Plant Archives Vol. 24, No. 1, 2024 pp. 1499-1504 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org

DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2024.v24.no.1.211

EFFECT OF ORGANIC FARMING PRACTICES ON SOIL BIOLOGICAL PROPERTIES

Manjunatha Bhanuvally[1], N.H. Sunitha[2], Sharanabasava[3]*, S. Ravi[4] and Mahadevaswamy[5]

[1]Department of Soil Science and Agricultural Chemistry, Agriculture Extension Education Centre, Hadagali-586 127, Karnataka, India.
[2]Department of Home Science, Agriculture Extension Education Centre, Hadagali-586 127, Karnataka, India.
[3]Department of Soil Science, University of Agricultural Sciences, Raichur - 584 104, Karnataka, India.
[4]Department of Soil Science, ICAR - KVK, Hagari - 583 111, Karnataka, India.
[5]Department of Agricultural Microbiology, University of Agricultural Sciences, Raichur - 584 104, Karnataka, India.
*Corresponding author E-mail : sharannatekar88@gmail.com

(Date of Receiving-05-12-2023; Date of Acceptance-09-03-2024)

ABSTRACT

A survey conducted in the Bellary district of the Northern Dry Zone, Karnataka (Zone-3), focused on farmers practicing organic methods for over five years. Information on organic inputs used in groundnut, ragi, onion, drumstick, and maize cropping systems was gathered. Soil samples from 30 selected organic and conventional farms in each cropping system unveiled a consistent increase in dehydrogenase activity and total microbial population in organic farming soils. This indicates the positive impact of organic practices on soil biological activity. The results emphasize the contribution of organic farming to improved soil health through elevated microbial counts and dehydrogenase activity, attributed to increased organic carbon. Embracing organic practices emerges as a promising strategy for sustainable agriculture, fostering soil health and overall system sustainability.

Key words : Conventional farming, Dehydrogenase, Organic farming, Soil microbes, Sustainability.

Introduction

Before the 1960s, traditional agricultural practices in developing countries relied heavily on organic manures, including composts, crop residues, animal manures and green manures. However, the landscape shifted with the rise of inorganic chemical fertilizers in the 1960s, offering increased accessibility and ease of handling compared to their organic counterparts. Chemical fertilizers proved more efficient in crop response, particularly during the "Green Revolution", marked by the introduction of high-yielding crop varieties responsive to intensive fertilizer application. This period saw a significant shift from organic to chemical-based nutrient practices, driven by the adoption of high-yielding varieties and expanded irrigation coverage. By the early 1970s, many developing nations witnessed a substantial replacement of traditional crop nutrient sources with chemical fertilizers. Unfortunately, this transition led to a decline in the utilization of organic manures, coupled with the excessive and imbalanced use of high-analysis fertilizers. The repercussions included soil fertility issues such as acidity, alkalinity, multiple nutrient deficiencies and an overall degradation of soil health.

Organic farming practices have profound effects on soil biological properties, fostering a dynamic and diverse ecosystem beneath the surface. They have more positive impact of organic farming on soil biology. Organic farming fosters a thriving microbial community in the soil, promoting increased microbial activity. The application of organic amendments, such as compost and animal manure, serves as a rich source of nutrients for microorganisms, contributing to nutrient cycling, organic matter decomposition, and the release of essential elements for plant growth. Additionally, organic farming is associated with elevated levels of soil enzymes, particularly dehydrogenases, indicating heightened microbial metabolic activity. The presence of organic inputs stimulates enzyme production, facilitating the breakdown of complex organic compounds into simpler forms that plants can readily utilize (Sudhakar *et al.*, 2002 and Darwin, 1881).

The incorporation of organic matter into the soil improves its structure by enhancing aggregation. Soil microorganisms, including fungi and bacteria, play a crucial role in creating stable soil aggregates. This improved structure promotes better water infiltration, root penetration, and aeration, ultimately contributing to healthier plant growth. Furthermore, organic farming practices, such as crop rotation and cover cropping, create a diverse habitat for soil organisms, including beneficial bacteria, fungi, earthworms and other macro- and microorganisms. This balanced and diverse soil ecosystem helps control pests, diseases and enhances overall soil resilience. Organic farming encourages the accumulation of organic carbon in the soil, contributing not only to enhanced soil fertility, but also aiding in carbon sequestration. This process mitigates the effects of climate change by storing carbon in the soil. Unlike conventional farming, which often relies on synthetic chemicals, organic farming practices prioritize natural inputs, reducing the risk of soil and water pollution and benefiting both terrestrial and aquatic ecosystems. The collective influence of organic farming practices leads to improved soil health, characterized by healthy soils rich in beneficial microorganisms, enzymes and organic matter. This provides a stable foundation for sustainable agriculture, resulting in increased crop yields and resilience to environmental stresses.

Organic farming practices promote a harmonious relationship between plants, microorganisms and the soil environment. The emphasis on natural inputs and sustainable practices not only enhances soil biological properties but also contributes to long-term agricultural productivity and environmental well-being. Keeping these facts in mind, the present investigation was taken up with the following objective. To know the effect of organic farming practices on soil biological properties.

Materials and Methods

A survey was conducted, with help of department of agriculture, NGOs, KVKs and extension workers, aimed at identifying organic farming practitioners in the Northern Dry Zone (Zone-3) of Bellary district, Karnataka. Specifically, farmers with more than five years of experience in organic farming were selected for inclusion. The survey gathered comprehensive data on the types and quantities of organic materials employed by these farmers in their primary agricultural systems. This collaborative effort sought to pinpoint and understand the practices of long-term organic farmers in the region.

Location of study area

Zone 3, the largest among the agro climatic zones in the state, is predominantly located on the black soils of North Karnataka, covering a substantial geographical expanse of 48.74 lakh hectares. A significant 76.60% of its total area is dedicated to agricultural pursuits, show casing its primary agricultural character. Positioned between 300 and 460 meters above mean sea level at latitude 17° 25' N and longitude 76° 65' E, the Northern Dry Zone is characterized by its relatively low average annual rainfall of 613 mm, marking it as the region with the least precipitation in Karnataka. The soils in this zone are notably fertile, with medium black soils being the most prevalent, followed by both deep and shallow black soils.

Soil sampling

During the winter seasons of 2020 and 2021, soil samples were collected from 30 selected organic farms with diverse cropping strategies in different taluks of Bellary district, situated within the Northern Dry Zone of Karnataka. As part of a comprehensive study on the impact of organic farming on soil microbial activities and soil qualities, corresponding soil samples were also obtained from adjacent conventional farms employing identical crop and cropping strategies to serve as control samples. This approach aimed to provide a comparative analysis, allowing for a thorough investigation into the specific influences of organic farming practices on soil microbial activities in the specified agricultural context.

Biological properties of soil

Dehydrogenase activity

Five grams of soil sample and 0.2 g of $CaCO_3$ were taken in the test tubes and treated with 2 ml of 2 per cent 2, 3, 5 triphenyl Tetrazollium Chloride (TTC) and 2 ml of distilled water was added to create anaerobic condition. Sample was mixed thoroughly using glass rod and incubated at 37^0C for 24 hours. The amount of triphenyl formzone (TPF) formed in soil was extracted using methanol and filtered through a funnel plugged with cotton. The soil was repeatedly washed with methanol to remove all reddish colour and diluted to 100 ml. The intensity of reddish colour was measured at 485 nm by taking methanol as blank. The amount of TPF formed was calculated using calibration graph prepared from TPF standard (Casida *et al.*, 1964).

Total Microbial population

Total microbial population count in the soil was determined by Serial dilution and plate count method by Pramer and Schmidt (1964).

Dilution and plate count technique was used for enumerating the living microorganisms in soil, 10g soil was suspended in 100ml water to obtain 10-1 dilution. 1ml of this suspension was added to 9ml water to get a dilution of 10-2. Similarly, the dilution was continued until 10-6 dilution was obtained. From 10-4 dilution 1ml was added to sterile Petri plate for enumeration of bacteria and 1ml from 10-3 dilution for fungi. Then 15ml of the appropriate medium was added to each plate and rotated in clockwise and anticlockwise direction. After solidification, the plates were incubated in inverted position at room temperature. After the incubation period, the colonies were counted assuming that each viable cell will give rise to a single colony. Finally, the number of colonies (CFU) in 1g of soil was calculated by using the following formula as described by Skinner *et al.* (1952).

$$\text{No. of colonies per gram of soil} = \frac{\text{No. of microbial count} \times \text{Dilution factor}}{\text{ml. taken for dilution} \times \text{Weight of soil}} \left(\text{CFU}\, g^{-1} \text{soil}\right)$$

Results and Discussion

Dehydrogenase activity

The findings of the study on dehydrogenase activity, a key indicator of overall biological activity in soils across various cropping systems are summarized in Table 1. Organic farming consistently demonstrated higher dehydrogenase activity compared to conventional farming in all examined cropping systems.

In the groundnut-based cropping system, the average dehydrogenase activity due to organic farming increased from 32.47 to 38.36 µg TPF per g per day, representing an 18.49% overall increase. Notably, the soils of G1 farmer exhibited the highest increase (26.33%), while G2 farmer's soils showed the lowest increase (5.38%). For the ragi-based cropping system, dehydrogenase activity increased from 34.84 to 36.64 µg TPF per g per day, resulting in a 5.22% average increase. The most significant increase occurred in soils of R10 farmer (9.74%). In the onion-based cropping system, the average dehydrogenase activity in organic farms rose from 36.23 to 37.53 µg TPF per g per day, with the highest increase observed in soils of O14 farmer (4.37%) and the lowest in soils of O18 farmer (2.48%). In the drumstick-based cropping system, there was an average 3.36 increase in dehydrogenase activity due to organic farming. The highest increase was in soils of D19 farmer (7.57%), and the lowest was in soils of D21 farmer (1.03%). In the maize-based cropping system, dehydrogenase activity increased from 36.06 to 37.20 µg TPF g^{-1} day^{-1} in organic farms, resulting in an average increase of 3.19%. The most substantial increase was in soils of M28 farmer (5.59%), while the lowest was in soils of M26 farmer (1.01%).

Table 1 : Dehydrogenase activities (ìg TPF formed g^{-1} soil day^{-1}).

Code	Organic farming	Conventional farming	% increase over conventional farming	T-test statistic
Groundnut based cropping system				
G1	39.58	31.33	26.33	6.31
G2	37.21	35.31	5.38	
G3	38.33	32.27	18.78	
G4	39.07	33.54	16.49	
G5	37.60	31.96	17.65	
G6	38.39	30.39	26.32	
Mean	**38.36**	**32.47**	**18.49**	
Ragi based cropping system				
R7	37.43	36.19	3.43	4.92
R8	36.22	34.35	5.44	
R9	37.06	35.10	5.58	
R10	36.94	33.66	9.74	
R11	35.86	34.01	5.44	
R12	36.31	35.72	1.65	
Mean	**36.64**	**34.84**	**5.22**	
Onion based cropping system				
O13	38.93	37.46	3.92	10.23
O14	36.58	35.05	4.37	
O15	37.24	36.34	2.48	
O16	38.62	37.09	4.13	
O17	36.21	34.70	4.35	
O18	37.62	36.71	2.48	
Mean	**37.53**	**36.23**	**3.62**	
Drumstick based cropping system				
D19	36.93	34.33	7.57	3.58
D20	34.33	33.55	2.32	
D21	33.30	32.96	1.03	
D22	35.45	34.22	3.59	
D23	33.64	32.54	3.38	
D24	35.02	34.24	2.28	
Mean	**34.78**	**33.64**	**3.36**	
Maize based cropping system				
M25	38.00	37.44	1.50	3.99
M26	39.12	38.73	1.01	
M27	36.01	35.36	1.84	
M28	37.56	35.57	5.59	
M29	35.65	34.30	3.94	
M30	36.86	35.01	5.28	
Mean	**37.20**	**36.06**	**3.19**	

The study highlighted that organic farming positively influences enzymatic activities in soil, with higher dehydrogenase activity observed in organic farming across all cropping systems (Table 1). This improvement is attributed to increased organic carbon, total nitrogen, and phosphorus content resulting from the application of organic manures (Chandravanshi, 1998; Kukreja *et al.*, 1991; Wlodarczyk *et al.*, 2002; Kourtev *et al.*, 2005 and Liu *et al.*, 2010).

Total Bacterial Population (No. × 10^5 CFU g^{-1} of soil)

Table 2 presents the outcomes of the study on total microbial population, serving as a comprehensive metric for biological activity in soils across various cropping systems. In all cropping systems investigated, soils under organic farming consistently exhibited heightened microbial population activity compared to conventional farming.

Within the groundnut-based cropping system, the average bacterial population due to organic farming increased from 44.49 to 48.79 (No. × 10^5 CFU g^{-1} of soil). G4 farmer's soils experienced the highest increase in bacterial population (12.10%), while G5 farmer's soils demonstrated the lowest increase (5.62%). The overall increase in bacterial population averaged 9.71%. For the ragi-based cropping system, the average of six soils displayed an increase in bacterial population from 40.28 to 41.65 (No. × 10^5 CFU g^{-1} of soil). The average increase in bacterial population due to organic farming reached 3.40%, with the highest increase observed in soils of R9 farmer (5.73%) and the lowest in soils of R8 farmer (0.64%).

In the onion-based cropping system, the average of six soils indicated an increase in bacterial population from 40.19 to 42.01 (No. × 10^5 CFU g^{-1} of soil). The average increase due to organic farming was 4.53%, with the highest observed in O14 farmer's soils (5.28%) and the lowest in O15 farmer's soils (4.15%). In the drumstick-based cropping system, the average increase in bacterial population from 38.67 to 39.61 (No. × 10^5 CFU g^{-1} of soil) due to organic farming amounted to 2.45%. D21 farmer's soils showed the highest increase (3.51%), while D20 farmer's soils exhibited the lowest (1.21%). Within the maize-based cropping system, bacterial population due to organic farming increased to 42.82 (No. × 10^5 CFU g^{-1} of soil) compared to 41.21 (No. × 10^5 CFU g^{-1} of soil) in conventional farms. The average increase in bacterial population was 3.89%, with M25 farmer's soils recording the highest increase (6.29%) and M28 farmer's soils the lowest (2.47%).

This study underscores the consistent enhancement of microbial populations in soils under organic farming across diverse cropping systems (Table 2). The observed increases are attributed to organic farming practices, which likely contribute to improved soil conditions, fostering a conducive environment for microbial growth. These findings align with previous research emphasizing the positive impact of organic farming on microbial activities in soil (Cong *et al.*, 2005 and Thangasamy *et al.*, 2018).

Total Fungi Population (No. × 10^3 CFU g^{-1} of soil)

Table 2 presents the findings on fungal populations in soils across various cropping systems under organic and conventional farming practices. Notably, organic farming demonstrated a decrease in fungal population in the groundnut, ragi, onion, drumstick and maize-based cropping systems.

In the groundnut-based cropping system, the average fungal population due to organic farming decreased from 27.69 to 26.21 (No. × 10^3 CFU g^{-1} of soil). G1 farmer's soils exhibited the highest decrease in fungal population (13.11%), while G2 farmer's soils showed the lowest decrease (2.34%). Overall, there was a 6.13% decrease in fungal population. For the finger millet-based cropping system, the average of six soils indicated a decrease in fungal population from 33.36 to 29.59 (No. × 10^3 CFU g^{-1} of soil) due to organic farming, resulting in a 12.75% average decrease. The highest decrease occurred in soils of R7 farmer (13.14%), and the lowest decrease was in soils of R8 farmer (12.22%).

In the onion-based cropping system, the average fungal population decreased from 34.01 to 30.67 (No. × 10^3 CFU g^{-1} of soil) in soils under organic farming, representing a 10.89% average decrease. The highest decrease in fungal population was observed in soils of O18 farmer (14.11%), while the lowest decrease was in soils of O17 farmer (5.12%). Within the drumstick-based cropping system, the average decrease in fungal population from 33.54 to 29.78 (No. × 10^3 CFU g^{-1} of soil) due to organic farming was 12.62%. The highest decrease was noticed in soils of D23 farmer (14.09%), and the lowest was in soils of D24 farmer (11.60%). In the maize-based cropping system, fungal population due to organic farming decreased to 31.39 (No. × 10^3 CFU g^{-1} of soil) compared to 34.84 (No. × 10^3 CFU g^{-1} of soil) in conventional farms, resulting in a 10.99% average decrease. M28 farmer's soils recorded the highest decrease (13.52%), while M29 farmer's soils exhibited the lowest decrease (8.97%).

The decline in fungal populations in organically

Table 2 : Total Microbial Population in soils under different cropping system.

Code	Bacteria (No. × 10^5 CFU g^{-1} of soil)				Fungi (No. × 10^3 CFU g^{-1} of soil)			
	Organic farming	Conventional farming	% increase over conventional farming	T-test statistic	Organic farming	Conventional farming	% increase over conventional farming	T-test statistic
	Groundnut based cropping system							
G1	48.77	45.46	7.28	9.82	18.00	20.36	13.11	3.77
G2	48.48	43.67	11.01		28.18	28.84	2.34	
G3	49.75	44.98	10.60		26.77	29.71	10.98	
G4	49.93	44.54	12.10		28.74	29.42	2.37	
G5	49.45	46.82	5.62		29.03	30.41	4.75	
G6	46.33	41.49	11.67		26.54	27.4	3.24	
Mean	**48.79**	**44.49**	**9.71**		**26.21**	**27.69**	**6.13**	
	Ragi based cropping system							
R7	46.80	45.29	3.33	4.82	29.38	33.24	13.14	109.44
R8	39.50	39.25	0.64		30.60	34.34	12.22	
R9	43.16	40.82	5.73		28.50	32.24	13.12	
R10	40.26	38.86	3.60		29.09	32.91	13.13	
R11	41.09	39.38	4.34		29.68	33.31	12.23	
R12	39.11	38.07	2.73		30.29	34.12	12.64	
Mean	**41.65**	**40.28**	**3.40**		**29.59**	**33.36**	**12.75**	
	Onion based cropping system							
O13	41.51	39.85	4.17	17.15	29.63	33.16	11.91	8.22
O14	43.67	41.48	5.28		32.2	36.26	12.61	
O15	43.16	41.44	4.15		30.82	34.49	11.91	
O16	42.36	40.24	5.27		29.33	32.17	9.68	
O17	41.09	39.45	4.16		31.23	32.83	5.12	
O18	40.26	38.65	4.17		30.82	35.17	14.11	
Mean	**42.01**	**40.19**	**4.53**		**30.67**	**34.01**	**10.89**	
	Drumstick based cropping system							
D19	39.47	38.82	1.67	6.63	29.61	33.4	12.80	31.98
D20	41.01	40.52	1.21		30.76	34.33	11.61	
D21	39.78	38.43	3.51		28.72	32.40	12.81	
D22	40.60	39.3	3.31		29.31	33.07	12.83	
D23	38.29	37.26	2.76		30.45	34.74	14.09	
D24	38.49	37.66	2.20		29.84	33.30	11.60	
Mean	**39.61**	**38.67**	**2.45**		**29.78**	**33.54**	**12.62**	
	Maize based cropping system							
M25	45.46	42.77	6.29	3.36	30.96	34.43	11.21	17.33
M26	41.52	40.08	3.59		33.19	37.12	11.84	

Table 2 continued...

Table 2 continued...

M27	41.53	40.24	3.21		31.14	34.32	10.21	
M28	43.18	42.14	2.47		30.03	34.09	13.52	
M29	44.1	42.34	4.16		30.65	33.40	8.97	
M30	41.11	39.68	3.60		32.39	35.69	10.19	
Mean	**42.82**	**41.21**	**3.89**		**31.39**	**34.84**	**10.99**	

managed soils may be attributed to continuous organic matter addition, stimulating microbial activities through root exudates and increased carbon substrate from crop residue (Friedal *et al*., 2001). These findings align with Fraser *et al*. (1988), emphasizing the impact of organic matter additions on microbial load compared to inorganic farming practices (Abebe *et al.,* 2017).

Conclusion

In conclusion, the study consistently revealed a notable increase in dehydrogenase activity and a higher total microbial population in soils under organic farming across various cropping systems. This signifies the positive impact of organic farming practices on enhancing biological activity in the soil. The results strongly suggest that organic farming contributes to improved soil health by elevating total microbial counts and dehydrogenase activity. The observed increase in these biological indicators is attributed to the augmentation of organic carbon status in the soils, a key element for sustainable production. The findings underscore the significance of organic farming in influencing soil properties and fostering sustainable yields. In summary, embracing organic farming practices emerges as a promising strategy for promoting soil health, thereby contributing to the overall sustainability of agricultural systems.

Acknowledgement

The author thanks to faculty of extension education centre, Hadagali. I acknowledge the unconditional support rendered by all farmers and Department of soil science, UAS, Raichur.

References

Abebe, Z. and Deressa H. (2017). The effect of organic and inorganic fertilizers on the yield of two contrasting soybean varieties and residual nutrient effects on a subsequent finger millet crop. *Agronomy*, **7(2)**, 42-45.

Casida, L., Klein D. and Santoro T. (1964). Soil dehydrogenase activity. *Soil Sci*., **98(3)**, 371-376.

Chandravanshi, P. (1998). Studied on physical, chemical and microbiological properties of an *Alfisol* subjected to permanent manuring and cropping schedule. *M.Sc (Agri.) Thesis*, University of Agricultural Sciences, Bangalore.

Cong, T., Ristaino J.B. and Shuijin H. (2005). Soil microbial biomass and activity in organic tomato farming systems: Effects of organic inputs and straw mulching. *Soil Biol. Biochem*., **20(1)**, 1-9.

Darwin, C.R. (1881). The formation of vegetable mould through the action and worms with observations on their habitats, John Murry, London, p. 326.

Fraser, D.G., Doran J.W., Sahs W.W. and Lesoing G.W. (1988). Soil microbial populations and activities under conventional and organic management. *J. Environ, Qual*., **17(1)**, 585-590.

Friedal, J.K., Gabel D. and Stahr K. (2001). Nitrogen pools and turnover in arable soils under different durations of organic farming. II. Source and sink function of the soil microbial biomass or competition with growing plants. *J. Plant Nutr. Soil Sci*., **164(2)**, 421-429.

Kourtev, P.S., Huang J.G. and Ehrenfeld W.Z. (2005). Enzyme activities during litter decomposition of two exotic and two native plant species in hardwood forests of New Jersey. *Soil Biol. Biochem*., **34(2)**, 1207-1218.

Kukreja, K., Mishra M.M., Dhankar S.S., Kapur K.K. and Gupta A.P. (1991). Effect of long-term manurial application on microbial biomass. *J. Indian Soc. Soil Sci*., **39**, 685-687.

Liu, E., Yan C., Mei X., He W., Bing S.H., Ding L., Liu Q., Liu S. and Fan T. (2010). Long- term effect of chemical fertilizer, straw, and manure on soil chemical and biological properties in northwest China. *Geoderma*., 158(3): 173-180.

Pramer, D. and Schmidt, E. L. (1964). *Experimental soil microbiology. Soil Sci*., **98(3)**, 211.

Skinner, F.A., Jones P.C.T. and Mollison J.E. (1952). A comparison of a direct- and a plate-counting technique for the quantitative estimation of soil micro-organisms. *J. Gen. Microbiol*., **6(1)**, 261-271.

Sudhakar, G., Christopher Lourdura A., Rangasamy A., Subbian P. and Velayuthan A. (2002). Effect of vermicompost application on the soil properties, nutrient availability, uptake and yield of rice - A Review. *Agricultural Review*, **23(2)**, 127-133.

Thangasamy, A., Gorrepati K., Ahammed T.S., Savalekar R.K., Banerjee K. and Chavan M.K. (2018). Comparison of organic and conventional farming for onion yield, biochemical quality, soil organic carbon, and microbial population. *Arch. Agron. Soil Sci*., **64(2)**, 219-230.

Wlodarczyk, T., Stepniewski W. and Brzezinska M. (2002). Dehydrogenase activity, redox potential and emissions of carbon dioxide and nitrous oxide from Cambisols under flooding conditions. *Biol. Fertil. Soils*, **36(2)**, 200-206.