CHAPTER-1
INTRODUCTION
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Agriculture exerts both favourable and unfavourable consequences on environment. In India, agriculture is the mainstay of national economy. Wheat is Asia’s second most important staple, and demand has been growing much faster than for rice. Wheat now makes up 19.2 per cent of total calorie supply. Asia is the wheat leader in all three growth parameters, area, output and yield. Wheat output is now close to half the regions for rice harvests. As with rice, practically all wheat is used for domestic consumption. A massive agricultural transformation will make wheat the number one grain in developing countries as well as industrialized nations within the next decade, says the Consultative Group on International Agricultural Research (CGIAR). “Wheat is a real miracle crop of this century,” according to Ismail Serageldin, Chairman of CGIAR and World Bank Vice President for Environmental Sustainable Development (Press Release-October, 1995).

*Triticum aestivum*, commonly known as wheat, is a famous member of family Graminae. *Triticum aestivum* is the second most important crop, after rice in India. It has registered tremendous increase in area and production after 1950-51 and more specifically after the green revolution. The production has grown from 65 lakh tonnes in 1950-51 to 71.81 million tonnes in 2001-02 (Statistical Abstract, 2004). Indian wheat crop is planted in November and harvested in late April. The wheat crop is much more amendable to modern mechanised farming as it is less labour intensive than rice. It is extensively grown in North Western India specially Punjab, Haryana and Uttar Pradesh.
Wheat crop's production in Punjab and Haryana is one third of India's total wheat production. Wheat crop plant grows under moderate to low rainfall but requires fairly assured irrigation facilities. Around 70% of global water is used for agriculture, 20% for industries and remaining 10% for domestic activities. Demand for water will increase in all three areas as population grows and as countries become more industrialised. It is estimated that by 2020 around two-third of the world's population will be living in water stressed conditions. Industrial and agricultural demand for water must be considered against the backdrop of inadequate water supply and sanitation in many areas of the world (WBCSD August, 2005).

Keeping in view of tightening supply and rapid expansion in demand, fresh water is expected to emerge as a key constraint for future agricultural growth as the global water demand has grown by 2.4% per year (Selvarajan and Joshi, 2000). To compensate the increasing agricultural demand, some work has also been done on recycling and utilization of certain industrial effluents for agricultural purposes. Effluent generation in the industry obviously depends upon the size and activities of the industry. The industrial waste can be defined as end by-product not usable for the industry, hence has been discharged out.

The current practices adopted for disposal of the industrial wastes in India includes discharge into public sewers, river or in sea through creeks and gestures and on the land with little or no treatment. Unlike domestic waste, the industrial waste is very difficult to generalize and it varies from industry to industry. It has been observed that about fifty percent of the wastes are toxic
and deleterious. These effluents when discharged into nearby water bodies are known to produce alterations in the hydro-graphical parameters of water bodies. Irrespective of immediate or present effects, effluents that are discharged into water or on land cause harmful effects to aquatic organisms, plants, land, as well as on human health. All the major rivers have become polluted. In North India, river Yamuna can be described as a clogged sewer. Thousands of industrial units located in Haryana, Delhi and Uttar Pradesh are responsible for the major pollution load that flows in Yamuna. According to official sources, Panipat is among the six Haryana towns, which has been covered under the Yamuna Action Plan. A wide variety of both organic and inorganic pollutants such as heavy metals, suspended solids, phenols, oil and greases, toxins, acids, salts, dyes, cyanides and other chemical substances, many of which are dangerous to aquatic life which in turn responsible for the biopurification process normally taking place in river. Industrial discharge also contains heavy metals such as copper, chromium, cadmium, mercury, nickel, lead, etc., which can get transformed into more toxic compounds. They may accumulate in aquatic organisms and leads to biomagnification in the food chain. Therefore, in order to protect the environment, the importance of determination of level of pollutants in industrial effluents should be realised. Efforts to improve the standard of living of man through the control of nature and development of new products by industrial development have also resulted in the pollution or contamination of the environment.

Most of the world’s air, water and land resources are now partially poisoned by industrial effluents from industrial processes including those of
crude oil and gas. According to a survey, entire country produces 18,422 million litres of wastewater per day (Khan, 2000), when the effluent from oil industry are not properly disposed off, there is general belief, backed up by scientific evidences that, they cause pollution to surface and underground water with dangerous consequences to life. There is a possibility of safe use of this wastewater for recycling in industrial process as well as its potential for commercial productivity. If this effluent can be safely utilized for irrigation purpose it will minimise the environmental pollution, reduce the problem related to effluent handling, storage and disposal, preserve the quality of water and reduced the requirement of fertilizer. Due to the perennial shortage of irrigation water, farm production can be enhanced if the industrial wastewater is safely utilized.

In consequent of the endeavours of the central government, in our country, the past few years saw a significant reduction in pollution levels as out of the 1551 industries, 17 were highly pollution generating industries (aluminium, caustic, pulp and paper, copper, zinc, distillery, iron, steel, dyes, fertilizer, leather, pesticide, thermal power plant, pharmaceutical, and petrochemical). Only 20 industries were found not meeting minimum national standard (Balu, 2002). The treated effluent of almost all of the industries can also be used judiciously for irrigation purposes and hence prevent pollution and disposal problems (Gautam and Bishnoi, 1990; Anac et al., 1993; Raman et al., 1996; Pandit et al., 1996; Nemade and Shrivastava, 1997; Sanjeeda et al., 1998; Singh and Bahadur, 1998; Ranganathan et al., 1999; Chhonkar et al., 2000a; Dhankhar and Dahiya, 2000; Rao and Rao, 2002).
Global economic prosperity and sophistication of modern civilisation over the best part of last century was greatly accelerated by an abundant supply of liquid gold i.e. oil energy. This energy source has also played a critical role in agriculture. Given this dependency on oil, it is surprising that more attention has not been given to studies of its endowment in nature. The oil industry has made great technological advances since exploration began 150 years ago (Campbell, 2001). Petroleum is the crude oil, naturally occurring liquid that can be distilled or refined to make fuels, lubricating oils, asphalts and other valuable products used in a broad sense. Crude oil and natural gas are used to make feedstock for manufacturing of hundreds of petrochemical products, including paints, plastics, synthetic rubber and fibres, fertilizers, drugs and explosives.

Indian petroleum product consumption has grown by 6.3% over the past 10 years ending 1997-98. The oil demand in India is expected to increase. The indigenous production of oil is 33 MMT. Our import dependence, which is 66.5% now, is likely to go up substantially (Petro-tech 2001). The refining capacity in the country has reached 110 million tonnes. Indigenous production of oil has been hovering at 32 million tonnes. The problem of providing good quality oil at reasonable price in present scenario assumes significance (Choudhary, 2001).

Indian refineries have been provided stable and higher returns than the predicted ones under the administered price mechanism (Petro Tech., 2001). Mainly seven companies are responsible for refining the oil in India such as Indian oil Corporation Ltd. (I.O.C.). Bharat Petroleum Corporation Ltd.
(BPCL), Hindustan Petroleum Corporation Ltd. (HPCL), Cochin Refineries Ltd. (CRL), Madras Refineries Ltd. (MRL), Bongaigoan Refinery and Petrochemicals Ltd. (BRPL) and Mangalore Refinery and Petrochemicals Ltd. (MRPL). These seven refineries have a combined installed capacity of 69.14 million metric tonnes as on April 01, 1999 (Refinery – Marketing – Distribution, 2000). All oil refineries follow the same basic process for processing of crude oil. Crude oil, mixture of many different organic hydrocarbons, get converted into specific components such as gasoline, diesel fuel, jet fuel, kerosene, lubricating oils, tars and asphalts by these industries. The general procedure is to first remove water and other impurities from the oil, then distil the crude oil into its various fractions and then, if necessary, further change these fractions through chemical reactions into their final products. For processing the oil, refineries use a large amount of water. Hence, water is an essential part of the petroleum industry. It is used in many applications, from enhancing production in oil fields to making steam for processing units at petroleum refineries. A by-product of oil production and petroleum refining process, this water must be treated before being discharged or reused. Oil production and processing facilities produce, on an average, more water than oil. Approximately 68 million barrels of oil (one barrel is equivalent 42 gallons) are produced daily across the globe. Six barrels of water are typically produced per barrel of oil. Four hundred and eight million barrels (or 17 billion gallons) of water is treated for disposal or reuse daily in the industry, which is enough water to fulfil 58 million average households water need for one year. Petroleum refineries use roughly one barrel of water to
refine one barrel of oil. Between cooling water, utility water, boiler feed water and other uses, more than 2.8 billion gallons of clear water are used at petroleum refineries around the world every day. Additionally the average petroleum refinery generates about 0.6 barrels of wastewater per barrel of oil processed. This equates to 1.7 billion gallons of wastewater that must be treated to meet environmental discharge (Shultz, 2005). This water was contaminated by waste oil and other impurities from refining processes.

The problem of disposal and utilisation of refinery effluent has drawn considerable concern and attention of scientists, technologist and environmental government regulators etc. Oil industry damages the environment in many ways. In water oil films floating on the water surface can prevent natural aeration and lead to the death of aquatic life. Pollution induces loss of farmlands, economic crops, soil fertility and poisoning of fresh and marine water. Apart from pollutants introduced into the environment from production operations, refinery wastes have characteristics which constitute potential water, land and air pollutants. Atmospheric pollutants arising from refinery operations include oxides of nitrogen, carbon, sulphur and hydrogen sulphide. Liquid refinery effluent contains oil, grease, phenol, suspended solids, biological oxygen demanding organic matter and heavy metals.

Sustainable use of these resources and actions for reversing the degradation are, therefore, the obligations of the present generation. This will help in reducing the pressure on deep tube well water and other drinking water sources which can be conserved for human consumption. Little progress has been made towards the use of treated industrial effluents for agriculture and
aquaculture. The main reason for this being that at present there are no standard protocols and institutionalised attesting authority to ensure the safe agricultural use of water. But recently integrated scientific approaches offer tremendous scope for developing industrial treatment systems that can make efficient use of effluent and hence nutrients of the seemingly wastes of industries for the agricultural crops without further endangering the natural resource base of water, soil and vegetation. Hence, an alternative pathway for evaluating the potential of treated refinery effluent for the enrichment of soil and providing irrigation water for intensely irrigated crop namely wheat (*Triticum aestivum*) was taken into consideration for the present study.

For the present investigation the partially treated effluent of Panipat refinery was taken for the irrigation of *Triticum aestivum*. Panipat refinery is the 7th refinery of Indian Oil Corporation Ltd. (Fig. 1.1). This refinery is referred to as the country’s technically advanced refinery, build in an area of around 2200 acres of land at a project cost of Rs. 3868 crore. The refinery has an installed capacity of 6 million metric tonnes of oil per annum (MMTPA). It receives crude oil from Vadinar in Gujarat coast through a 1339 km long pipeline. The refinery is designed for processing both indigenous and imported crude oil. The refinery has processed about 25 types of imported crude oil from countries like Saudi Arabia, Iran, Iraq, Dubai, Kuwait, Malaysia, Nigeria and other African countries since commissioning in 1998. Currently, the capacity of the refinery is being expanded to 12.0M MPTA. The refinery is capable of producing about 8 lakh tonnes of jet fuel, 12 lakh tonnes of kerosene and 26 lakh tonnes of diesel annually. Other products include naphtha, mineral
Fig. 1.1
Location of Study Site
turpentine oil, bitumen, sulphur etc. Besides, about 2.4 lakh tonnes of cooking gas is presently made available to the people. Panipat Refinery meets the demands of petroleum products not only of Haryana, but also of the entire north-west region including Punjab, Jammu and Kashmir, Himachal Pradesh, Chandigarh, Uttaranchal state and some parts of Rajasthan and Delhi.

If the concerned literature on refinery effluent utilization in agriculture is reviewed, it can be reported that the effluents has responded well in augmenting the crop yields but their unscientific and unsystematic use has also caused degradation of land and landscape. Hence the proper understanding of the ways of applying the refinery effluent in various crop/cropping systems for different agro-ecological regions and subsequent effect on the growth responses and associated environmental impacts is required. The practice of utilizing the effluent in agricultural fields may give enhanced crop productivity response and can also save the inorganic fertilizer use. Land disposal is considered to be most favourable approach to control the increasing volumes of wastewater of oil refinery. Irrigation, one of the principal methods of land treatment is used very often by different scientists (Day, 1973; Pound and Crites, 1973; Sopper and Kardos, 1974; Greene et al., 1980; Burns et al., 1985; Singh and Mishra, 1987; Joshi and Kalra, 1995; Chhonkar et al., 2001). In addition, treated wastewater is now attracting much attention as a potential source of available water for agricultural use.

Looking into the increased environmental awareness, even in developing countries, wastewater treatment is of utmost importance (Gupta et al., 1995). United States Environmental Protection Agency (USEPA) considered
following heavy metals Cr, Cu, Zn, Ni, Pb and Hg as highly critical (Arther and Vohra, 1995). Various methods employed for removal of heavy metals from effluents such as precipitation of metals, use of ion exchange resins, electrochemical reduction, membrane separation processes are encountered with certain major disadvantages such as high energy requirement, incomplete metal removal, generation of large quantities of toxic waste sludge, which necessitates careful disposal in further steps (Shrivastava and Thakur, 2003). These processes are sometimes neither effective nor selective. Most of them are expensive too (Meena et al., 2004). Because of these disadvantages of above processes, there is an increasing demand for an economic and ecofriendly technology. In this endeavour, biological material has emerged as an ecofriendly and economic substitute (Kannan and Srinivasan, 1997; Volesky and Holan, 1995). Biosorption is a non-directed physico-chemical interaction between metal or radionuclide species and cellular compounds of biological origin (Shumate and Strandberg, 1985). From a long time activated carbon and peat occupied the case of biosorbent, but they are geographically restricted in distribution. Hence, biosorbents developed from plant and fungal biomass become an unanimous choice. Furthermore, removal of pollutants from effluent by immobilizing the biosorbents proves to be best option for commercial application. After complete treatment effluent is free from pollutants and can serve as potential fertilizer and irrigational water.

Hence, keeping in view, the pros and cons of land disposal of refinery effluent, regarding environmental quality of this industrial effluent in mind, an investigation was conducted to determine the effect of Panipat refinery effluent
on the physiology of *Triticum aestivum* var. PBW-343 and on sandy loam soil of Rohtak city of Haryana, India and ultimately removal of some crucial heavy metals and phenols from effluent. The present investigation has the following objectives:

2. To evaluate the effect of industrial effluent on Physico-chemical properties of soil.
3. To determine the effect of industrial effluent on the germination behaviour of the crop *Triticum aestivum*.
4. To study the effect of industrial effluent on growth, nutrient uptake and nitrate reductase activity of crop plants.
5. To evaluate the effect of industrial effluent on potential nutrient value and energy content of crop plants.
6. To study the biomass production of crop under the application of industrial effluent.
7. To develop the biosorbent for removal of toxic substances.
8. To immobilise the developed biosorbent for its easy handling.