CONCLUSIONS AND DISCUSSION

Chapter-7

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The present investigation was undertaken to study the impact of Lead on seed germination and seedling growth. Based on the dose response curve obtained during the studies, one promotory and an inhibitory concentration of lead acetate was selected. Effects of these two concentrations of lead acetate on growth and development of some rainy seasion crop plants were also under taken.

1. Effect of various concentrations of Pb on seed germination.

2. Effect of Pb on seedling growth of test plants.

3. Seedling growth under the influence of various concentrations of lead amended soil.

4. Effect of municipal and petrochemical polluted water on seed germination.

5. Seedling growth under the influence of above polluted water treatment.

6. Effect of Pb on Root nodulation.

7. Impact of Pb on branching and tillering pattern of test plants.

The investigations carried out in this laboratory on the above indicated lines have given the following informations.

1. Pretreatment as well as post radicle emergence treatment with various concentrations of lead acetate (1×10^{-5} M, 2.5×10^{-5} M, 5×10^{-5} M, 1×10^{-4} M, $2,5\times10^{-4}$ M, 1×10^{-3} M, 2.5×10^{-3} Pb) are inhibitory to seed germination and seedling growth, with maximum inhibition at the highest concentration treatment. The concentration of lead acetate higher than above stated concentrations was lethal to seed germination marked cultivar specific and organ specific differences often exist.

2. Phasic pretreatment studies indicate that seedling growth is inhibited in all phases (Regimes) of phasic pretreatment, however, maximum inhibition is reported in mid phase treatment sets.

3. Seedling growth of test plants grown on lead amended soil (50 mg/Kg) is inhibited. However species specific, cultivar specific and orgen specific differences are observed to exist. Lower most concentration of lead amended soil(5mg/Kg) is promotory to seedling growth of test plants.

4. Water polluted by petrochemicals (Automobile service station) and municipal sewage showes differntial toxicity to

seedling growth of test plants. i.e. Lethal for Maize, inhibitory for Rice and promotory for Vigna. The municipal sewage treatment has promotory effect on seedling of test plants.

Although irrigation by municipal sewage water enhances growth and yield, however, this practice constitues of deceptive type of pollution. This is because, the crop growth is enhaced by this practice and leads satistaction to the farmers and consumers. There occurs accumulation of toxic heavy metals in edible parts of plants and through the food Chain these toxic heavy metals reach in human body and cause health hazard.

1. Our observations, on the effects of lead on seed germination and seedling growth of plants, reveal that lead starts to exist its effects from very begining of plants life. To study the pollution effects of lead on Ecophysiological studies of some selected cultivars of crop plants, we have used lead acetate and it has been shown by us that halides of lead have nearly similar effects.

2. Our findings on seedling growth indicate that the lead acetate is inhibitory to seedling growth, with maximum inhibition at the highest concentration. These observations are comparable with the earlier ones.

Singh, K.R. et al. (1994) reported that lead is highly toxic to seedling growth at 5.8 ppm or more depessing growth and even killing (lethal) the seedling of *Triticum aestivum* cv. SD-2285 Farooqi, S. et al. (1994), observed that 10 mgl 1 Pb depressed seedling growth and caused injury symptoms i.e. marginal and interveinal chlorosis alteration in pigmentation, abnormally small leaves in *Hordeum vulgare* cv. K-12.

Tripathi, D. N. (1993), Observed the heavy metal contents of aromatic crops treated with industrial effluents and sewage sludge. It was reported that Higher amounts of Heavy metals (Pb, Cd, and Cr) were found in the roots of aromatic crops than the other parts of the plant. For this it has been suggested that aromatic crops palmarosa (Cympopogon martinii) and lemongrass (Cymbopogon flexuosus) can be successflully grown under polluted soil water environment.

Observations on growth studies made by Beg et al. (1994), indicate that heavy metals (Hg Pb and Cd) cause toxic effects on seedling growth of *Hordeum vulgare*. In the case of Hg and Pb the lowest dose i.e. 20 ppm. is strong enough to affect the rate of germination and vegetative growth. While in case of Cd, the concentration of Cd upto 40 ppm. promote the rate of germination and seedling growth. The concentration above 40 ppm. Showed toxic effects. These three metals i.e. Hg, Pb, and Cd retarded the vegetative growth and germination percentage in Barley in decreaseing toxicity order Hg > Pb > Cd.

Our observation on inhibition of seedling growth by Pb, are comparable with earlier observations on other heavy metals also, Cd (Jain 1980), Hg (Sharma 1982), Zn (Bhargava, 1982), Ni (Singh, Aruna, 1993, Singh, Suman 1993, Farooqi, S. 1994, Singh, D. 1993) Cr (Singh, Srivastava and Pundir 1994). Cultivar specific and organ specific differences existing in our observations are comparable to findings of Bagchi (1976) with Cd toxicity to rice cultivars and Hg to Pisum stivum by Sharma (1983), Nickel to Triticum aestivum (1996) and to Coriandrum sativum (1993) by Singh Suman and Aruna respectively. The investigation described above has many unique features with regard to experimental design and findings. Thus the impact of lead on seedling growth was studied not only by pretreatment method but also by giving post radicle emergence treatment. These methods were adopted to compare the growth effects caused by above stated Pb treatments.

Beside the pretreatment and post - radical emergence treatment, phasic pretreatments of Pb were also given to the seeds of test plant. For this whole imbibition period was divided into six equal phases and Pb treatment was given in each phase seperately.

Phasic pretreatment studies indicate that Pb uptake by seeds of test plants from the solution takes place in all the phases (Regimes) but it is maximum in the mid phase. This reasion is, therefore, responsible for maximum inhibition of seedling growth in mid phase (Regime-4) treated sets. This interesting finding requires further indepth investigations. Our observations on phasic pretreatment on seedling growth are comparable with the earlier observations with other heavy metals also viz. Ni (Singh, D. (1992), Singh Suman (1994), Singh Aruna (1996).

Thus the present work, earlier work from out and other laboratories have clearly shown the hazardous nature of Lead, although very low concentrations of this heavy metal is apparantly not harmful. Control of Lead pollution seems to check all the sources of Pb pollution. Lead which has already been discharged into the environment will continue to reach in our body through food chain and may attain lethal concentration.

As regard control of this metal it is suggested that there should by check for further addition of this metal and recovery of Pb from the ecosystem. The possible approaches of control are:

i) Check be installed at the source in form of effluent emission filters.

ii) Polluted places may be cleaned by Bioaccumulation.

iii)Lead may be recycled by recovering them from the ash of such bioacumulators.

4. Studies on irrigation with water polluted by municipal sewage indicated that this type of irrigation leads to enhance growth of seedlings of test plants. Enhancement of seedling growth is propably due to higher amounts of nutri- ents present in polluted water which has been used for germination and seedling growth studies. Similar results on growth and yield by irrigation with polluted water contain- ing sewage and sludge were also obtained by other workers Linnman et al. 1973; Anderson and Nilsson; Valdares et al. 1983; Singh Suman 1992, Priti Singh et al. 1994; Tripathi 1993; and Singh Meenakshi et al. 1996.

Linnman et al. (1973), have reported that application of sewage sludge to soil, increased the yield of wheat accompanied by incrcase in Cd content in plants including grains. Similarly, Andersson and Nilsson (1976), also re- ported that application of sewage and sludge to soil lead to an enhanced growth accompanied by higher levels of Mn, Zn, Co, Cr, Pb, Cd and Hg in plant parts. Growth promotion and accumulation of heaving metals by polluted water irrigation has been also reported by Banerji and Kumar (1979) in *Daucus Carota*, *Solanum tuberosum* and *Zea mays*. Valdares et al. (1983) treated soil with sewage sludge rich in heavy metals seperately. It was obsrved that sewage sludge poor in heavy metals enhanced the growth and yield on the other hand, sewage sludge rich in heavy metals inhibited the growth and yield of *Beta vulgaris*. Further, this type of heavy metals in plant parts. Singh, Suman *et al.* (1992) studied the impact of municipal sewage on germination, seedling growth and yield of *Triticum aestivum* cv. RR-21 and reported that this treatment was promotory for above physiological aspects of test plant.

Studies on the effects of polluted water on seedling growth of *Phaseolus mungo* cv. T-9, made by Singh, Priti and D. Singh (1994) indicate that there was inhibition of growth of seedling parts which was parallel or lesser transfer of dry matter to seedling parts from the residual cotyledon pair grown in polluted water as compared to the grown in clean water. Tripathi, D.N. (1993), treated aromatic crops (*Cymbopogon martinii* and *Cymbopogon feoxuosus*) with indistrial effluents and sewage sludge and reported that yield of aromatic oil was increased which was accompanied by accumulation of heavy metals in the organs of test plant.

Singh, Meenakshi and D. Singh (1996) performed experiments to study the impact of polluted water (containing petrochemical and domestic sewage) on germination and seedling growth of *Triticum aestivum* cv. SD-2285, *Cicer arietinum* cv. G-130 and *Cajanus cajan* cv. Bahar and reported that this treatment showed differential response by the test plants. The polluted water used was lethal, inhibitory and promotory to *Triticum aestivum*, *cicer aeritinum* and *Cajanus Cajan* respectively.

It is well established that polluted water irrigation causes the accumulation of heavy metals in plant organs and also in edible parts of plants. Therefore this practice of irrigation with polluted water lead to deceptive pollution problem, encouraged by the better growth and yield of plants, in such polluted soil, the formers practice irrigation with polluted water creating unknowingly in long run, the biological hazard of heavy metal toxicity for the consumers.

Thus the toxic heavy metals thus accumulated in edible part of plants reach into humnan body through food chain and causse several diseases to consumers. The ions of heavy metals beyond two permissible level in human body create health hazard by blocking or inhibiting catalytic action of several enzymes.

Our observation on promotion of seedling growth by polluted water irrigation is comparable with the earlier obsrevations on wheat (Singh *et al.* 1992) on potato, carrot and maize (Banerji *et al.* 1979), however, it varies with the investigations on *Phaseolus mungo* T-9 (Singh Rita *et al.*, 1995) and on *Cicer arietinum* G-130. (Singh Meenakchi 1996).

Growth of test plants grown in Pb amended soil (50mg Pb/kg soil) showed over all inhibition of root, shoot, leaf and nodule number, length and fresh weight. These findings are in agreement with those of Vergnano and Hunter (1953), Singh, A. and D. Singh 1996, Singh S., D. Singh (1996), Tsui (1955), Tsui *et al*. (1959), Kashin (1968), Roth *et al*. (1971), Vesper *et al*. (1978), AustenField (1978b), Heale and Ormrod (1982) who reported similar growth effect by nickel treatment. Arnon (1937) reported that $NiCl_2$, $NiSO_4$ and $Ni(NO_3)_2$ inhibits growth of Barley. Similarly Hunter and Vergnano (1953) investigated that spray of 5 ppm Ni depresses the growth of oat, Tsui (1955) reported that pre-treatment of seeds with Ni at a concentration of 250 ppm inhibits the growth of wheat. Kashin (1968), investigated that high concentration of nickel in culture solution inhibits the growth of barley and Oat. Roth *et al*. (1971), investigated inhibition of grwoth is Soyabeans by Ni treatment. Kauser (1978) reported inhibitory effect of nickel on growth of white beans. Similarly Austenfield (1979a), reported that growth the growth of *Phaseolus vulgaries* cv. Saxa is inhibited by increasing the concentration of Nickel sulphate. Inhibition of grcwth by lead treatment has been reported on Barley (Beg *et al*. 1994) on *Triticum* (Singh, K.R. *et al*. 1994). It is concluded that lead and Nickel has similar growth affect which is also comparable with other heavy metals e.g. Cd, Cu, MG, Mn, Al, Zn, Hg, Cr, Co etc. Our observations regarding Ecophysiological studies of lead pollution to test plants indicates that 10mg Pb/1Kg soil is promotory and 50mg Pb/1Kg soil is inhibitory for growth. It has been also investigated that above this highest concentration of Pb amended soil test plants. Show injury symptoms e.g. marginal and interveinal chlorosis, alteration in pigmentation, severl leaf drop and abnormally small leaf. Differential toxicity of Pb in Oryza sativa cvs. was reported by us during the studies which is comparable to the toxicity Cd in rice varieties reported by Bagchi, S. (1976).

It was also observed that toxic, level of Pb in the soil and plants was associated with visual symptoms and variation in growth of test plant. There were also differential responses of plant genotypes to lead treatments. Further with increasing Pb levels, root tissue becomes severely discoloure, lateral roots were few in number, stunted, thickened and bulbous root tip developed. Growth and development of plants were severely retarded.

Inhibition of root growth in our experiments is comparable with those of Farooqi (1994), Singh, K.R. (1994), They reported that treatmet with lead acetate inhibits the growth of main and secondary roots. Similarly, srivastava, N, Singh, R. et al. (1996), reported that more than 50mg Pb/Kg soil has a depressive action on root growth of Cicer arietinum cv. G-130 an 500 mg Pb/Kg soil stops the growth.

Stem growth inhibition in our experiments is comparable to that of Farooqui and Singh (1994). They reported that Pb caused stunted shoot growth. Our observation of decrease in leaf number, leaf area are comparable to that of Beg et al. (1994). They reported that high concentration of lead reduces the width of leaf. Similar result was obtained by Lisanti (1958) and Quinche et al. by Nickel treatment. They reported that high concentration of Nickel in when added to soil, it decreases the leaf yield by 7-8% in Zea mays.

Yield reduction observed by us in comparable with the observations of Chucka et al. (1937), Kusaka et al. (1971), Lapa et al. (1969), and Kim et al. (!978) who performed the experiment by Nickel amended soil Chucks et al. (1937), reported that addition of excess of heavy mtal (Ni) to soil, produces significant yield reduction of Potato. Lapa et al. (1963), also reported that spraying of heavy metals on potato tubers resulted into a severl reduction in yield. Kusaka et al. (1971), reported that soil with 50 ppm. of Ni reduces turnip yield by 20%. Similarly Kim et al. (1978), reported yield reduction of Oryza sativa with addition of Nickel along with other heavy metals viz. Cu, Cr, Co and Mn to the nutrient solutions and culture. Singh Aruna (1996) and Singh, Suman (1996) also reported a decrease in yield of Pisum sativum and Cicer arietinum respectively by Nickel amended soil tereatment. Therefore Ni has similar depressive action on yield as other metals e.g. Pb.