SUMMARY AND CONCLUSIONS

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Chapter 6

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The objectives of the present study were-

- To study the influence of different organic fertilizers on soil physical parameters.
- To study the soil availability and uptake pattern of nutrients due to the application of organic fertilizer.
- To investigate and characterize the organic matter build up of black pepper growing soil.
- To study biological index of soil fertility based on soil dehydrogenase and acid phosphatase activities.
- To study the effect of organic fertilizers on P- adsorption.
- To study soil quality as influenced by organic fertilization and
- To assess the effect of treatments on crop growth, yield and quality of black pepper.

To achieve the above objectives the following studies were made-

1. A greenhouse experiment to assess the effect of different organic fertilizers on organic fractions of soil, transformation, and availability of nutrients, growth and yield of black pepper. The experiment was laid out in Peruvannamuzhi Experimental Farm of the Indian Institute of Spices research (IISR), Calicut, Kerala.

2. An incubation experiment to evaluate the relative efficiency of organic fertilizers in enhancing microbial biomass in typical black pepper growing soils Ustic Humitropept of Peruvannamuzhi and Tropic Argiustoll of Wayanad. The study was conducted at IISR laboratory.

3. A laboratory incubation experiment to study the effect of organic fertilizers on P-adsorption in typical black pepper growing Ustic Humitropept soils was laid.
4. A field experiment to study the relative efficiency of organic fertilizers on physico-chemical properties of soil, organic fractions of soil, on soil quality and yield and quality of black pepper. The field experiment was laid out at Ashoka Plantations, Boikeri, Coorg, Karnataka state.

The following salient findings were obtained from the above investigations:

1. A decrease in bulk density with an increase in water holding capacity of soil was obtained with the addition of organic fertilizers to soil. The incorporation of organic fertilizers ameliorated the soil physical properties of major pepper growing soil. Among the organic sources, FYM was significantly superior, followed by vermicompost.

2. Annual application of organic fertilizers over the years significantly increased the soil pH. The humic acid contributed by the soil organic matter on the application of organic fertilizers not only complexed \( \text{Al}^{3+} \) and \( \text{Fe}^{2+} \) ions in the acidic soil but also increased the soil pH.

3. The organic carbon build up in the soil was significantly enhanced due to the application of organic sources. Among the organic fertilizers vermicompost through addition of organic matter from the source was superior.

4. Application of vermicompost in the soil enhanced the soil availability of micronutrients due to the solubilizing effect of complexes formed by organic fractions in vermicompost.

5. The microbial biomass of soil was enhanced due to the application of organic fertilizers. Among the organic sources vermicompost was superior. The increased levels of accumulated enzymes in the soil and more importantly, direct contribution of enzymes by the organic manures themselves, might be responsible for greater soil enzyme activity.

6. Adsorption of P was significantly reduced with the increased levels of P- application in the presence of FYM, compared to other organic sources. This may be due to the formation of phospho-humic complexes and coating of sesquioxide surface humus to form protective cover that reduces P fixing capacity of an acid soil. Among
the soils, the higher adsorption in Peruvannamuzhi soil as compared to that of Pulpally may be attributed to the higher clay content in the soil of Peruvannamuzhi.

7. Humic acid fraction had high $E_{4}/E_{6}$ value which indicates the release of hydrophilic organic fraction from soil organic matter. The humic acid content was high in the high altitude pepper growing ultisol soil of Coorg.

8. The soil enzyme activities were highly correlated with the soil organic carbon, total N and microbial biomass carbon.

9. The yield of black pepper was significantly increased due to application of organic fertilizers. Among the sources, vermicompost and FYM treatments were superior. The improved physico-chemical and biological properties of soil resulted in higher yield.

10. Application of organic sources significantly enhanced the quality of black pepper. The piperine and oleoresin content was enhanced due to application of organic fertilizers.

11. Among the organic treatments, the benefit /cost ratio was highest on FYM application followed by vermicompost treatment.

From the results obtained in these experiments the following broad conclusions might be drawn-

1. Application of organic fertilizers decreases the bulk density and increases water holding capacity of the soil. The decrease in bulk density was significantly high in FYM treated plot. The other organic treatments also showed decrease in bulk density of the soil but at a subdued level. In the surface layers of soils organic matter bonded to clay particles through association with Al or Fe plays a major role in the formation of stable soil aggregates. The other possible organic binding agents are polysaccharides, waxes and other hydrophobic organics which help in binding soil particles. These hydrophobic materials resist biodegradation and chemical decomposition and have long residence
time in soils. Hence there has been further decrease in bulk density at crop maturity in the experimental plot.

2. The organic fertilizers have moderating effect on soil acidity. The rise in soil pH on addition of organic fertilizers might be due to microbial decomposition and decarboxylation of organic acid anions released from organic sources by microbial action. Another possible mechanism for the organic fertilizer induced increase in pH is specific adsorption of humic material or organic acids on to Al and Fe hydrous oxides with the consequent release of OH⁻ ions.

3. The increase in the accumulation of humic acid in the high altitude pepper growing soil of Coorg is attributed to continuous addition of litter and subsequent humus synthesis. The high value of $E_4/E_6$ of humic acid shows low degree of aromatic condensation and large proportion of aliphatic groupings in the humus.

4. The adsorption of P reduced with the increased levels of P application in the presence of FYM. It is evident that in relation to P adsorption and P availability, the major effect of applying organic fertilizers to soils is the addition of P in the residues. The added P increases P availability directly and is specifically adsorbed onto soil colloid surfaces and as a result, the availability of subsequently added P is raised. Adsorption of organic compounds produced during residue decomposition also decreases adsorption of subsequently added P and increases its availability. Further, the increase in soil pH that occurs during the decomposition of organic fertilizers increases surface negative charge and decreases P adsorption.

5. Enzyme activity in the soil was enhanced due to application of organic fertilizers and was highest in vermicompost treatment. Greater dehydrogenase and acid phosphatase activity is an indicator of higher microbial biomass and enzyme activities. The improved soil physical properties and nutrient availability would have increased the enzyme activity.
6. The application of organic fertilizers which regulate soil microbial activity is ultimately reflected in the total nitrogen and organic carbon content of the soil. Soil organic carbon provides a measurement of soil's total inventory of organic matter, while microbial biomass and enzyme activity reflect forms of labile organic matter. These properties also have a functional role in soil and thus provide information relating to the magnitude of that function in nutrient storage, biological activity and soil structure. Soil quality assessment is therefore based on the relation between composition and functioning of soil.

7. The overall beneficial effect of organic agriculture is reflected in the Benefit/Cost analysis. For every rupee invested the net return was Rs.3.8 for FYM application and Rs. 3.2 for vermicompost application.

Cattle dung which is a near inexhaustible resource of organic matter can be potential organic fertilizer. On the whole the net return for vermicompost application is lower than that of FYM, but the piperine and oleoresin content of black pepper was highest on vermicompost incorporation in soil. Hence the use of vermicompost is attractive for practical application because of the unique way in which it is produced even right in the field and the nutrient rich extractant—vermiwash which improved the yield and quality of black pepper. But the higher production cost of vermicompost resulted in lower B/C ratio inspite of high yield obtained on application of vermicompost. Farmers can make vermicomposting cost effective if it is produced in their farms by recycling the farm wastes with initial investment which will fetch net return in the long run.

It is felt that there exists some information gap for which more work is considered necessary. These are indicated below -

Future research must concentrate on
1. The extent to which an increase in pH and adsorption of organic molecules results in increased P availability is still unclear and further research is
warranted. Knowledge of the extent to which application of organic residues can reduce fertilizer P requirement is needed so that integrated soil fertility management can be devised. Such programmes would greatly benefit resource poor farmers who are currently struggling to produce crops on acidic P-deficient soils.

2. The future endeavor to improve and maintain soil quality and resilience must address certain indicators, which are quantifiable as physical, chemical and biological parameters or functions of soils. Our approach in this respect must be holistic and realistic.

3. There is a great scope for future research both in relation to the mechanism that are involved and their relative importance and also the practical significance of using organic fertilizers in the management of black pepper growing acid soils.

A window of hope has finally opened in the form of a growing demand for organic food, world wide and this opportunity should not be missed and could be exploited for benefit of Indian farmers.