

A Comparative Analysis of Soil Properties Under Organic and Inorganic *Triticum aestivum* (Wheat) Farm Soil

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Wheat (*Triticum aestivum*) is one of the important staple crop of India. Increased awareness in people about harmful effects of inorganic fertilizers on soil health turned some progressive farmers to use organic fertilizers. Present study is an attempt to scientifically analyze the effects of organic and inorganic fertilizers application on various physico-chemical, microbial and enzymatic properties of soil. Soil samples were collected from farms growing wheat crop under organic and inorganic fertilizers application. To replicate the results two farms from each category of organic and inorganic fertilizers application were selected in Cchodavadi village of Bhesan Taluka, Junagadh District, Gujarat, India. Soil samples were collected at two growth stages of crop i.e. from standing crop (pre-harvesting stage) and at post-harvest stage and analyzed for various physico-chemical, microbial and enzymatic properties following standard procedures. Results show that fungal diversity and population of phosphate solubilizers, yeast, rhizobium, azotobacter and actinomycetes were higher in organic soils than that of inorganic farm soil and further, their counts were found higher at pre-harvesting stage than post-harvesting. Similar trend was recorded for content of organic carbon and activities of phosphatase (acid and alkaline) and urease. On the other hand content of available nitrogen, phosphorus and potassium were found higher in inorganic soil compared to organic soil and here also their content were higher at pre-harvest stage than post-harvest. It can be concluded that application of organic fertilizers to soil improves its physico-chemical, microbial and enzymatic properties.

Keywords: Organic and inorganic farming, soil health, soil fertility.

Crop productivity depends on soil health whose indicators are amount of essential nutrients, soil reaction, activities of enzymes and microbial population in soil. A number of factors affect these indicators and the most closely related factor is fertilizers applied to soil. Broadly, fertilizers are of two types- organic and inorganic, based on their origin. Organic fertilizers are produced by animal wastes whereas chemical or inorganic fertilizers are produced in factories using chemicals. Organic fertilizers contains all the essential plant nutrients

whereas inorganic fertilizers contains only one or two major nutrients but in highly concentrated form. Both the fertilizers have their inherent advantages and disadvantages. Organic fertilizers were used initially but gradually with time they were replaced by inorganic fertilizers but growing concern of people about harmful effects of inorganic fertilizers and pesticides farmer takes U-turn and began to use organic fertilizers again. This awareness is higher in peoples from developed countries that's why consumers from United States purchased more organic food¹. Reliance on organic agriculture from food security point of view also increased^{2,3}.

In present study wheat farm soils from organic and inorganic fertilizers application history

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were analyzed for various physico-chemical, microbial and enzymatic properties to find out the truth behind the role of organic and inorganic fertilizers application on soil health. This work is done by first author under guidance of co-authors for her M.Sc. Dissertation.

MATERIALS AND METHODS

Study site and sample collection

Surface soil samples under *Triticum aestivum* were collected from two organic and two inorganic farms of Chhodavadi village of Bhesan Taluka, Junagadh District, Gujarat, India by standard method. Sample were collected two times, before harvesting (26th December, 2011) and after harvesting (15th February, 2012) of *Triticum aestivum* (Wheat). Soil samples were collected aseptically in ultraviolet treated sterile plastic bag.

Analysis of soil samples

Collected samples were analysed immediately in laboratory for microbial and enzymatic parameters and stored at 3°C for chemical analysis. Counts of species of rhizobium, azotobacter, actinomycetes, yeast, and phosphate solubilizers and fungal diversity were studied by standard serial dilution pour plate method⁴. Phosphatase and urease activities were checked by spectrophotometry and titrimetric methods^{5,6}. Standard procedures followed for soil physico-chemical analysis are- soil pH and electrical conductivity⁷, organic carbon⁸, available nitrogen⁹, available phosphorus¹⁰, and available potassium¹¹. Average results of two replicates are presented here.

RESULTS AND DISCUSSION

Microbial Analysis

The population of phosphate solubilizers, yeast, rhizobium, azotobacter and actinomycetes were higher in organic soil than that of inorganic soil (Table-1) and this increase ranged between 35.48% (population of yeast) and 235.71% (population of azotobacter). Further, the microbial count was higher at pre-harvesting stage than that of post-harvesting and ranged between 29.34% (rhizobium) and 123.81% (azotobacter) high.

Observation over five years showed that organic nutrients source have a stimulating

influence on the soil microbial communities as seen by the increase in microbial population. Total bacterial, fungal and actinomycetes population were found to increase under organic farming¹².

Increase the amount of organic matter, improves water and air relationships in the soil, thus intensifying count and enzymatic activity of soil microorganisms^{13,14}.

Increased availability of substrates (carbon and nitrogen) required for microbial population build up could be the probable reason for this increase¹⁵.

Soil organic carbon had a positive and significant relationship with actinomycetes count. The data revealed that, with improvement in organic carbon status of the soil, the microbial population increased^{16,17}.

Data presented in Table-2 clearly reflects that organic soil have more fungal species compared to inorganic soil but their diversity decreased at post-harvesting stage than that of pre-harvesting stage.

The fungal population showed positive correlation with organic carbon in all the treatment at the surface soil depth showing that the addition of the fertilizers increase the organic carbon content of the soil and thereby increase the fungal population¹⁸. Higher microbial diversity in organically managed soil was reported earlier¹⁹.

Other researchers have shown that incorporation of organic amendments increase the soil microbial activity²⁰, microbial diversity²¹ and density of bacterial species²². Another possible reason is manual promoted biological and microbial activities, which accelerated the breakdown of organic substance in the added manure.

Effect of fertilizers and pesticides can be either (immediate or short-term impacts) due to harm to the organisms that come in contact with the chemical or indirect due to changes caused by the chemical to the environmental and/or food source of the organisms being studied²³.

A number of studies have shown that organic farming leads to higher soil quality and soil biological activity than conventional farming^{24,25,26}.

Chemical Analysis

All the three major nutrients for crop i.e. nitrogen, phosphorus and potassium were found 105.01, 53.89 and 50.00% higher in inorganic soil

compared to organic soil but organic carbon content follow the reverse trend and remains 68.06% higher in organic soil than inorganic soil. Among pre- and post-harvesting stages nutrients contents remain higher in pre-harvesting stage.

Increased content of available major nutrients in inorganic fertilizers receiving soil is reported earlier²⁷⁻²⁹. Humus portion of organic fertilizers is responsible for increased organic carbon content in soils. Immobilization and mineralization of nutrients are two important processes that take place simultaneously in soil with the addition of organic manures. A slight but consistent increase in organic carbon under tropical condition had been reported earlier³⁰. The increase in soil pH was due to release of NH_3/NH_4 ions.

Increase in the value of electrical conductivity due to organic amendments is reported previously by a number of workers³¹⁻³³ and it occurs because the decomposition of organic materials released acids or acid forming compounds that reacted with the sparingly soluble salts already present in the soil and either converted them into soluble salts or at least increased their solubility.

Enzymatic activity

Activities of acid phosphatase, alkaline phosphatase and urease remains 5.85, 44.44 and 22.23% higher at pre-harvesting stage and 13.64, 60.0 and 23.96% higher at post-harvesting stage in organic soil compared to inorganic soil. Pre-harvesting stage soil reflects 5.0, 1.56 and 10.55% higher content in organic soil and 12.73, 12.5 and

Table 1. Microbial population in soil ($\times 10^3$ cfu/g of dry soil)

Microorganisms	Organic soil		Inorganic soil	
	Pre-harvesting	Post-harvesting	Pre-harvesting	Post-harvesting
Phosphate solubilizers	11.9 (158.69)* (41.67)**	8.4 (147.06)*	4.6	3.4
<i>Yeast</i>	8.5 (80.85)* (102.38)**	4.2 (35.48)*	4.7	3.1
<i>Rhizobium</i>	31.3 (81.98)* (29.34)**	24.2 (112.28)*	17.2	11.4
<i>Azotobacter</i>	23.5 (235.71)* (123.81)**	10.5 (66.67)*	7.0	6.3
<i>Actinomycetes</i>	6.1 (96.77)* (38.64)**	4.4 (91.30)*	3.1	2.3

*Comparison of pre-harvest value of organic soil with pre-harvest value of inorganic soil and post-harvest value of organic soil with post-harvest value of inorganic soil

**Compared to post-harvest value of organic soil

Table 2. Fungal diversity in soil

Soil	Pre Harvesting	Post Harvesting
Organic soil	<i>Penicillium</i>	<i>Penicillium</i>
	<i>Neurospora</i>	<i>Aspergillus</i>
	<i>Aspergillus</i>	<i>Neurospora</i>
	<i>Alternaria</i>	
	<i>Curvularia</i>	
Inorganic soil	<i>Mucor</i>	
	<i>Penicillium</i>	<i>Penicillium</i>
	<i>Aspergillus</i>	<i>Aspergillus</i>
	<i>Neurospora</i>	

12.12% higher content in inorganic soil of acid phosphatase, alkaline phosphatase and urease. We know that enzyme activity depends on microbial number and their activities. Stimulated microbial activity is reported due to addition of organic residues and enzymes produced thereby showed higher activity than direct addition of enzymes from organic sources³⁴. Higher number of microorganisms in organic soil at pre-harvesting stage results in higher enzymatic activity compared to inorganic soil and post-harvest stage. Inhibition of enzyme synthesis by microorganisms in

Table 3. Physico-chemical properties of soil

Physico-chemical characteristics	Organic soil		Inorganic soil	
	Pre-harvesting	Post-harvesting	Pre-harvesting	Post-harvesting
Available nitrogen(kg/ha)	275.50 (70.22)**	161.85	564.79 (105.01)* (97.76)**	285.6
Available potassium (kg/ha)	228.4 (77.88)**	128.4	342.6 (50.00)* (59.05)**	215.4
Available phosphorous (kg/ha)	193 (50.78)**	128	297 (53.89)* (15.12)**	258
Organic carbon(%)	3.21 (68.06)* (31.02)**	2.45	1.91 (41.48)**	1.35
pH	7.79	9.5	7.67	9.1
Electrical conductivity (mS/m)	28	22	28	23

**Comparison of pre-harvest value of organic soil with pre-harvest value of inorganic soil and post-harvest value of organic soil with post-harvest value of inorganic soil

**Compared to post-harvest value of same soil

Table 4. Enzymatic activity in soil

Enzymes	Organic soil		Inorganic soil	
	Pre harvesting	Post harvesting	Pre harvesting	Post harvesting
Acid phosphatase (μg of p-nitrophenol/g/hr)	262.5 (5.85)*	250 (13.64)*	248	220
Alkaline phosphatase (μg of p-nitrophenol /g/hr)	325 (44.44)*	320 (60)*	225	200
Urease (% NH_4 released)	34.26 (22)*	30.99 (23.96)*	28.03	25.00

*Comparison of pre-harvest value of organic soil with pre-harvest value of inorganic soil and post-harvest value of organic soil with post-harvest value of inorganic soil

inorganic fertilizers amended soil due to presence of inorganic ions may also be the reason of lower enzyme activities in these soils²⁸.

Decreased microbial count and studied physico-chemical and enzymatic properties in post-harvesting stage compared to pre-harvesting in both the soils may be due to lowered nutrients content in soil after crop uptake. Nutrients content affects microbial number and activities hence they also goes down in post-harvesting stage. Changes in chemical properties of soil by long term application of mineral fertilizers are reported

earlier³⁵. The continuous use of fertilizers under intensive cropping might alter the status of microorganisms such as bacteria, fungi and actinomycetes in the soil³⁶. Productivity and sustainability of organic agriculture over conventional was proved by a number of workers³⁷⁻³⁸.

CONCLUSION

On the basis of experimental results, it can be concluded organic farm soils are more

healthier than that of inorganic farm soil in terms of higher microbial numbers and increased nutrients content and enzymatic activities.

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