CHAPTER—III

Physico-chemical properties of soil under different agricultural practices

Introduction

The growth and development of VAM fungi are affected by many climatic and ecological factors (Saif, 1984). Generally physico-chemical properties of soil include pH, moisture content, organic matter (C), bulk density of soil and other essential elements like C, H, O, N, P, K, S, Ca, Fe, and Mg, which have direct and indirect effect on crop plants through different VAM fungi (Johansen et al., 1993). The absorption and translocation of nutrients like N, P, K, and other micro-nutrients from soil through root hairs and mycorrhizal associations to the different parts of the crop plants (Ibijibijen and Urquiaga, 1996) depend mostly on the physico-chemical properties of soil (Jensen et al., 1982). It has been seen that both bulk density, porosity and particle fractionation plays a very vital role in soil for VAM fungal sp. for easy translocation of water and mineral nutrients (Jones et al., 1970). Organic matter (C) can be said to be very important in each and every way that organic compounds are the important constituents of plant structure, protoplasm and enzymes. This can be easily transferred from root to the shoot parts by VAM fungus by fungal biomass in agricultural fields (Dalal and, 1991). Nitrogen is also very important constituents of amino-acids, and enzymes, which can be easily transferred by external hyphae of VAM fungus i.e G. intradices (Johansen et al., 1996). Phosphorus is also a constituent of many compounds in plants i.e A.T.P, NADP, pyridoxal phosphate a co-enzyme can easily assimilated by VAM fungal sp. (Scott et al., 1996). Sometimes agricultural practices, high rainfall, and high relative humidity causes soil compaction, which also increase bulk density and alters the porosity, water holding capacity
of the soil (Hoffmann and Jungk, 1995). These properties of soil and climatic factors influence plant growth by mechanical resistance (Bengough and Mullins, 1991).

**Materials and Methods**

For the analysis of physico-chemical properties of soils, the soil samples were collected from three agricultural practices in separate sterilised polythene bags. pH, moisture content, total nitrogen, available phosphorus, available potassium, organic carbon and bulk density of collected soil were determined as follows:

**Determination of soil pH:**

10 g of soil was taken in 50 ml of distilled water stirred for 15 minutes on a magnetic stirrer and pH of the solution was read by a digital pH meter.

**Determination of % Moisture content of soil:**

10 g of soil was taken in three replicates, kept in a hot air oven at 100°C and weighed till a constant weight was obtained. The percent moisture content was calculated as follows:

\[
\text{Percent moisture content} = \frac{\text{initial wt} - \text{final wt}}{\text{initial wt}} \times 100
\]

**Bulk density of soil:**

The volume and the mass of the soil sample after drying was taken for the measurement of bulk density by following formula

\[
\text{Bulk density} = \frac{\text{Mass of soil after drying}}{\text{Total volume of soil}}
\]
**Determination of total soil Nitrogen** -(Semi-micro Kjeldahl method) (Allen, 1974).

**Procedure:** 1 g of sieved soil sample was taken into a 50 ml of round bottomed Kjeldahl flask, to it 2 g of K$_2$SO$_4$-HgO mixture, and 3 ml of conc. H$_2$SO$_4$ were added and kept in the digestion rack till a pale green colour develops. Then it was allowed to cool and diluted with 50 ml of water and filtered the digest. After filtration the solution was distilled with 40 % NaOH. The released ammonia was absorbed in 4 % boric acid and treated with 1N HCL. The blank digest was prepared with reagents only.

**Calculation:**

\[
T = \frac{\text{ml/140Hcl used for titration}}{10^2 \times \text{aliquot (ml)} \times \text{sample weight (mg)}}
\]

\[
N(\%) = \frac{T(\text{ml}) \times \text{solution volume (ml)}}{10^2 \times \text{aliquot (ml)} \times \text{sample weight (mg)}}
\]

**Determination of available Phosphorus** - (Allen , 1974)

For the determination of available phosphorus Molybdenum blue method was followed. The available phosphorus was extracted in 0.002 N H$_2$SO$_4$. 1 g air dried sieved soil was taken in a 250 ml conical flask and to it 100 ml of extract solution was added and was stirred for 30 minutes, and filtered through Whatman No-42 filter paper. 3 ml of aliquot was pipetted out in a 50 ml volumetric flask and 2-3 drops of dinitrophenyl indicator was added to the aliquot. Then 2 ml of sulpfomolybdic acid was added. The flask was shaken for a while and then 0.5 ml of chlorostannous acid was added and the volume was made to 50 ml. The
absorbance of the solution was taken in spectrophotometer at 700 nm. The concentration of phosphorus was calculated with the help of standard curve by the following formula

Calculation:-

\[ C = \text{mg (P)} \text{ obtained from the graph} \]

\[ \text{Available P(%) = } \frac{C \times \text{solution volume (ml)}}{10 \times \text{aliquot (ml)} \times \text{sample wt (g)}} \]

**Determination of available Potassium : -(Allen, 1974)**

Potassium was extracted in ammonium acetate solution, which was prepared by mixing 575 ml of glacial acetic acid with 600 ml of ammonia solution and diluted to 10 litres with distilled water. The pH of the solution was adjusted to 7.0±0.05 with the help of acetic acid and ammonia solution. 1 g of sieved soil was added to 125 ml of extraction soln. and was stirred constantly for one hour and filtered through Whatman-44 filter paper. The required potassium was read through flame photometer and converted into known unit through standard graph and calculated by following formula.

Calculation:- \[ C = \text{mg K obtained from graph} \]

\[ \text{Available K (%) = } \frac{C \times \text{solution volume (ml)}}{10^4 \times \text{sample aliquot (g)}} \]
Determination of Organic Carbon:

The rapid titration method of Walkey and Black (1934) was followed for the determination of organic carbon. 1 g air dried sieved soil was taken in a dry and cleaned 500 ml conical flask along with 10 ml of 1 N K$_2$Cr$_2$O$_7$ and 20 ml of conc.H$_2$SO$_4$. The flask was not disturbed for 30 minutes. To this, 10 ml of 85% phosphoric acid was added and titrated with 1 N FeSO$_4$ solution with diphyrrylamine indicator. For blank (without sample) same procedure was followed. Three replicates were maintained in all the cases. The organic carbon was determined as follows:

Calculation: If $T$ ml of 0.4 M Ferrous ammonium sulphate are used in the titration then:

$$\text{Organic Carbon (\%)} = \frac{(27.5 - T) \times 0.12}{\text{sample weight (g)}}$$
Fig-10 Physical properties (pH, moisture content and bulk density) of valley, terrace and jhum practice soil.
Fig-11:- Chemical properties (Total nitrogen, available phosphorus, available potassium and organic carbon) of valley, terrace and jhum practice soil.

- **Nitrogen content of soil**
  - L.S.D=0.005
  - Months: 1996

- **Phosphorus content of soil**
  - Months: 1996

- **Potassium content of soil**
  - Months: 1996

- **Organic carbon content of soil**
  - Months: 1996
Results

It was observed that the moisture content (%) from Mar-Jun ranged from 15.012 ±0.015 - 44.037 ±0.015 in valley practice, 14.980 ±0.015 - 24.864 ±0.015 in terrace practice and 12.012 ±0.025 - 13.057 ±0.025 in jhum practice and from Jul-Dec the moisture content (%) was 16.971±0.035 - 55.981 ±0.035 in valley practice 25.861 ±0.065 - 34.871±0.065 in terrace practice and 14.065±0.025 - 34.085±0.025 in jhum practice, whereas from Jan-Feb the moisture content (%) remained moderate in all the three agricultural practices i.e Valley (24.001±0.015-25.012±0.015), terrace (24.981 ±0.025-25.981±0.025) and jhum (13.001±0.045-25.091±0.045) (Fig-10). It was observed that the soil pH of valley practice was 5.12 ±0.005 - 5.62 ±0.005 in 1996 and 5.02±0.005-5.90±0.005 in 1997, and in terrace practice the pH was 5.03±0.075-5.08 ±0.075 during the month of Jan-May in 1996, whereas the pH range increased up to 5.06±0.005-5.72±0.005 from Jun-Dec in 1997. Whereas in jhum practice the pH range was 4.29±0.005-4.71±0.005 in 1996 and the range became high (4.23±0.025-5.00±0.025 ) in 1997 (Fig-10). It was observed that the bulk density of the terrace practice was more i.e (1.5±0.005-1.6±0.005) mg$^{-3}$ and in valley practice was moderate i.e (1.3±0.005-1.4±0.005) mg$^{-3}$, whereas in jhum practice low bulk density was observed i.e (1.1±0.005-1.3±0.005) mg$^{-3}$ during the study periods.

(Fig-10.

The percentage nitrogen content in valley practice was highest followed by terrace and least in jhum practice. The percentage nitrogen content (Jan-Dec) in valley practice ranged highest followed by terrace and least in jhum practice. The percentage available phosphorus content (Jan-Dec) in valley practice ranged highest followed by terrace and least
in jhum practice. The available potassium content (Jan-Dec) in valley and terrace practices ranged almost same followed by least in jhum practice, and the percentage organic carbon content (Jan-Dec) in valley practice ranged highest followed by jhum and least in terrace practices. (Fig:-11).

**Discussion**

In valley practice the percentage moisture content (%) was highest during the month of May-Oct due to heavy rainfall followed by moderate moisture content in terrace practice and least in jhum practice, which may be due to sloppy land which can not hold water for a longer period, whereas the plain valley land can hold water for a longer period in all the three agricultural practices. The low percentage moisture content (%) during Mar-May, may be due to the increase in soil temperature, and due to more evaporation rate than the rest of the months. In valley practice the soil pH ranged highest (Jan-Dec) in both the years may be due to the plain land which can hold the hydrogen ion concentration for a longer period followed by moderate in terrace practice may be due to the sloppy land which washed away the hydrogen ion quickly during heavy rainfall, whereas in jhum practice the soil pH range was least (4.29-4.71) in both the years may be due to sloppy and rocky land which helps in carrying away the hydrogen ions by rainfall and deposits in the adjacent bottom areas.

The highest percentage nitrogen content of valley practice than terrace and jhum practices may be due to the plain land, high decomposition rate of vegetations by microbes, carrying away by heavy rainfall from different adjacent mountains and mineralisation (Singh *et al.*, 1991), and in terrace practice the percentage nitrogen content was moderate than
valley may be due to sloppy land which deposits part of the nitrogen content in the adjacent bottom areas, whereas in jhum practice the percentage nitrogen content was comparatively less than valley and terrace practices may be due to heavy rainfall which washed away the existing nitrogen and accumulated in the nearest ground level. The low percentage phosphorus content in all the three agricultural practices during study period may be due to uptake by the crop plants in previous harvesting and absence of rainfall, whereas higher percentage during May-Dec may be due to rainfall and carried away by heavy rainfall from the adjacent hills and accumulated in the adjacent plain valley land. In jhum practice the percentage phosphorus content was least than valley and terrace practices may be due to high shower of rainfall, and rocky land which deposited in the adjacent bottom areas. It was also found that the percentage potassium content of both valley and terrace practices were almost similar, whereas in jhum practice the percentage potassium content was least may be due to rocky soil, presence of less vegetation and washing away by heavy rainfall and accumulated in the adjacent low land areas. It was seen that percentage carbon content in jhum practice was highest during the study period than valley and terrace practices may be due to burning of existing and collected vegetations for jhum cultivation by farmers and natural mineralisation process (Robertson, 1983) (Fig-11).