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Effect of zero budget natural farming on organic carbon and microbial population of wheat

Komal Gupta, SS Bhadauria and BS Kasana

Abstract
A field experiment was conducted to study the, "Effect of zero budget natural farming on organic carbon and microbial population of wheat". The study was accomplished during *rabi* season of 2019-20 and 2020-21 at Research Farm, College of Agriculture, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior (M. P.). The experiment was laid out in a Randomized Block Design; comprising of fifteen treatments. The results indicated that significantly higher microbial population *viz*., Bacteria (x10^5 cfu g^{-1} soil), actinomycetes (x10^3 cfu g^{-1} soil) and fungi (x10^4 cfu g^{-1} soil) were found with the treatment T_{12}: Beejamrutha + Jeevamrutha + Panchgavya (1000 ml + 500 l + 15 lit. ha^{-1}) and T_{13}: Beejamrutha + Panchgavya + Ghanajeevamrutha (1000 ml + 15 lit. + 25 kg ha^{-1}) at par with T_{14}: Ghanajeevamrutha + Jeevamrutha + Beejamrutha (25 kg + 500 l + 1000 ml ha^{-1}). No significant effect of T_{14}: Ghanajeevamrutha + Jeevamrutha + Beejamrutha (25 kg + 500 l + 1000 ml ha^{-1}) were observed on organic carbon content in soil. The lowest values for bacteria (x10^5 cfu g^{-1} soil), actinomycetes (x10^3 cfu g^{-1} soil), fungi (x10^4 cfu g^{-1} soil) and organic carbon content were recorded under treatment of T_{15}: 100% RDF (N:P:K 120:60:40 kg ha^{-1}). Application of liquid organic manure failed to generate any significant effect on soil physico-chemical properties.

Keywords: wheat, natural farming, organic carbon and microbial

Introduction

Wheat (*Triticum aestivum* L.) is the second most important cereal crop, next to rice in the world belongs to the family *Poaceae.* It is the leading cereal grain, where 40% of the world populations use it as a staple food (Anonymous, 2007) [1]. Its increasing demand on incessant basis is due to increase in the population of India and World. Green revolution technologies played a great role in alleviating hunger but have also resulted in some adverse effects on our natural resources. Post green revolution, usage of chemical fertilizers involved single or combinations of nitrogen, phosphorus and potassium components in the fertilizers have hampered soil health drastically by reducing organic content, increasing salinity, disturbing local pH (Wang *et al.*, 2008) [15]. During the last few years there has been increasing interest in the use of Panchagavya, Jeevamrutha, Beejamrutha and Ghanajeevamrutha liquid Organic formulations. Panchagavya, Jeevamrutha, Beejamrutha and Ghanajeevamrutha are four organic products which have received wide spread attention and acceptability among organic farming practitioners. Application of cow-based bio-enhancers, botanicals, organic manures and bio fertilizers such as Panchagavya, Jeevamrutha, Beejamrutha and Ghanajeevamrutha has led to a decrease in the use of chemical fertilizers and has provided high quality products free of harmful agrochemicals for human safety. Soil biological properties are important indicators of soil health. Most of fertile soils are rich in the population of both flora and fauna. Fungus, bacteria, actinomycetes are major soil biological components those enrich the soil with various enzymes and increase the soil fertility (Zhen *et al.*, 2014) [15]. Various indigenous formulations such as cow urine and dung based Beejamrutha, Jeevamrutha and Panchgavya have shown their beneficial effects on soil biological properties (Shubha *et al.,* 2014 and Sreenivasa *et al.,* 2009) [12]. Beejamrutha, Ghanajeevamrutha and Jeevamrutha 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) [2].

Locally adapted nutrient management measures for wheat which are technically sound, environmental friendly, economically viable, socially acceptable and practically feasible are yet to be studied thoroughly for Madhya Pradesh.

Materials and methods

A field experiment titled, "Effect of zero budget natural farming on organic carbon and microbial population of wheat" was carried out during *Rabi* season of 2019-20 and 2020-21 at Research Farm, College of Agriculture, Rajmata Vijayaraje Scindia Krishi Vishwavidyalaya, Gwalior (M. P.). Fifteen treatments comprising of T_1: Control, T_2: Beejamrutha (1000 ml ha^{-1}), T_3: Jeevamrutha (500 l ha^{-1}), T_4: Panchgavya (15 lit ha^{-1}), T_5: Ghanajeevamrutha (25 kg ha^{-1}), T_6: Beejamrutha + Jeevamrutha (1000 ml + 500 l ha^{-1}), T_7: Beejamrutha + Panchgavya (1000 ml + 15 lit. ha^{-1}), T_8: Beejamrutha + Ghanajeevamrutha (1000 ml + 25 kg ha^{-1}), T_9: Jeewamrutha + Panchgavya (500 l + 15 lit. ha^{-1}), T_{10}: Jeevamrutha + Ghanajeevamrutha (500 l + 25 kg ha^{-1}), T_{11}: Panchgavya + Ghanajeevamrutha (15 lit. + 25 kg ha^{-1}), T_{12}: Beejamrutha + jeevamrutha + Panchgavya (1000 ml + 500 l + 15 lit. ha^{-1}), T_{13}: Beejamrutha + Panchgavya + Ghanajeevamrutha (1000 ml + 15 lit. + 25 kg ha^{-1}), T_{14}: Ghanajeevamrutha + Jeevamrutha + Beejamrutha (25 kg + 500 l + 1000 ml ha^{-1}) and T_{15}: 100% RDF (N:P:K 120:60:40 kg ha^{-1}) in randomized block design with three replications. All the recommended cultural operations were followed throughout the experimentation. Observations were recorded on organic carbon and soil microbial population *viz.*, actinomycetes (x 10^3 cfu g^{-1} soil), Fungi (x 10^4 cfu g^{-1} soil) and Bacteria (x 10^5 cfu g^{-1} soil) of wheat. The data were subjected to statistical analysis by adopting appropriate analysis of variance as described by (Gomez and Gomez, 1984) [3]. Organic carbon was determined by Walkley and Black's rapid titration method as described by Walkey (1947) [14].

Soil microbial population

The soil samples were collected from 0-15 cm surface soil from all the plots at the time of harvest in wheat. The soil samples were soaked into 90 ml deionized water at the rate of 10 gm. Later this mixture was shaken for 10 minute and kept for 5 minute. Thereafter, 1ml of the supernatant was diluted twice and inoculated in the diluted water at the constant temperature of 30 ºC. All samples were performed in triplicate, and were used for enumeration of microorganisms. The viable microbial counts were analyzed by the standard technique of serial dilution and dour plating. Enumeration of bacteria and fungi was carried out in soil extract agar medium (James, 1958) [4] and Rose Bengal Agar medium (Parkinson *et al.*, 1971) [16]. The Kenknight's Agar medium (Wellingtonn and Toth, 1963) [16] was used for enumeration of actinomycetes. After allowing for development of discrete microbial colonies during incubations under suitable conditions, the colonies were counted and the number of viable bacteria, fungi and actinomycetes [expressed as colony forming units (cfu)] per gram dry weight of soil was estimated by taking into account the soil dilutions.

Preparation of *Panchagavya*

A wide mouth plastic container was taken. It was clean and sun-dried for a day or two to sterilize it. Then the cow dung (7 kg) and ghee (1 kg) were mixed in the container using a wooden stick. It was stirred clockwise direction in a rhythmic motion. Then it stirred in anti-clockwise direction. The container was covered using thick cloth to protect it from insects. This mixture was left for three days. After 3 days cow urine (10 l) and water (10 l) were mixed than kept for 15 days with regular mixing both in morning and evening hours. After 15 days cow milk (3 l), cow curd (2 l), tender coconut water (3 l), jaggery (3 kg) and well ripened banana (12 no.) were mixed. *Panchagavya* was ready after 30 days.

Preparation of *Jeevamrutha*

Jeevamrutha was prepared by mixing *desi* cow dung (10 kg), cow urine (10 l), jiggery (2 kg), pigeon pea flour (2 kg) and hand full of soil collected from rhizosphere of Banyan tree. All these were put in 200 liter capacity plastic drum and mixed thoroughly and volume was made up to 200 liter. The mixture was stirred well in clock wise direction and kept in shade covered with wet jute bag up to nine days and it was used for soil application.

Results and Discussion

Effect on soil microbial population

The population of bacteria, actinomycetes and fungi in the soil recorded after the harvest of crop has been presented in the Table 1.

Bacteria (x 10^5 cfu g^{-1} soil)

Significantly higher population was recorded with application of T_{12}: Beejamrutha + Jeevamrutha + Panchgavya (1000 ml + 500 l + 15 lit. ha^{-1}) at harvest and was at par with application of T_{14}: Ghanajeevamrutha + Jeevamrutha + Beejamrutha (25 kg + 500 l + 1000 ml ha^{-1}), T_{13}: Beejamrutha + Panchgavya + Ghanajeevamrutha (1000 ml + 15 lit. + 25 kg ha^{-1}), T_9: Jeewamrutha + Panchgavya (500 l + 15 lit. ha^{-1}), T_7: Beejamrutha + Panchgavya (1000 ml + 15 lit. ha^{-1}) and T_{11}: Panchgavya + Ghanajeevamrutha (15 lit. + 25 kg ha^{-1}) at harvest during both the year and on mean basis. Significantly lower population of bacteria was recorded with the sole application of either T_{15}: 100% RDF (NPK 120:60:40 kg ha^{-1}) during both the year and on mean basis. Panchagavya is the fermented organic liquid manure with high microbial load, which includes effective microorganisms and methyl trophs profile bacteria also. These would have enhanced the production of phyto hormones like auxins and gibberellins. The increase in plant height might be due to application of nutrients through foliar spray of Panchagavya enhanced the growth rate of plant since it contains the favourable macro and micro nutrients, growth hormones and bio fertilizers in liquid formulation. Similar findings have been reported by Kumar *et al.* (2011) [5] and Sahare (2015) [10].

Actinomycetes (x 10^3 cfu g^{-1} soil)

Compared with zero budget natural farming increased the abundance of Actinomycetes. Significantly higher population was recorded with application of T_{12}: Beejamrutha + jeevamrutha + Panchgavya (1000 ml + 500 l + 15 lit. ha^{-1}) at harvest and was at par with application of T_{14}: Ghanajeevamrutha + Jeevamrutha + Beejamrutha (25 kg + 500 l + 1000 ml ha^{-1}), T_{13}: Beejamrutha + Panchgavya + Ghanajeevamrutha (1000 ml + 15 lit. + 25 kg ha^{-1}). Lowest population of actinomycetes was observed in T_{15}: 100% RDF (NPK 120:60:40 kg ha^{-1}) during both the year and on mean basis. Sreenivasa *et al.* (2011) [13] reported the increase of actinomycetes population may be caused congenial condition for the growth of microbes in organic boosters and by the ingestion of nutrient rich organic wastes which provide energy and also act as substrate for the growth of micro organisms. A considerable increase in viable count of the actinomycetes in organic booster was noticed by Gore and Sreenivasa (2011) [13]. These results are confirmed with findings reported by Pathak and Ram (2013) [8].

Fungi (x 10^4 cfu g^{-1} soil)

Maximum fungal population was recorded in T_{13}: Beejamrutha + Panchgavya + Ghanajeevamrutha (1000 ml + 15 lit. + 25 kg ha^{-1}), which was at par with the treatment of T_{14}: Ghanajeevamrutha + Jeevamrutha + Beejamrutha (25 kg + 500 l + 1000 ml ha^{-1}) and T_{12}: Beejamrutha + jeevamrutha + Panchgavya (1000 ml + 500 l + 15 lit. ha^{-1}) during both the year and on mean basis. Sreenivasa *et al.* (2009) [12] reported the higher population of fungi in Panchgavya, Beejamrutha and Biodigester. Further, Gore and Sreenivasa (2011) [13] analyzed microflora in organic boosters and noticed the more number of fungi in Panchgavya, Jivamrutha followed by Beejamrutha. Moreover, Rupela (2008) [9] studied sample from different layers of heap and remarked that some samples of Amrutmitti had upto 100 million plant growth promoting bacteria (siderophore producers) in every gram of the compost which was highest ever measured in any compost.

Effect on organic carbon (%)

The observations on organic carbon **(%)** as influenced by different zero budget natural farming in wheat were recorded at harvest and the data are given in Table 2. The organic carbon found to increase in soil with the advancement of crop and reached to highest level at harvest. However, organic carbon content in the soil was affected did not significantly due to different zero budget natural farming in wheat. The higher numerical value of organic carbon content was found under the treatment of T_{14}: Ghanajeevamrutha + Jeevamrutha + Beejamrutha (25 kg + 500 l + 1000 ml ha^{-1}). However, it was comparable to T_{12}: Beejamrutha + jeevamrutha + Panchgavya (1000 ml + 500 l + 15 lit. ha^{-1}), T_{13}: Beejamrutha + Panchgavya + Ghanajeevamrutha (1000 ml + 15 lit. + 25 kg ha^{-1}) and T_{11}: Panchgavya + hanajeevamrutha (15 lit. + 25 kg ha^{-1}). The minimum organic carbon was recorded under treatment of T_{15}: 100% RDF (NPK 120:60:40 kg ha^{-1}) during both the years and on mean basis. The higher build-up of SOC in the organic sources applied plots may be attributed to slower break down rate (less and constant mineralization rate) and increased above and below ground organic residues due to enhanced crop growth (Moharana *et al*., 2012) [6].

Table 1: Microbial population in soil on wheat as influenced by different zero budget natural farming

Treatment	Microbial population in soil								
	Bacteria (x10^5 cfu g^{-1} soil)			Fungi (x10^4 cfu g^{-1} soil)			Actinomycetes (x10^3 cfu g^{-1} soil)		
	2019-20	2020-21	Mean	2019-20	2020-21	Mean	2019-20	2020-21	Mean
T1	8.96	10.21	9.59	5.85	7.21	6.53	1.43	1.46	1.44
T2	10.57	12.78	11.67	7.46	8.93	8.20	5.09	5.62	5.36
T3	16.21	18.37	17.29	10.42	11.62	11.02	2.39	2.53	2.46
T4	16.47	18.89	17.68	15.52	16.52	16.02	3.09	3.22	3.16
T5	15.09	16.63	15.86	8.25	9.61	8.93	1.87	1.78	1.83
T6	14.07	15.10	14.59	10.53	12.15	11.34	6.05	6.17	6.11
T7	18.30	20.64	19.47	11.47	12.74	12.11	6.57	6.85	6.71
T8	16.15	17.89	17.02	9.71	11.09	10.40	6.29	6.70	6.50
T9	19.44	21.53	20.49	11.84	13.92	12.88	5.74	6.11	5.93
T10	16.98	19.33	18.16	11.15	12.57	11.86	5.39	5.85	5.62
T11	17.25	20.20	18.72	12.21	14.12	13.17	6.24	6.40	6.32
T12	22.26	26.21	24.23	12.77	15.75	14.26	9.03	9.43	9.23
T13	18.62	21.23	19.93	19.94	21.77	20.86	8.62	8.94	8.78
T14	21.23	24.78	23.00	18.09	19.88	18.98	6.89	7.20	7.05
T15	6.61	8.34	7.47	4.63	5.23	4.93	1.20	1.11	1.16
SEm±	0.45	0.35	0.31	0.33	0.39	0.19	0.27	0.19	0.22
CD=0.5%	1.34	1.05	0.93	0.98	1.15	0.55	0.79	0.58	0.67
CV	4.94	3.38	3.19	5.03	5.21	2.67	9.12	6.37	7.52

Table 2: Organic carbon in soil on wheat as influenced by different zero budget natural farming

Treatment	Organic carbon in soil (%)		
	2019-20	2020-21	Mean
T_1	0.48	0.49	0.49
T_2	0.52	0.53	0.53
T_3	0.52	0.54	0.53
T_4	0.50	0.52	0.51
T_5	0.54	0.55	0.54
T_6	0.54	0.55	0.54
T_7	0.53	0.54	0.54
T_8	0.54	0.55	0.55
T_9	0.53	0.54	0.54
T_{10}	0.53	0.54	0.54
T_{11}	0.57	0.58	0.58
T_{12}	0.58	0.59	0.58
T_{13}	0.59	0.60	0.60
T_{14}	0.59	0.61	0.60
T_{15}	0.49	0.50	0.49
SEm±	0.05	0.03	0.04

CD=0.5%	0.14	0.08	0.11
CV	NS	NS	NS

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