an increase and above it inhibitory effect was observed.

Soap detergent effluent:

The effect of soap and detergents effluent was studied by Somashekhar and Siddaramaiah (1993) in *Pennisetum typhoides* and *Pisum sativum.* It was found that effluent at higher concentration delayed the effect of effluent on germination seedling growth in millet and pulse crop. It was seen that at lower concentration of effluent the promotory effects were observed.

Tannery industry effluent:

Kumar and Chauhan (1993) studied the effect of tannery industry effluent on root and shoot development in *Allium cepa* and found that the effluent was unsuitable for irrigation. Madhappan (1993) studied the effect of effluent on germination, morphological characters and pigment concentration in *Phaseolus aureus* and found that the effluent was unsuitable for irrigation. Arora and Chauhan (1996) also concluded that the effluent had inhibitory effect on the germination percentage and total

Table 1 : Impact of effluents released from various industries on various plants / soil parameters

Effluent source	Plant used	Parameter studied	Effluent conc. (%)	Results	Reference
Chemical industry effluent	*Hibiscus esculentus*. L. (Bhindi)	Germination, plant growth, foliage and chlorophyll content, flowering and fruiting	dna	In 5% effluent, germination capacity, seedling development, plant growth, foliage and chlorophyll content increased whereas flowering and fruiting days were observed to be reduced.	Swaminathan *et al*. (1989)
	Cyamopsis tetragonoloba var. PNB (Guar)	germination root and shoot length, dry matter accumulation, crop productivity	5, 10, 15, 25, 50, and 100	At 5%, 10% and 15% concentrations there was increase in crop productivity, root and shoot length and dry matter accumulation. In 25% concentration growth retardation was observed. In 100% no germination was observed.	Kumar *et al*. (1990)
Dairy effluents	*Phaseolus aureus* (green gram)	germination, seedling growth and pigment content	25, 50, 75 and 100	With the increase in effluent concentration, decrease in seed germination, seedling growth and pigment content.	Kumar *et al*. (1997)
	Phaseolus aureus (green gram) *Phaseolus mungo* (black gram)	Do	Do	Do	Prasanna *et al*. (1997)
	Triticum aestivum	Germination, Biomass,	do	With increase in dilution, rate of germination increased.	Kulkarni and Dhawedkar (1998)
	Triticum aestivum	Germination and growth behaviour	Do	Seed germination was slow in pure effluent (9 days) as compared to that of diluted(7 days) and control (4 days).	Gautam and Bishnoi (1990)
	Cicer arietinum (gram)	Nodulation and germination, seedling growth, biomass.	dna	High concentration of effluents were toxic, lower concentration were not toxic.	Dayama (1987)
	Arachis hypogaea (Groundnut)	Germination and seedling development.	dna	Diluted effluent increased the chlorophyll, carbohydrate and protein content of the seedlings, the pure effluent decreased the amount of physiological parameters.	Swaminathan and vaidheeswaran (1991)
	Vigna radiata	Germination and seedling development	0-100	Germination energy index showed a gradual decline from 0.966 in control to 0.167 in 100% effluent treatment. In seedling growth inhibitory effect was more on radicle than on hypocotyls.	Sujatha *et al*. (1992)
	Pisum sativum (pea)	Germination and seedling growth	varying concentration	With increasing concentration of effluents there was decrease in root and shoot length and total biomass.	Gupta and Nathawat (1992)
	Green gram	Growth and dry weight of seedlings	dna	Effluents at low concentrations enhanced the growth and dry weight of seedling where as higher concentration carried deleterious effect on seedling growth.	Vijayaregan and Lakshmanchärya (1994)
	Tree species and soil properties	Germination percentage	dna	highly sodic textile effluents can be used for growing the tree species and its deleterious effects can be mitigated by the addition of gypsum in the soil.	Aggarwal *et al*. (1994)

Contd.....1

Table 1 contd ……

	Pisum sativum var. Rachna	Germination percentage	Dna	Untreated effluents contained soda ash and dyes which were deleterious to the growth of plants. Treated effluents in lower concentration can be used for irrigation.	Kumar (1997)
Distillery effluents	*Cajanus cajan*	Germination percentage, seedling growth and pigment content	Dna	Increased concentration of effluent induced a gradual decrease in the germination percentage and seed of germination index.	Sahai and Srivastava (1986)
	Arachis hypogaea	Seedling growth, catalase activity, chlorophyll level and ACA contents	5, 15, 25, 35, 50, 75 and 100	At higher concentration, germination and seedling growth was inhibited.	Naidu and Raman (1995)
	Casuarina equestifolia	Shoot and root, biomass production, NPP, relative growth rate	20, 40, 60, 80 and 100	Upto 60% concentration effluents it was found that, there was decline in all parameters.	Banerjee *et al.* (1999)
	Beta vulgaris	Germination, early seedling growth and pigment content	do	Higher concentration (>5%) of effluents were found to be toxic.	Sharma *et al.* (2002)
	Phaseolus aureus	Growth, total chlorophyll and protein content	1, 5, 10, 15 and 20	1-10% concentration of effluents stimulated the parameters studied. 15-20% had toxic effects.	Chandra *et al.* (2004)
Fertilizer factory	*Sesamum indicum*	Seed germination, seedling growth and pigment content	Dna	Upto 5% concentration the value of germination percentage, seed germination index increased. Upto 10% length of radicle and plumule, seedling biomass and pigment content considerably increased.	Sahai and Srivastava (1988a)
	Oryza sativa (Jaya)	Germination and seed of germination index.	1, 2.5, 5, 10, 25, 50, 75, 100%	Upto 5% concentration, positive results were observed in the parameters.	Sahai (1988b)
	Phaseolus vulgaris	Germination, seedling growth, pigment content.	Do	With increase in effluent corresponding decrease in the parameters studied was observed.	Sahai and Srivastava (1988a)
	Momorodica charantia	Do	do	Do	Sahai and Srivastava (1988a)
	Brassica oleracea var. botrytis	Germination and seedling growth	1, 2.5, 5, 10, 25, 50, 75, 100%	With increase in effluents concentration, corresponding decrease in percentage germination and speed of germination index	Sahai and Srivastava (1988b)
	Brassica Oleracea var. capitata	Germination and seedling growth	do	With increase in effluents concentration, corresponding decrease in percentage germination and speed of germination index	Sahai and Srivastava (1988b)
	Brassica campestris	Seedling growth and biochemical characteristics.	0-100	Germination energy index showed a gradual decline from 0.966 in control to 0.107 in 100% effluent concentration. Decreased pigment concentration with increase concentration of effluent.	Aggarwal and Gupta (1992)
Industrial effluents	*Lens esculenta* (Masoor)	Percentage of seed germination, morphological features of plant.	25, 50, 70 and 100	Maximum growth was observed at 50%effluent concentration.	Rampal and Dorjey, (2000)
Iron foundary factory	Cereal and vegetable crops	Growth and yield	dna	Only spinach showed a significant increase in the yield and growth. Rest crops showed reduction in growth and yield.	Gupta and Maury, (1987)

Contd... Table 1

Contd……Table 1

Newsprint factory	*Vignia sinensis Vicia faba, Cassia tora, Cassia occidentais*	Germination, seedling growth	dna	No adverse effects were observed.	Jaboen and Abraham (1997)
Paper industry	*Zea mays* (maize)	Germination and seedling growth. Chlorophyll content	0, 5, 10, 25, 50, 75, 100%	Highest overall growth was found upto 25% concentration of effluents but chlorophyll content was higher at 75% concentration of effluent.	Chaudary *et al.* (1987)
	Hordeum vulgare	Germination seedling growth, pigment content	do	Best seedling growth occurred at 25% effluents concentration, gradual decrease in germination was observed above 25% concentration	Chaudary *et al.* (1989)
	Different tree species, plant soil nodulation, endomycorrhizal development	Plant growth	dna	Treated effluents showed positive effects on plant growth etc.	Ray and Barman (1988)
	Helianthus annuus L.	Physiological parameters	dna	With increased effluents concentration and time, decreasing trends were observed in given parameters.	Das and Behara (1993)
	Oryza sativa L. var. Masuri	Germination	100	In effluent affected areas, germination decreased.	Dutta and Boissya (1997)
	Arachis hypogaea	Germination percentage, seedling growth, dry weight.	10, 25, 50, 70, 100	With the increase in effluent concentration parameters decreased.	Sundramoorthy and Kunjithapatham (2000)
	Eichhornia crassipes and *Spirodela polyrhiza*	Chlorophyll a and Biomas	25, 50, 75, 100	With the corresponding increase in concentration of effluents and duration of exposure, given parameters decreased	Srivastava and Pandey (1999)
	Cicer arietinum	Germination and seedling growth	100	There was at various concentrations of effluents	Mall *et al.* (2004)
	Oryza sativa	Germination and seedling growth	dna	Effluent treated plants showed delayed and retarded decline in germination as compared to control.	Baruah and Das (1998)
Pulp and paper industry	Jowar and bajra	Germination and seedling growth	dna	Untreated effluents of paper mill when employed as it or diluted showed negligible adverse effect on growth and seedling germination.	Karande *et al.* (1993)
	Agricultural crops	Ground water resource, soil fertility, crop production.	dna	Untreated effluent was not adequate to safeguard the environment and showed negative correlation with the Parameter	Sundari and Kanakarani (2001)
	Trigonella foenumgraceum (Methi)	Germination and seedling growth.	5, 10, 25, 50, 75, 100	Increased germination and seedling growth upto 25% concentration and above it, there was decline in parameters.	Reddy and Borse (2001)
	Triticum aestivum (wheat) var. 2329	Growth, yield and nutrient quality	25, 50, 75 and 100	Diluted effluent showed increase in chlorophyll content, plant height, shoot and root biomass, grain yield etc. where as concentrated effluent showed a decrease in parameters.	Singh *et al.*(2002)

Contd…. Table 1

Contd….. Table 1

Pharmaceutical industry	*Brasssica juncea*	Germination, dry matter accumulation and yield	dna	Increase in parameters was found upto 40% of effluents concentration and with the increase in concentration there was decrease in given parameters	Patel *et al.* (1990)
Rice mill effluent	Cereal crops	Germination percentage	dna	Upto 50% concentration germination percentage increased, >50% concentration inhibitory effect was observed.	Padhan and Sahu (1999)
Sewage	*Sargassam johnstonii*	Vegetative growth	dna	1/10 to 1/1000 concentration of sewage in sea water increased the number of germlings.	Tiwari and Rao (1982)
	Vicia faba	Biomass, morphology and productivity	dna	Plants irrigated with treated sewage showed increase in parameters than plants irrigated with raw sewage	Singh *et al.* (1999)
	Vegetation and soil	Heavy metal pollution	dna	Plants irrigated with sewage water showed higher concentration of heavy, metals as compared to plants irrigated with tap water.	Bansal (1998)
	Eichhornia crassipes	Nutrient accumulation	dna	Plants studied act as biofilter and removed nutrients thus make it fit for irrigation purpose.	Mohan and Hosetti (1998)
Sugar industry	*Cicer arietinum*	Activity of enzymes	dna	Activity of peroxidase and catalase was stimulated by effluent while the activity of dehydrogenase was enhanced at lower doses of effluent. The activity of enzyme acid phosphatase was inhibited.	Muramkar and Chavan (1985)
	Tomato and *Meliodogyne incognita*	Plant growth and effect of *Meliodogyne* spp. on tomato	5, 15, 25, 35, 50, 75, 100%	Beneficial effect of effluent was observed on plant and also caused by *Meliodogyne* sp. root knot was inhibited.	Singh *et al.* (1992)
	Abelmoschus esculentus	Germination, seedling growth and biomass	do	Upto 25% concentration of effluent parameters showed an increase and above it inhibitory effect was observed.	Hari Om *et al.* (1994)
Soap and detergents	*Pennisetum typhoides* and *Pisum sativum*	Germination	dna	Effluent at higher concentration delayed and suppressed germination of seeds	Somashekhar and Siddaramaiah 1993
	Millet and pulse crops	Germination and seedling growth	dna	At lower concentration of effluent promotory effects on parameters were observed.	Kumar *et al.*, (1993)
Tannery industry	*Allium cepa*	Root and shoot development	dna	Effluent was unsuitable for irrigation	Kumar and Chauhan (1993)
	Phaseolus mungo and *Phaseolus aureus*	Germination, morphological characters and pigment concentration.	dna	Effluent was unsuitable for irrigation	Madhappan (1993)
	Hordeum vulgare	Germination percentage, total biomass.	dna	Inhibitory effect on the parameters Observed	Arora and Chauhan (1996)
	Titicum aestivum HD 2204	Germination percentage, total biomass.	dna	Inhibitory effect were observed.	Sharma and Mehrotra (1996)

biomass in *Hordeum vulgare*. Similarly, Sharma and Mehrotra (1993) also observed inhibitory effect of the effluent on germination percentage and total biomass in *Triticum aestivum* H.D. 2204.

For convenience, review of literature on the effect of different industrial effluents on various crops/soil parameters is given in the Table 1.

REFERENCES

Aggarwal, R.K.,Kumar, P., Harsh, L.N. and Sharma, B.M. (1994). ,Effect of effluent of textile industry on growth of tree species and soil properties in an arid environment. *Indian Forester,* **120**(1): 40-47.

APHA (1998). *Standard methods for the examination of water and waste water* (18th Edn.). American Public Health Association., Washington D.C.

Arora, R. and Chauhan, S.V.S. (1996). Effect of tannery effluent on seed germination and total biomass in some varieties of *Hordeum vulgare* L. *Acta Ecologica*, **18**(2):112-115.

Augusthy, P.O. and Mani, A.S. (2001). Effect of rubber factory factory effluent on seed germination and seedling growth of *Vigna radiatus* L. *J. Environ. Biol.*, **22**(2): 133-139.

Banerjee, A.C., Bajwa, I. and Behal, K.K. (1999). Effect of distillery effluents on growth of *Casuarina euisetifolia*. *J. Ind. Pollution Control*, **20**(2):199-204.

Baruah, B.K. and Das, M. (1998). Study on the impact of paper mill effluent on germination behaviour and seedling growth of crop plants. *Polution Res.*, **17**(1): 65-68.

Chandra, R., Kumar, K. and Singh, J. (2004). Impact of anaerobically treated and untreated (raw) distillery effluent irrigation on soil microflora, growth, total chlorophyll and protein contents of *Phaseolus aureus* L. *J. Envirn. Biol.*, **25**(4):381-385.

Chaudary, S. K., A.N., Jha and Srivastava, D. K. (1987). Effect of seedling growth of maize: *Environ. Ecol.,* **5**(2):285-287.

Chaudary, S. K., Jha, A.N. and Srivastava, D. K. (1989). Impact of paper mill effluent on seed germination, seedling growth and pigment content of *Hordeum vulgare*. *Environ. Ecol.*, **7**(1):193-195.

Dayama,O.P. (1962). Germination value, an index combining speed and completeness of pine seed germination. *Forest Sci.,* **8**:386-396.

Dutta, S.K. and Boissya, C.L. (1996). Effect of paper effluent on germination of rice seed (*Oryza sativa* L. var. Masuri) and growth behaviour of its seedlings. *J. Ind. Pollution Control*, **12**(2):123-128.

Gautam, D.D. and Bishnoi, S. (1990). Effect of dairy effluent on wheat (*Triticum aestivum*). *J. Ecobiol.*, **4**(2):111-115.

Gupta, R.K. and Maury, A.N. (1987). Performance of certain cereal and vegetable crops irrigated with iron foundary effluent. *J. Ind. Pollution Control*, **4**(2):49-56.

Jabeen, C. and Abraham, S. (1997). Effect of Hindustan News Print factory effluent on seed germination seedling characters in some leguminous plants. *J. Environ. Biol.,* **18**(4):379-382**.**

Karande, S.M., Ghanvat, N.A. and Gunjal, P.S. (1993). Influence of untreated effluents at pravara pulp and paper mill and Pravara distillery on seed germination and early seeding growth in jowar and bajra. *Proc. Acad. Environ. Biol.*, **2**(1):5-10.

Kulkarni, P.B. and Dharwadker, S.M. (1998). Effect of daily effluent on biochemical parameters of wheat seeds and fish. *Proc. Acad. Environ. Biol.,* **7**(1):57-60.

Kumar, S. and Chauhan, S.V.S. (1993) Effect of tannery effluent on root and shoot development in *Allium Cepa*. *Acta Ecologica*, **15**(1):24-28.

Kumar, Milind (1997). Studies on effect of textile mill effluent on *Pisum sativum*. M.Phil., Thesis, University of Jammu, Jammu, J&K (India).

Kumar, Ramesh, K.T., B.Patel and Pushpalata (1990). Effect of chemical factory effluent on germination and growth of guar (*Cyamposis tetragonoloba* L. Taub.var. PNB. *Adv. Plants Sci.,* **3**(11): 34-42.

Lakshmi, S. (1998). Toxicity effect of tannery effluent on seed germination, seedling growth of paddy (*Oryza sativa* L.) and groundnut (*Arachis hypogaea* L). M. Phill Thesis, Annamalai University, T.N. (India).

Madhappan, K. (1993). Impact of tannery effluent on seed germination, morphological character and pigment concentration of *Phaseolus mungo* L. and *Phaseolus aureus* L. *Pollution Res.,* **12**(3):159-163.

Mall, Manisha, Singh, P. and Singh, J. (2004). Physico-chemical characterization of paper mill leachate and its impact on seeding growth of *Cicer arietinum*. *J. Ind. Pollution Control*, **20**(1): 59-65.

Murumkar, C.V. and Chavan, P.D. (1985). Influence of water pollution on germination of gram (*Cicer arietinum* L.) Current Pollution Research India, (Environmental Publications, Karad), pp. 235-238.

Naidu, M.K. and Raman, G.K. (1995). Distillery waste impact of *Arachis hypogea* L. *J. Environ. Biol.,* **16**(2):181-186.

Padhan, A. and Sahu, K.S. (1999). Effect of rice mill effluent on seed germination of some cereal crops. *Pollution Research*, **18**(2) :187-189.

Prasanna, K.P.G., Pandit, B.R. and Kumar, M.R.K. (1997). Effect of dairy effluent on seed germination,seedling growth and pigment content of green gram (*Phaseolus aureus* L.) and black gram (*Phaseolus mungo*). *Adv. Plants Sci.*, **10**(1):129-136.

Rampal,R.K. and P. Dorjey (2000). Effect of foam industry effluent on *Lens esculenta Moench* var. Malika. *Indian J. Environ. Protection.*, **21**(1):14-17.

Rao, A.V., Jain, B.L. and Gupta, I.C. (1993). Impact of textile industrial effluents on agricultural land. *J. Environ. Health*, **35**(2):132-138.

Raza, S.H., Nirmala, B., Murthy, M.S.R. and Fatima, N. (1987). Effect of industrial effluent on soil and natural vegetation of Nacharum Industrial Complex. *Acta Ecologica*, **9**(1):28-33.

Reddy, P.G. and Borse, R.D. (2001). Effect of pulp and paper mill effluent on seed germination and seed growth of *Trigonella foenumgramceum* L. (Methi). *J. Ind. Pollution Control*, **17**(1):165-169.

Sahai, R. and Neelam (1988b). Effect of fertilizer factory effluent on *Oryza sativa* L. var. Jaya. *Geobios*, **15**(283):118-120.

Sahai, R. and Srivastava, Chetna (1988a). Effect of fertilize factory waste on seed germination, seedling growth and pigment content of plants. *J. Indian Botanical Soc.,* **67**(384): 309-311.

Sahai, R. and Srivastava, Chetna (1986c). Effect of distillery waste on the seed germination and seedling growth and pigment content of *Cajanus cajan. J. Indian Botanical Soc.,* **65**(2):208-211.

Sahai, R. and Srivastava, Chetna (1988b). Effect of fertilizer factory waste seed germination and seedling growth of two vegetable crop plants *Brassica oleracea* L.var. botrytis and *Brassica oleracea* L. var. capitata. *J. Environ. Biol.,* **9**(4): 381-385.

Sharma, D.C. and Mehrotra, S.C. (1993). Chromium toxicity effect on wheat (*Triticum aestivum* L. cv. HD 2204). *Indian J. Environ. Health*, **35**(4): 330-332.

Singh, Anoop, Aggarwal, S.B., Rai, J.P.N. and Singh, P. (2002). Assessment of pulp and paper mill effluent on growth, yield and nutrient quality of wheat (*Triticum aestivum* L.). *J. Environ. Biol.*, **23**(3):283-288.

Singh, M.K., Singh, S.K., Mait, S.K. and Sen, P.K. (1999). Effect of raw and treated sewage on morphology, growth and productivity of *Vicia faba*. *Indian Environ. Protection*, **19**(10):753-757.

Singh, Anoop Aggarwal, S.B., Rai, J.P.N. and Singh, Pratibha (2002). Assessment of the pulp and paper mill effluent on growth, yield and nutrient quality of wheat (*Triticum aestivum* L.). *J. Environ. Biol.,* **23** (3): 283-288.

Singh, S.K., Khan, A.A. and Singh, K. (1992). Effect of sugar factory effluent on *Meloidogyne incognita* and plants growth of tomato. *Current Nematology*, **3**(1):19-20.

Somashekar, R.K. and Siddaramaiah (1993). Effect of soap and detergent factory effluent on soil and crop plants. *J. Indian Pollution Control*, **9**(2):77-84.

Somashekar, R.K., Gowda, M.T.G., Shettigar, S.L.N. and Srinath, K.P. (1984). Effect of industrial effluents on crop plants. *Industrial J. Environ. Health*, **26**(2):136-146.

Srivastava, A.K. (1988). Studies on sugar factory effluent and their effects on plants distribution. *Adv. Plants Science*. **1**(2):290-294.

Srivastava, P.K. and Pandey, G.C. (1990). Paper mill effluent induced toxicity in *Eichhornia crassipes* and *Spirodela polyrhiza*. *J. Environ. Biol.*, **20**(4): 317-320.

Sujatha, R., Kishanswami, K. and Subburum, V. (1992). Toxicity of selected dyes to *Vigna radiata* (L.). Wilc. *Geobios*, **19**(2):81-87.

Sundari, S. and Kanakarani, P. (2001). Effect of pulp unit effluent on agriculture. *J. Indian Pollution Control*, **17**(1):83-97.

Swaminathan, K. and Vaidheeswaran (1991). Effect of dyeing factory effluent on seed germination and seedling development of ground nut (*Arachis hypogaea*). *J. Environ. Biol.,* **12**(4):353-358.

Swaminathan, K.K. Manomaniand and Pongaliappan (1989). Recycling of alcohol and chemical industry effluent for its fertilizer value. In: *Trends in Environmental pollution and pesticide toxicology* (Chief Shashi Kant). Jagminar Book Agency, New Delhi. pp. 287-294.

Vijayaregan, P. and Lakshamanacharya, A.S. (1993). Effect of textile mill effluent on growth and development of green gram seedling. *Adv. Plants Sci.,* **6**(2): 359-365.