

Soil Profile Studies of Organic and Conventional farms growing Chilli, *Capsicum annuum*

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ABSTRACT

The experiments were conducted to determine effects of farming practises on soil quality of fields. Comparative analyses of soil samples from organic and conventional farms were carried out for soil organic matter nitrogen, phosphorus, potassium, salinity, and soil pH. Applications of organic manures increase the availability of organic elements in soil naturally and improve the Nutrient Use Efficiency (NUE) of crops. Standard chemical analytical methods were used to determine organic matter, EC, pH, in soil. Special attention was paid to phosphorus, nitrogen and potassium. Soil profile analysis showed that organic farming gradually enhances soil quality naturally. Results indicated increasing levels of organic carbon, total nitrogen, phosphorus, potassium, CEC, pH of soil from farms practising organic farming.

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KEY WORDS : Conventional; Farming; Organic; Soil; Sustainable agriculture.

Abbreviations

FYM=Farm Yard Manure

NUE= Nutrient Use Efficiency

NPK= Nitrogen, Phosphorus and Potassium

CEC= Cation Exchange Capacity

NPOP= National Program for Organic Production

IFOAM= International Federation of Organic Agriculture Movements

EC= Electrical Conductivity

Introduction

Organic farming has emerged as a progressive approach towards sustainable agriculture, producing crops without deteriorating environment. The major aim of the system is to incorporate integrated environmentally safe approaches for agricultural production. World is well aware of hazards due to usage of huge amount of synthetic fertilizers and pesticides in the conventional farming system. Green revolution increased crop yield many folds, but indiscriminate use of chemicals caused deterioration

of soil quality on a large scale. The agriculture practices affect soil health and soil nutrient cycling process at large.

Agriculture alone accounts for 17.9% of the GDP (2015) of India and also incorporates approximately 50% of the workforce¹³. The demand for organic products is increasing per year over the world. Studies indicate that most of the consumers purchase organic products for health, nutrient benefits and to avoid chemicals used during processing and harvesting of the food products³⁰. Organic food quality is the main concern in attracting the consumers³¹. Excessive use of chemical inputs during green revolution resulted in the rapid degradation in soil quality, biodiversity and adversely impacted farmers' health¹⁴. From a consumer perspective, the increasing quantities of pesticides and fertilizers led to contamination of food and associated health damage¹⁹. NPOP (National Program for Organic Production) has developed some standards for organic farming under guidelines of international organic production standards such as CODEX and IFOAM (International Federation of Organic Agriculture Movements). Increase in yield at conventional

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TABLE-1: Various methods used in comparative soil analysis

S. No.	Methods used in soil testing kit	Nutrients	Extracting Solutions
1.	Olsen's method ¹⁷	Phosphorus	0.5M NaHCO ₃ , pH 8.5
2.	Bray's method ⁵	Phosphorus (P ₁) Phosphorus (P ₂) Potassium	0.025 N HCl and 0.03 N NH ₄ F 0.1 N HCl and 0.03 N NH ₄ F 22% sodium perchlorate, pH 7.0
3.	Troug's method ²⁸	Phosphorus I.A.R.I. method, New Delhi	0.002 N sulphuric acid containing 3 gm. (NH ₄) ₂ SO ₄ per litre, buffered to pH 3.0, 1 N ammonium acetate, pH 6.8
4.	Ammonium acetate method ⁸	Potassium	1N ammonium acetate, pH 7.0
5.	Palaskar method ¹⁸	ammoniacal nitrogen, available sulphur	10% Sodium chloride, Nessler reagent, 10% Sodium tartrate and mono-calcium phosphate sol ⁿ , BaCl ₂
6.	Kjeldahl method ⁹	Available nitrogen	sulfuric acid, 60% NaOH, 10% Na ₂ S ₂ O ₃ , 2% boric acid
7.	DTPA-CaCl ₂ -TEA method ¹¹	Zn, Cu, Fe, Mn, B, Mo	Diluted HCl, DTPA extractant

farm using excess chemicals did not last long²⁶. Organic farming leads to an improvement in soil quality, crop yield, and overall sustainability of crop production systems²²: maximises the use of farming resources; avoids the use of chemical inputs; and pesticides.

The types of pesticides and manures applied in field primarily affect nitrogen (N) and phosphorus (P) level in the soil - limit crop yields in many ways³. Soil indispensably play role in plant physiology⁶. Soil quality is important for crop growth and final yield. Organic manure compensates required elements-macro and micro- in the soil, naturally. Livestock manure returns N (Nitrogen), P(phosphorus), and K(potassium) (macronutrients), as well as magnesium, Ca (calcium), S (sulphur), and Mn (manganese) (micronutrients) to maintain the soil fertility. Nutrients available for plants improved in the experimental soil after organic manures spread, although soil microorganism were recorded variably in soils^{20, 29}. Bacteria found in the soil are helpful to humification, decomposing, and recycling organic matters¹⁵. Microbial populations enhance the production of plant growth regulators (gibberellin and auxin) in roots of plants that soil is rich in organic manures and increase plant growths¹.

Capsicum annuum, Belong to the family

'Solanaceae', originated from South and Central American regions of the new Mexico and Guatemala region as a wild crop around 7500BC²¹. Cultivated species of the genus are *Capsicum annuum*, *C. frutescens*, *C. chinense*, *C. pubescens*, and *C. baccatum*²⁴. The world's hottest *chilli* "naga jolokia" is cultivated in Tezpur, Assam. It is used as food ingredient and/or spices in many cuisines attributing their sensory, colouring, flavouring, heat, pungency and unique aroma. *Capsicum annuum* is an important vegetable and spice crop grown all over the country. Fruits are important source of phenolic compounds, carotenoids, ascorbic acid etc. which provide medicinal properties to it such as antibacterial¹⁰ antioxidant and anti-carcinogenic activity⁷.

Material and Methods

The study area were selected in Jhunjhunu district of Rajasthan (28.1317° N, 75.4022° E). The farms converted from conventional to organic farming take time to modify soil content. Three types of agriculture farms for organic farming were selected. Soil samples from organic farms and conventional farms growing chili were taken. The soil samples named ORG I (collected from farms practicing organic farming since 2-3 years), ORG II (collected from farms practicing organic farming for 5-6 years), ORG III (collected from farms practicing organic

TABLE-2: Results of soil analysis of organic and conventional farms growing chilli.

S.No.	Name of Compound(unit)	ORG I	ORG II	ORG III	CON
1	pH	8.30	8.32	8.83	8.25
2	Electrical conductivity	0.29	0.25	0.22	0.41
3	Organic carbon (%)	0.31	0.34	0.39	0.37
4	Phosphate(per kg)	25	28	36	22
5	Potash(per kg)	320	335	342	330
6	Zn(ppm)	0.60	0.68	0.72	0.52
7	Fe(ppm)	4.26	4.92	5.22	4.20
8	Cu(ppm)	0.22	0.28	0.32	0.20
9	Mn(ppm)	2.24	2.22	3.20	2.20
10	S(ppm)	22.4	28.2	32.4	16.8
11	Available N(kg/ha)	170-190	195-205	215-225	150-165

farming for 7-8 years) and CON (collected from conventional farms) were taken for the analysis.

Soil Analyses

We collected soil samples from 0-15 cm soil depth near the rhizosphere. Collected samples of soil were first air-dried, removed debris or grounded mechanically. In soil testing, physical, physio-chemical and chemical test determining texture, pH (soil reaction), electrical conductivity, organic carbon, mineralizable nitrogen, available phosphorous and potassium to know soil fertility and productivity. We analyzed soil samples according to the methods developed by the National Institute of Agricultural Science and Technology¹⁶. Application of fertilizers for conventional farming was 100 kg ha⁻¹ of urea and 250 kg ha⁻¹ of NPK, while for organic practitioners give input like animal waste, compost and green manure as required. Analyses for soil organic-Carbon, Nitrogen, available-phosphorus, available-potassium, CEC), and pH parameters were done.

Results and Discussion

Data suggested that fields practicing organic farming soil are significantly better in pH, CEC (cation exchange capacity) and base saturation levels contrasting to conventional farms. Soil pH determine micro-organisms' community structure and diversity²⁷, which invariably controls the decomposition and nitrification. Long-term FYM/manure addition increased CEC due to

the colloidal nature of organic matter and increase soil fertility or yield. Continuous use of inorganic chemicals reduced the organic carbon content of soil (Table-2). Available nitrogen in soil significantly increased with application of green manure. Available Nitrogen is very high in organic 3year field *i.e.* (215 to 225 kg per ha) while low in conventional field (150 to 165 kg per ha) (Table- 2). Chemical fertilizers decreased the availability of Ca and Mg, while the application of FYM increased the levels of exchangeable Ca and Mg. Fe, Mn, Zn and Cu contents.

Our results show P, K, Zn, Fe, Cu, Mn, S gradually increase in organic fields with time (Table 2). The levels of nutrients at conventional farm, especially where urea and NPK fertilizers were readily used, they are water soluble and leach out easily. Earlier workers reported leaching of fertilizers from soil of organic farms was Much lower (30-50%) than conventional farming systems^{2,25}. In our study we found that pH of organic field was slightly higher (8.83) compared to conventional field (8.25). Total organic carbon assistances to recover soil texture, capacity to exchange cation and water holding, thus exerts constructive impact on soil fertility and overall health^{4,12}.

The results from soil analysis were very encouraging and indicating that soil of organic field has good parameters like pH, EC and all micro and



Fig. 1 : Various practices of farming for chilli crop; (A) Farmer spraying pesticides on chilli crop; (B) Vermi compost prepared by farmer to increase soil fertility; (C) Organic growing chilli; (D) Vermi compost bed.

macronutrients. The level of NPK has shown significantly higher results in an organic soil sample. Availability of

nutrients changes in soil carbon, nitrogen recycling augments plant defense mechanism and soil fertility increase due to support of microflora growth.

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