Abstract

Soil, being one of the earth's most vital ecosystems, is essential for the continued existence of life on the planet, as it forms the basic life support components of biosphere. Soil and their characteristics are of great importance in an agricultural economy. It is the fundamental resource base for any agricultural production system. External agricultural inputs such as mineral fertilisers, organic amendments, microbial inoculants, and pesticides are applied with the ultimate goal of maximising productivity and economic returns, often to the detriment of environmental quality, particularly of soil, vegetation and water resources. The extensive use of pesticides also continues to be a significant input in modern agriculture. Pesticides used in agriculture are mainly adsorbed and degraded in the top soil, while some pesticides, depending on their pattern of use can involve a risk of leaching, resulting in the contamination of shallow ground water and soil. There is also a growing public concern over the potential accumulation of heavy metals in agricultural soils owing to rapid urban and industrial development and increasing reliance on agrochemicals in the last several decades. Excessive accumulation of pesticides residues and heavy metals in agricultural soils may not only result in environmental contamination, but elevated heavy metals and pesticides uptake by crops may also affect food quality and public health safety.

Soil quality is considered a key element of sustainable agriculture. Soil fertility is the only vital component of soil quality. Without maintaining soil fertility, it is difficult to boost agricultural production for feeding the alarming population. Soil, as a valuable resource can be used sustainably or even enhanced, under careful management. Soil properties, comprising the physical, chemical and biological parameters that are

sensitive to changes in the management can be used as indicator to soil quality. The physicochemical study of parameters is important to agricultural chemists for plant growth and soil management.

Moreover, considering the toxic effects of pesticides, it is an utmost necessity to reduce the level of these chemical pollutants from the applied environmental region. Biological removal of chemopollutants becomes a method of choice in this context, as bacteria from natural environments can utilize different types of xenobiotics chemical compounds, including pesticides for their growth and thereby mineralize and degrade them.

The present research work entitled "**A study on the impact of selected organophosphorus pesticides on the soil quality of different land-uses of Dimoria Tribal Development Block, Assam**", was undertaken in the Dimoria region of Kamrup district of Assam, which is having a history of repeated pesticide applications. In this region, there exist different landuse types and this particularly includes the bamboo plantation, horticulture, tea plantation, agro-forestry, natural forest, shifting cultivation, etc. However, for the present study paddy fields, horticultural farmlands and tea gardens were selected. A survey of the study area was carried out to assess the extent of widely used pesticides and the farmers' level of awareness on the key issues like on the impacts of pesticide, toxicity of pesticides, handling practices, disposal practices through well-structured questionnaires and were also ranked accordingly before sample collection and analysis. Based on the survey, malathion and quinalphos insecticides were selected for the study. Considering the various implications of pesticides used on soil quality of the area the following objectives were formulated:

1. To assess the soil quality of the selected landuse systems of Dimoria Tribal Development Block in terms of its physico-chemical parameters.
2. To analyse the impact of agrochemicals used on heavy metals accumulation.
3. To compare the soil quality of the selected conventionally managed systems with that of some selected organically managed systems, in terms of the nutrient status (basically available NPK) to access the impact of agrochemicals on soil quality.
4. To analyse the presence of pesticide residues (malathion and quinalphos) on soil of the selected landuse systems of the Dimoria Block.
5. To isolate and characterize the pesticide (malathion and quinalphos) degrading bacteria.
6. To study the effect of temperature, pH, carbon and nitrogen sources on the growth of pesticide degrading bacterial isolates.

For the present study, samples were collected from some selected conventional and organic agro-ecosystems of the area, and one sample was collected from natural forest, which was considered as the control sample for various analytical and microbiological analyses. Three soil samples at 0-15 cm depth were collected randomly from each sampling station. The samples were collected over a two-year period. Physicochemical analysis of the soil samples, involves the analysis of different physical and chemical properties of soil, considering soil texture, soil temperature, soil moisture content, bulk density and soil water holding capacity among the various physical parameters, chemical parameters determined were soil pH, soil E.C, organic matter content and available nitrate-nitrogen, phosphorus and potassium, along with the determination of heavy metal concentrations, the following elements were taken into account-cadmium, copper, chromium, lead, nickel, and zinc and presence of pesticides residues (malathion

and quinalphos), under study. The results examined in both the systems were compared to assess the impact of pesticide application on the soil quality of the selected landuse systems.

On the basis of the physico-chemical analysis of soil, it was observed that the soil quality of the selected landuses varied depending on soil conditions like nutrient availability, pH, temperature, moisture etc. The experimental results of the analysis were compared with the mean rating given by chemical ranking chart of Indian Council of Agricultural Research (ICAR).

Soils in the systems under study were sandy clay loam, clay loam type and that of the natural forest was of silt loam type. Soil temperature ranged from 19.3 to 28^0C. Moisture content of the soil of various landuses varied adequately, which was within the range of 3.61-22.24%. The present study did not show much variation in bulk density of soil samples that ranges from 1.07 to 1.43 g/cm^3, indicating low permeability and soil porosity. The water holding capacity of the soil of the landuse systems was in the range of 29.30 to 65.51%. The soils in the systems under study were found to be acidic in nature that ranges from 4.26-5.9. The EC values of the soils examined ranges from 128.7 µS/cm to 196.03µS/cm. Most of the soil samples under study revealed organic matter near-by or above 3%, which were moderate according to ICAR rating, 1997.The available Nitrate-Nitrogen examined in the soil of various landuses was marginal as according to chemical rating chart, (ICAR, 2005) which ranged from 1.9-6.0 mg/kg. However, the experimental results of available phosphorous distribution in the study area were low (2.21-14.5 kg/ha) in all the landuses, as per the guidelines of IAS-International Agriculture Standard for Phosphorus. The low availability of P might be due the acidic nature of the soils of the study area, as, in acidic soils, there is a tendency

toward lower P levels over time. The available potassium value were also medium to low concentration (43.29-164.2 kg/ha) in the landuse systems, as according to the IAS-for Potassium. In terms of NPK availability the soil status can be regarded as of moderate quality.

The mean values of the heavy metal concentrations (mg/kg) in soils of different land-uses ranges in the following order; Cd (0.16-0.83) < Ni (2.56-29.06) < Cu (4.66-27.16) < Cr (8.03-46.06) < Zn (26.30-99.83). The results also showed that, as of now the soils could not be said to be contaminated with heavy metals because the metal content levels conformed to the world-wide background content of metals range in the soil.

The study further revealed that there were no significant differences between organic and conventional management for most of the soil physical and chemical properties measured. However, soil samples from the conventionally managed system exhibited slightly higher values of soil water holding capacity and significantly higher values of electrical conductivity (EC) and higher concentrations of K, Cu and Zn, than the organic systems, which were likely the result of extensive agrochemicals application (in the forms of chemical fertilizers and/or pesticides).

The presence of pesticides (malathion and quinalphos), were examined with the help of Gas chromatograph. Out of the two pesticides, taken for the study, only malathion was detected in four soil samples in trace amount. However, in none of the soil samples quinalphos was detected. This indicates that in the present study, the pesticides might get metabolized by organisms or free enzymes in the soil to some other compounds or might move through soil with water.

With regards to the microbiological studies, it was observed that bacterial isolates *designated as MS 1, MS 2, QS 1, and QS 2* had the capacity to utilize the pesticide and grow well in the medium supplemented with pesticides. Moreover, among the four bacterial isolates the bacteria*, MS 1*utilized the pesticides effectively and showed maximum growth followed by *MS 2*, *QS 1,* and *QS 2*. The bacterial isolates showed maximum growth in the Minimal salt broth containing malathion followed by quinalphos. The maximum growth rate of bacteria was recorded at 35°C followed by 25°C, 45°C and 55°C and pH 7 followed by pH 6, pH 8, pH 5 and pH 4 . Moreover, the growth of bacteria was maximum in the presence of dextrose followed by fructose and lactose and in peptone followed by yeast extract and beef extract.

However, the study has fulfilled the limited purpose of strengthening database by generating the baseline data on soil quality of the study area, with special reference to the impact of agrochemicals on the soil quality and occurrence of pesticides degrading bacterial strains. This work will be a pre-cursor for future research on various soil quality issues. A few suggestions for carrying out future research on the study area have been incorporated at the end of the concluding chapter.