Int.J.Curr.Microbiol.App.Sci (2020) *9*(11): 3860-3867

EXCELLENT PUBLISHERS

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 9 Number 11 (2020)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2020.911.461

Impact of Farming Systems on Biological Properties of Soil

Abdul Wakil Barakzai[1*], R. S. Chandel[1], Sudhir Verma[2], P. L. Sharma[1] and Maneesh Pal Singh[1]

[1]Department of Entomology, [2]Department of Soil Science and Water Management, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan- 173230, Himachal Pradesh, India

**Corresponding author*

ABSTRACT

Keywords

Zero budget natural farming, conventional farming, cauliflower, soil micro-flora, enzymes

Article Info

Accepted:
24 October 2020
Available Online:
10 November 2020

The experiment was carried outat Model Farm, Zero Budget Natural Farming (ZBNF) system and the research farm of Entomology, Dr. Y. S. Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh (India) during the years 2018-20, to study the biological properties of soil under zero budget natural farming (ZBNF) system, where only indigenous cow urine and dung based on-farm produced formulations *viz*. Beejamrit, jeevamrit and ghanjeevamrit were used, in comparison to conventional farming (CF) practices with recommended fertilizer and pesticide doses in cauliflower ecosystem. The results indicated that the increased in soil micro-flora (bacteria, fungi and actinomycetes) and enzymes (dehydrogenase, phosphatase and urease) activities were higher in ZBNF than CF system. This study explored new and exciting possibilities for the restoration and promotion of a healthy agro-ecosystem to sustain crop production and enhance soil nutrients carrying capacity.

Introduction

Soil is the fundamental natural resource on which all living and nonliving things are evolved and sustained for carrying out vital life processes. Sustainable agriculture directly relies on soil health which is defined as the capacity of the soil to ascertain environmental quality, sustain biological productivity, and maintain health of all living beings (Neemisha, 2020 and Doran and Safley, 1997). Soil biological properties are important indicators of soil health. Most of fertile soils are rich in the population of micro-flora. Fungus, bacteria, actinomycetes are major soil biological components those enrich the soil with various enzymes and increase the soil fertility (Buscot and Varma, 2005; Henneron *et al.*, 2015; Zhen *et al.*, 2014; Simoni *et al.*, 2013and Huber *et al.*, 2001).

When fertilizers and pesticides are used in farmlands, they are transmitted directly or indirectly into the corns and vegetable that affects the human health. Moreover, as pesticides are applied over the vegetable which are directly entering into human or livestock bodies. Excessive use of fertilizers may pollute the underground water with nitrate which is very hazardous to humans or livestock. Nitrate contaminated water can immobilize some of the hemoglobin in blood (Sharma and Singhvi, 2017). Pesticides are often considered a quick and easy solution for controlling weeds and insect pests in urban landscapes, but they contaminate almost every component of our environment. Pesticide residues are found in soil, air and in surface and ground water across the nation, and urban pesticide uses contribute to the problem. Pesticide contamination poses significant risks to the environment and non-target organisms ranging from beneficial soil microorganisms, to insects, plants, fish, and birds. Contrary to common misconceptions, even herbicides can cause harm to the environment (Kumar *et al.,* 2013).Indiscriminate use of agro-chemicals (toxic herbicides, insecticides, fertilizers) post green revolution has adversely impacted soil biological properties (Daikh *et al.,* 2016; Ghosal and Hati 2019). It is a fact that deterioration of soil biological parameters leads to loss of soil fertility and decreasing yield (Singh and Lal, 2019). Various indigenous formulations such as cow urine and dung based Beejamrit, Jeevamrit and Panchgavya have shown their beneficial effects on soil biological properties (Shubha *et al.,* 2014 and Sreenivasa *et al.,* 2009), and are getting popular among farmers. Beejamrit, ghanjeevamrit and jeevamrit contain a lot of microbial properties and increase the soil micro-flora with drastic increase in different soil enzymes. These formulations are rich in bacteria, fungus and actinomycetes population which not only provide basic soil conditioning but also have long lasting effect that leads to improvement in other soil biodiversity like soil arthropods, earthworms and other beneficiary fauna. Cow urine and dung based products are highly effective in improving the soil properties, and they increases the population of beneficial bacteria and fungus which act as antagonist against the plant pathogenic microorganisms (Gangadhar *et al.*, 2020). In present investigation we observed the effect of beejamrit, ghanjeevamrit and jeevamrit and other organic amendments on soil flora and fauna in comparison with conventional farming practices. These initial investigations make a strong point to consider ZBNF as a form of regenerative agriculture.

Materials and Methods

The present investigation was carried out at Zero Budget Natural Farming (ZBNF) system and the research farm of Entomology, Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh (India) during the years 2018-20. Cauliflower (PSBK-1) was raised in Conventional Farming (CF) system with recommended doses of fertilizers, *viz*. urea @ 300kg, SSP @ 675kg and MOP @ 85kg per hectare. Full dose of SSP, MOP and one-third of urea were applied at the time of transplanting. Same variety of cauliflower was grown in ZBNF system along with pea (dicot), coriander (cash crop) and mustard (trap crop) were sown as per the geometry in each plot with central row of pea than two rows of cauliflower, two rows of coriander and two marginal rows of Indian mustard**.** These were treated with beejamrit, jeevamrit and ghanjeevamrit. Randomly seven soil samples were taken from each field using soil auger up to 10 cm depth. These were used to determine the micro-flora and enzymatic activity in soil. Bacteria, fungi and actinomycetes were counted (CFU/ml) by plating 0.1 ml of suitable dilution on separate plates, incubated at 28±2°C and cultured in Nutrient agar, Potato dextrose agar and Kenknight and Munaier medium (Subba, 1999). Soil enzyme dehydrogenase (Thimmaiah, 1999), soil Phosphatase (Tabatabai and Bremner, 1969) and urease (Thimmaiah, 1999) activities were also determined. All parameters were recorded at the initial and final of the crop period.

Results and Discussion

Effect of ZBNF and CF systems on soil properties

Effect of ZBNF and CF systems on microbial properties of soil

Soil micro-organisms play vital role in maintaining the soil health by decomposing the organic matter, nutrient cycling and improving the soil physical structure. The populations of bacteria, fungi and actinomycetes were determined in the laboratory to study the effect of the two farming systems (ZBNF and CF systems) on these organisms. The results of the study on the population of these micro-organisms made at the initial and final of the crop period have been presented below:

The ZBNF system greatly influenced the bacterial count in cropping season in comparison to the CF system. During the study, in ZBNF system, the bacterial population was (16.29±1.58 x 10^7 cfu g^{-1} soil) initially and increased to (23.86±2.11 x 10^7 cfu g^{-1} soil) at the final of the experiment, while in CF system, it was (13.86±1.37 x 10^7 cfu g^{-1} soil) initially and increased to (18.86±1.96 x 10^7cfu g^{-1} soil) at the final of the experiment. The per cent increased in bacterial population was 46.47 per cent in ZBNF system, as compared to 36.08 per cent in CF system. Fungi population was (6.86±0.34 x 10^4 cfu g^{-1} soil) initially and increased to (8.00±0.31 x 10^4 cfu g^{-1} soil) at the final of the experiment under ZBNF system, while in CF system, it was (6.14±0.34 x 10^4 cfu g^{-1} soil) initially and increased to (6.71±0.36 x 10^4 cfu g^{-1} soil)at the final of the experiment. The per cent increased in fungi population was higher in ZBNF (16.62%) as compared to CF (9.28%), respectively. The recorded data of actinomycetes revealed that, ZBNF system highly influenced the actinomycetes count in the cropping season as comparison to the CF system. During the experiment, actinomycetes population was (16.29±1.44 x 10^3 cfu g^{-1} soil) initially and increased to (25.14±1.71 x 10^3cfu g^{-1} soil) at the final of the experiment under ZBNF system, while in CF system, it was (12.86±0.74 x 10^3 cfu g^{-1} soil) initially and increased to (15.71±1.02 x 10^3cfu g^{-1} soil)at the final of the experiment. The per cent increased in actinomycetes population was significantly higher in ZBNF (54.33%) as compared to CF (22.16%), respectively (Table 1).

Although the entire soil microflora (Bacteria, fungi and actinomycetes) increased in both the farming systems, the increase was significantly higher in ZBNF system than CF system. Comparatively higher increase in soil microbial flora under ZBNF system may be due to repeated use of jeevamrit (soil drenching) which contains enormous amount of microbial load that multiplies in the soil and acts as a tonic to enhance the microbial activity in the soil and ghanjeevamrit which provide carbon as a source of energy to the microbes present in jeevamrit for their rapid multiplication and survival (Palekar, 2016). The results indicated that the liquid formulation of cow urine and dung resulted in higher microbial population, which is a pointer of healthy soil. Vishwajeet (2020) also reported increased of 3.83, 10.46 and 7.54 per cent in population of bacteria, fungi and actinomycetes, respectively, under Subhash Palekar Natural Farming (SPNF) system, whereas, in CF system the corresponding values were 4.35, 15.54 and 5.57 per cent.

Rana (2019) also recorded 3.03, 12.5 and 12.4 per cent increase in bacteria, fungi and actinomycetes population under ZBNF system, whereas, in CF system the corresponding change was 1.72, 4.44 and 5.96 per cent. Gangadhar *et al.,* (2020) reported higher bacterial population with Jeevamrit (28.27×10^5 and 31.59×10^5 cfu g^{-1} of soil, respectively) as compared to NCOF-decomposer (21.54×10^5 and 23.73×10^5 CFU g^{-1} of soil, respectively) in two different seasons. Puneet and Saini (2009) also reported effect of jeevamrit 5% on microbial population and found significantly higher colony forming units of bacteria (32.69×10^6), fungi (24.86×10^3) and actinomycetes (6.02×10^2). Sreenivasa *et al.,* (2009) recorded the microbial load of beejamrit and observed bacteria, fungi and actinomycetes were 15.4 $\times 10^5$, 10.5×10^3 and 6.8×10^3 cfu respectively. Devakumar *et al.,* (2018) also recorded higher ebacteria, fungi and actinomycetes 40.33×10^5 CFUg^{-1} of soil, 20.33×10^4 cfu g^{-1} of soiland 15.33×10^3 cfu g^{-1} of soil in jeevamrit.

Effect of ZBNF and CF systems on soil enzymes

Soil enzymes play a key role in the energy transfer through decomposition of soil organic matter and nutrient cycling, and hence play an important role in agriculture. These enzymes catalyze many vital reactions necessary for the life processes of soil micro-organisms and also help in stabilization of soil structure.

Although micro-organisms are the primary source of soil enzymes, plants and animals also contribute to the soil enzyme pool. Soil enzymes respond rapidly to any changes in soil management practices and environmental conditions. Their activities are closely related to physio-chemical and bio-logical properties of the soil. Hence, soil enzymes are used as sensors for soil microbial status, for soil physio-chemical conditions, and for the influence of soil treatments or climatic factors on soil fertility.

Understanding the possible roles of different soil enzymes in maintaining soil health can help in the soil health and fertility management, particularly in agricultural ecosystems. Enzymatic activity is a sensitive indicator of changes in soil environment, and it changes depending on the farming system. In this entry, we describe the effect of ZBNF and CF systems on the activity of major soil enzymes such as: Dehydrogenase, phosphatase and urease.

Data regarding dehydrogenase enzyme revealed that ZBNF practices have greatly influence dehydrogenase activity as compared to CF system.

During the experiment, the dehydrogenase were higher at final (11.14±0.34 µg TPF g^{-1} soil h^{-1}) as compared to the value at the initial (9.29±0.36 µg TPF g^{-1} soil h^{-1}) in ZBNF system, whereas in CF system, dehydrogenase activity was 7.57±0.30 µg TPF g^{-1} soil h^{-1}initially and increased to 8.57±0.30 µg TPF g^{-1} soil h^{-1} at the final of the experiment. The per cent increase was higher in ZBNF system (19.91%) as compared to CF system (13.21%), respectively. The phosphatase enzyme activity was higher at final (92.00±1.11 µg PNP g^{-1} soil h^{-1}) as compared to the value at the initial (87.43±1.43 µg PNP g^{-1} soil h^{-1}) in ZBNF system, whereas in CF system, phosphatase activity was 72.29±2.07 µg PNP g^{-1} soil h^{-1}initially and increased to 73.86±2.11 µg PNP g^{-1} soil h^{-1} at the final of the experiment. The per cent increase was higher in ZBNF system (5.23%) as compared to CF system (2.17%), respectively.Data regarding urease enzyme activity revealed that ZBNF practices greatly influenced urease enzyme activity as compared to CF system.

Table.1 Viable microbial count under ZBNF and CF systems during the experiment

Viable microbes	Farming systems					
	ZBNF			CF		
	Initial	Final	Change %	Initial	Final	Change %
Bacteria (x 10^7cfu g^{-1} soil)	16.29±1.58	23.86±2.11	46.47	13.86±1.37	18.86±1.96	36.08
Fungi (x 10^4cfu g^{-1} soil)	6.86±0.34	8.00±0.31	16.62	6.14±0.34	6.71±0.36	9.28
Actinomycetes (x 10^3cfu g^{-1} soil)	16.29±1.44	25.14±1.71	54.33	12.86±0.74	15.71±1.02	22.16

Table.2 Soil enzymatic activities under ZBNF and CF systems during the experiment

Enzymes	Farming systems					
	ZBNF			CF		
	Initial	Final	Change %	Initial	Final	Change %
Dehydrogenase (µg TPF g^{-1} soil h^{-1})	9.29±0.36	11.14±0.34	19.91	7.57±0.30	8.57±0.30	13.21
Phosphatase (µg PNP g^{-1} soil h^{-1})	87.43±1.43	92.00±1.11	5.23	72.29±2.07	73.86±2.11	2.17
Urease (µg urea g^{-1} soil h^{-1})	7.29±0.18	8.14±0.26	11.66	5.57±0.30	6.00±0.31	7.72

During the experiment, the urease enzyme activity was higher at the final of the crop (8.14±0.26 µg urea g^{-1} soil h^{-1}) as compared to the value at initial (7.29±0.18 µg urea g^{-1} soil h^{-1}) in ZBNF system, whereas in CF system, urease enzyme activity was 5.57±0.30 µg urea g^{-1} soil h^{-1}initially at the time of sowing and increased to 6.00±0.31 µg urea g^{-1} soil h^{-1} at the final of the experiment. The per cent increase was higher in ZBNF system (11.66%) as compared to CF system (7.72%), respectively (Table 2). In present investigation, the increasing percentage of soil enzymes activity *viz*. dehydrogenase, phosphatase and urease were high in ZBNF than CF system. The dehydrogenase, phosphatase and urease enzyme activity showed that higher increasing of 19.91, 5.23 and 11.66 per cent respectively, under ZBNF system as compared to the CF system, where this increase was 13.21, 2.17 and 7.72 per cent, respectively. The higher increment might be attributed to the higher organic carbon content or due to enhanced release of root exudates in the rhizosphere soil of ZBNF system. In CF system, the increment might be due to the recommended application of FYM and urea, as nitrogenous fertilizer. Vishwajeet (2020) also recorded beneficial effect of natural farming formulations on soil enzymatic activity in brinjal ecosystem. He reported23.79, 2.77 and 13.31 per cent increase in the soil activity of dehydrogenase, phosphatase and urease enzymes under SPNF system, whereas, the corresponding value of CF system were 10.11, 0.72 and 17.03 per cent, respectively. Rana (2019) reported similar results in cabbage grown under ZBNF, with 37.29, 7.31 and 10.51 per cent increase in activity of dehydrogenase, phosphatase and urease enzymes in ZBNF system, whereas the corresponding value of CF system were 4.65, 1.37 and 5.78 per cent, respectively. Verma *et al.*, (2018) reported that DHA increased from 6.9 µg TPF g^{-1} h^{-1} under CF to 7.3µg TPF g^{-1} h^{-1} under Organic Farming and was highest under ZBNF i.e. 8.4µg TPF g^{-1} h^{-1}. Similarly alkaline and acid phosphatase activity in ZBNF, the alkaline phosphatase activity increased to 105µg PNP g^{-1} h^{-1} in comparison to 65µg PNP g^{-1} h^{-1} and 71µg PNP g^{-1} h^{-1} under Conventional and Organic Farming systems, respectively. The acid phosphatase activity was also highest under ZBNF (112µg PNP g^{-1} h^{-1}) followed by Organic Farming (99µg PNP g^{-1} h^{-1}) and CF (84µg PNP g^{-1} h^{-1}).

Gangadhar *et al.*, (2020) also provided a supportive base to our study with dehydrogenase activity (53.70 TPF formed g^{-1} soil day^{-1}), acid phosphatase activity (31.35 PNP formed g^{-1} soil $hour^{-1}$), alkaline phosphatase activity (21.66 PNP formed g-1 soil $hour^{-1}$) and urease activity (5.97 g NH4-N formed g^{-1} soil $hour^{-1}$) in jeevamrit formulations. Soil enzymes are the basic degradation unit in soil, if their activity reduced that reduces the availability of nutrients in soil. The study revealed a significant increase in soil micro-flora i.e. bacteria, fungi and actinomycetes; and enzyme activities i.e. dehydrogenase, phosphatase and urease, from crop sowing till harvest. These initial investigations make a strong point to consider ZBNF as a form of regenerative agriculture.

References

Bano R and Roy S. 2016. Extraction of soil microarthropods: A low cost Berlese-Tullgren funnels extractor. *International Journal of Fauna and Biological Studies* 3(2): 14-17.

Buscot F, Varma A. 2005. Microorganisms in soils: roles in genesis and functions. *Springer-Verlag, Berlin, Heidelberg*.

Daikh, E B, EL-Mabrouk, A. and EL Roby, A. S. M. H. 2016. Effect of glyphosate herbicide on the behavior of soil arthropods in non-organic tomato system. *Advance agriculture biology*. 5(1): 1-15.

Devakumar N, Lavanya G and Rao G G E. 2018. Influence of Jeevamrutha and Panchagavya on beneficial soil microbial population and yield of organic fieldbean (*Dolichos lablab* L.). *Mysore journal of agricultural sciences* 52(4): 790-795.

Devakumar N, Shubha S, Gouder S B and Rao G G E. 2014. Microbial analytical studies of traditional organic preparations beejamrutha and jeevamrutha.

Doran J W and Safley M. 1997. Defining and assessing soil health and sustainable productivity. *CAB International*, *Walling ford*. pp. 1-28.

Gangadhar K, Devakumar N, Vishwajith and Lavanya G. 2020. Influence of different sources of organic manures and decomposers on enzymatic activity and microbial dynamics of rhizosphere soil of chilli (*Capsicum annum* L.). *International journal of current microbiology and applied sciences* 9(1): 542-555.

Ghosal A. and Hati A. 2019.Impact of some new generation insecticides on soil arthropods in rice maize cropping system. *The Journal of Basic and Applied Zoology*. 80(6): 1-8.

Henneron L., Bernard L., Hedde M., Pelosi C., Villenave C., Chenu C., Bertrand M., Girardin C. and Blanchart E. 2015. Fourteen years of evidence for positive effects of conservation agriculture and organic farming on soil life. *Agronomic Sustainable Development*. 35:169–181.

Huber S, Syed B, Freudenschuss A, Ernstsen V, Loveland P. 2001. Proposal for a European soil monitoring and assessment framework. Technical report no. 61. *European Environment Agency*, Copenhagen, Denmark.

Kumar S, Sharma A K, Rawat S S, Jain D K and Ghosh S. 2013. Use of pesticides in agriculture and livestock animals and its impact on environment of India. *Asian Journal of Environmental Science*. 8:51-57.

Neemisha. 2020. Role of Soil Organisms in Maintaining Soil Health, Ecosystem Functioning, and Sustaining Agricultural Production. *Soil Health*. 59:313-335.

Pahari D, Hazra A K and Saha G K. 2007. Diversity and distribution of soil arthropod communities in relation to altitude and edaphic factors of different altitudinal environments of Darjeeling Himalayas, India. *Rec. zool. surv. India* l07: 43-59.

Palekar S. 2016. Vegetable crops in zero budget spiritual farming. Zero budget spiritual agriculture system research, development and extension movement, Amaravati, Maharashtra.

Parisi V, Menta C, Gardi C, Jacomini C and Mozzanica E. 2005.Microarthropod communities as a tool to assess soil quality and biodiversity: a new approach in Italy. *Agriculture, Ecosystems and Environment* 105: 323–333.

Puneet K and Saini J P. 2009. Standardization of the doses and time of application of 'Jeevamrit'' in wheat under natural farming system. M. Sc*Thesis*. CSKHPKV, Palampur.

Rana A. 2019. Insect-pests, natural enemies and soil micro-flora in cabbage under Zero Budget Natural Farming and Conventional Farming systems. M. Sc *Thesis*. Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan (HP).

Sharma N and Singhvi R. 2017. Effects of chemical fertilizers and pesticides on human health and environment: A review. *International Journal of Agriculture, Environment and Biotechnology* 10:675-79.

Shubha S, Devakumar N, Rao G G E and Gowda S B. 2014. Effect of seed treatment, panchagavya application and organic farming systems on soil microbial population, growth and yield of maize.

Simoni S, Nannelli R, Castagnoli M, Goggioli D, Moschini V, Vazzana C, Benedettelli S and Migliorini P. 2013. Abundance and biodiversity of soil arthropods in one conventional and two organic fields of maize in stockless arable systems.*REDIA* 96: 37-44.

Singh A S and Lal E P. 2019. Impact of organic liquid formulation, jeevamrutha on photosynthetic pigments of *Ocimum basilicum* L. (sweet basil) under NaCl induced salinity stress. *Plant archives* 19: 1997-2001.

Sreenivasa M N, Naik N and Bhat S N. 2009. Beejamrutha: A source for beneficial bacteria. *Karnataka J. Agric. Sci* 22(5): 1038-1040.

Tabatabai M A and Bremner J M. 1969. Use of p-nitrophenyl phosphate for assay of soil phosphatase activity. *Soil biology and biochemistry* 1: 301-317.

Thimmaiah S R. 1999. Standard methods of biochemical analysis.Kalyani publishers, New Delhi, India. 545p.

Verma S, Chandel R S, Kaushal R, Yankit P and Sharma S. 2018.Soil quality management through Zero Budget

Natural Farming. https://www.icar.org. in/content/volume-24-no-3-july-september-2018

Vishwjeet. 2020. Population dynamics of insect-pests of brinjal and their natural enemies under SubhashPalekar Natural Farming and Conventional Farming systems. M. Sc *Thesis*. Dr. Y S Parmar University of Horticulture and Forestry, Nauni, Solan (HP).

Zhen Z, Liu H, Wang N, Guo L, Meng J, Ding N, Wu G and Jiang G. 2014. Effects of manure compost application on soil microbial community diversity and soil microenvironments in a temperate cropland in China. *Plos one* 9(10): 1-12.

How to cite this article:

Abdul Wakil Barakzai, R. S. Chandel, Sudhir Verma, P. L. Sharma and Maneesh Pal Singh. 2020. Impact of Farming Systems on Biological Properties of Soil. *Int.J.Curr.Microbiol.App.Sci.* 9(11): 3860-3867. doi: https://doi.org/10.20546/ijcmas.2020.911.461