SUMMARY AND CONCLUSION

The use of municipal waste water, industrial effluents, etc. for irrigation is a common practice. This is due to its abundance in N, P, K and organic matters (Day and Tuker, 1977; Behera et al., 1980). On other hand, industrial effluent contains very high levels of heavy metals (Arora et al., 1985). Thus, investigations were under-taken to pursue the effects of pharmamaceutical factory effluent on growth and yield and some biochemical components, under presoaking treatment as well as direct effluent treatment in the field. For experimental convenience, the whole work has been divided into six part.

I. Effluent Analysis:

The effluent was collected from the main discharging channel and was analysed for various physico-chemical properties as per the method recommended by A.P.H.A. (1975) and Trivedy and Goel (1986).

II. Presoaking treatment of mustard seeds under different concentrations of effluent:

Certified seeds of mustard (Brassica juncea L. Var. T 59) were allowed to soak for five hours at room temperature in different concentrations (10, 20, 30, 40, 50
and 60\% \) of the effluent. After five hours, seeds were dried at room temperature for 2-3 days. After drying, the seeds were again treated as before by soaking them in different concentrations of effluent for five hours and then drying for the second time. For the control, the seeds were allowed to soak in tap water. The soaking and drying periods were kept constant every time. These pretreated seeds of mustard in different concentrations of effluent were used for further experiments.

III. Effect of different concentrations of the effluent on germination percentage, seedling growth as well as growth and development of mustard plants grown after the seeds were subjected to presoaking treatments:

Pretreated seeds with different concentrations (Viz. 10, 20, 30, 40, 50 and 60\% \) of effluent were kept for germination. The percentage of germination was calculated after 24 hours and seedling growth in terms of mean of shoot and root length, were carried out at 24, 48, 72 and 96 hours of germination.

In the field, after 30, 45, 60, 75 and 90 days of growth period plants were picked randomly from each plot (different concentrations) for growth data.

The data regarding stem height and root length; number and dry weight of leaves and pods per plant;
leaf area from 1st node to 5 node and total plant dry weight were collected. From this data, Relative Growth Rate (RGR), Net Assimilation Rate (NAR) and Leaf Weight Ratio (LWR) were calculated. After 105 days, harvest data were recorded for pod number per plant, seed number per pod and 1000 seeds weight.

IV. Effect of different concentrations of the effluent on biochemical changes during the seedling germination as well as growth and development of mustard plants grown after the seeds were subjected to presoaking treatment:

Various enzymatic and metabolic estimations were carried in control, 20 and 60 % pretreated seedlings after 24, 48, 72 and 96 hours of germination as well as on the leaves of 4th node of control, 10, 20, 30, 40, 50 and 60 % pretreated plants during the 30, 45, 60, 75 and 90 growth periods.

V. Effect of different concentrations of the effluent on growth and development of mustard plant under direct effluent treatment in the field.

The untreated certified seeds sown in the plots and same concentrations of effluent, which were used in the previous experiments, (Viz. 10, 20, 30, 40, 50 and 60 %) were provided once a week in the same measure to each plot respectively.
After 30, 45, 60 and 75 days' growth period, stem height and root length; number and dry weight of leaves as well as pods and total plant dry weight were carried out. After 90 days, yield data were recorded.

VI. Statistical Analysis:

The data thus collected from all experiments (physiological as well as biochemical estimations were subjected to statistical analysis of variance and the following conclusions were drawn from the results obtained in the present study:

1. After analysing the physico-chemical properties of pharmaceutical factory effluent, it was noted to be alkaline and contained high amount of Na, Cl, suspended and dissolved solids.

2. Percentage of germination as well as root and shoot length were increased in lower concentrations of effluent pretreated seeds and it reduced in higher concentrations due to the excess amount of various metals in the effluent, which prevented or retarded the intake of water and caused toxicity to the embryo and endosperm during the soaking treatment. The highly positive significant difference in mean values of root and shoot length were observed in 20% pretreated seedlings.
3. The enhanced values of stem height and root length, number and dry weight of leaves, leaf area, number and dry weight of pods and total plant dry weight were observed in 20% pretreated seeds. An important factor in the process of growth and development; net assimilation rate and relative growth rate were higher in 20% pretreated plants, while leaf weight ratio was lower.

4. The reduction in stem height and root length, number and dry weight of leaf, leaf area, number and dry weight of pod and total plant dry weight in higher concentrations may be because of inhibition of synthesis of metabolites due to the effluent stress.

5. The reduced protein synthesis with higher concentration (60%) of effluent pretreated seedling and leaves, retarded the seedlings and plants growth as proteins are the major constituents of protoplasm. Protease activity was low in higher concentration pretreated seedlings, with minimum values of free amino acids and soluble proteins.

6. Protease activity was increased and protein content decreased in leaves of higher concentrations. In lower concentration, protease activity is inhibited and protein content increased markedly.
7. Free amino acids as well as soluble protein content increased in pretreated seedling with lower concentration (20%), and decreased with higher concentration (60%) of the effluent pretreated seedlings. In leaves, soluble protein content increased and free amino acids decreased with lower concentrations and with higher concentrations, the free amino acids increased and soluble proteins decreased.

8. The proline content decreased in seedlings as well as in leaves of lower effluent concentrations whereas, with higher concentrations the proline content increased both in seedlings and leaves. Accumulation of proline with higher concentration, may be considered as an osmoregulatory mechanism. The larger amount of Na+ and Cl- in higher effluent concentrations, increased the cell osmotic potential and as a consequence of reduction in cell osmotic potential, proline accumulates rapidly in the cytoplasm to maintain the cell osmotic potential. The findings suggested that the adaptive role of proline is related to survival requisite rather than maintenance of growth.

9. In the seedling and plant leaves, pretreated with higher concentration of effluent, therewas
considerable increase in the sugar content than that of lower concentrations which supports the assumption that sugar accumulates wherever there is a stress (Parker, 1972). This helped to maintain their turgidity and hydration of protoplasm. The higher concentrations of effluent inhibited the invertase activity and lower concentrations stimulated the enzyme activity in both seedlings and leaves. When the enzyme activity was inhibited, it did not allow, hydrolysis of sugars and thereby maintained the levels of sugars constant for their protective role.

10. RNA content increased and RNase activity decreased in seedlings of lower concentrations (20%) and with higher concentration (60%) pretreated seedlings the RNase activity increased and RNA content decreased markedly. The decreased RNA content and stimulated RNase activity is a common stress effect and is well-documented. However in lower concentrations decreased RNA content and increased RNase activity were observed.

11. The phenolic compounds in pretreated seedlings increased with lower concentrations (20%) and decreased with higher concentration (60%) of seedlings. Presence of higher concentrations of phenols showed a protective, and stimulative growth of seedlings with lower concentrations.
12. In leaves, the phenolic compounds increased with higher concentrations and its reduction with lower concentrations, which explains that phenol is utilized for regulation of growth and protection of plants in lower concentration pretreated plants and accumulation of phenols inhibitors of plant growth in higher concentration pretreated plants.

13. Both the oxidizing enzymes (peroxidase and catalase activity) increased in seedlings and leaves treated with lower effluent concentration as compared to control and higher effluent concentrations. Retardation of peroxidase concentrations indicates, the level of respirative and oxidative processes under effluent stress, and enhanced activities in lower concentrations, shows an enhanced growth, resulting in the higher rate of respiration.

14. Effluent pretreatment in higher concentrations reduced the photosynthetic pigments in leaves, which indicates that growth retardation occurred due to effluent stress. The increased pigment content over control with lower concentrations shows an enhanced plant growth.

15. Direct irrigation with effluent also stimulated better growth and yield of mustard plant with lower
concentrations, since the optimum levels of nutrient minerals were present in such concentrations of effluent. However, there was a decrease in all growth parameters and yield when irrigated with higher concentration of effluent.

Highly beneficial growth and yield response were observed under presoaking treatments of effluent as compared to the plants irrigated with lower concentration of effluent.

Evidently, the effluent used in the present study has an adverse effect on plant growth and its productivity at higher concentrations but the proper dilution (20%) brings down their toxic effect and acts as liquid fertilizer. Therefore, it leads to a deceptive pollution problem. Encouraged by the better growth and yield of plants, in such polluted soil, the growers practice of irrigation with polluted water, creating unknowingly, in the long run, the biological hazard of heavy metal toxicity for soil and consumers (Sharma and Kansal, 1986). In order to avoid much land pollution through direct application of effluent, it is suggested that presoaking treatment at low concentrations (20%) is the best method to obtain a beneficial yield response.