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Dynamics of different organic inputs on fertility status, biological properties of soil, yield and quality of crops under certified organic farms in Nagpur district of Maharashtra

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Abstract
The field investigation in relation to " Dynamics of different organic inputs on fertility status, biological properties of soil, yield and quality of crops under certified organic farms in Nagpur district of Maharashtra" was carried out during kharif- rabi season of 2018 – 19, to assess the biological properties of soil, quality and yield different crops as influenced by various organic resources. Soil samples of 0-10 cm depth were collected randomly after the harvest of crops from six locations of Nagpur district were selected for recording various observations and collected plant samples for quality parameters. Yield of crops was noted from farmer's field of above locations. In related fertility status of soil, the soil available N content was observed between 188.19 to 420.74 kg ha^{-1} under the application of organic and inorganic inputs. The application of organic inputs from 8 to 18 years resulted in maximum available N content of soil by 14.61 to 64.57 per cent over the application of inorganic fertilizer alone. The available P of soil were recorded between 12.09 to 25.56 kg ha^{-1} in the present investigation. The available P was recorded less in the organic field than the fertilizer applied field up to 31.65 per cent. The value of available K found very high in range in the present study. The magnitude of available K ranged from 321.56 to 454.45 kg ha^{-1}. The available sulphur ranged from 10.64 to 15.38 mg kg^{-1} i.e. marginal to adequate The maximum microbial count was recorded in organic field over the inorganic field. The count of bacteria, fungi and actinomycetes were varied from 15.75 to 25.00 X 10^7 cfu g^{-1}, 9.00 to 15.75 X 10^5 cfu g^{-1} and 7.50 to 14.75 X 10^5 cfu g^{-1} respectively. In all the locations the yield of Nagpur Mandarin found higher as compared to national average productivity of Nagpur mandarin (10.4 t ha^{-1}). The yield of sweet orange recorded 14.0 t ha^{-1} with the application of Ghanjivamrut @ 500 kg ha^{-1}. Grain yield of wheat was obtained between 1.9 kg ha^{-1}.When the field applied FYM for 9 years, maximum grain yield of pigeonpea was obtained with fertilizers alone as compared to application of organic source..The quality of crops was improved with application of organic inputs over the fertilizers application. The protein percent of rice was found maximum in organic field. From the study it can be concluded that, the application of organic inputs improve the biological properties of soil. In case of yield due to organic inputs littilbit decreased. Therefore organic and inorganic fertilizers in balanced form are efficiently sustain and enhance the biological properties of soil and maintained the yield and nutritional quality of various crops.

Keywords: Organic inputs, soil biological properties, FYM

Introduction
Organic farming was practiced in India since thousands of years. In traditional India, the entire agriculture was practiced using organic techniques, where nutrient, pesticides, etc. were obtained from plant and animal products.

Without the activities of soil organisms, organic materials would accumulate and litter the soil surface, and there would be no food for plants. The soil biota includes: moles, rabbits and rodents, woodlice, earthworm, beetles, centipedes, slugs, snails, ants, yeasts, bacteria (commonly action bacteria), fungi, protozoa, roundworms and rotifers. Of these, bacteria and fungi play roles in maintaining a healthy soil they act as decomposers that break down organic materials to produce detritus and other breakdown products. Organic farming has been considered as one of the best options for protecting sustaining soil health and productivity and is gaining lot of importance in present-day agriculture. Significant improvements in soil physical, fertility and biological properties have been reported in several organic farming experiments although grain yield under organic farming is often less than under conventional farming due to so-called organic transition effect.

Materials and methods

The field investigation was conducted during kharif - rabi season of 2018-2019 at the certified farmer's fields (organic field) of Nagpur district. Survey and samples were taken on organic and in the vicinity of organic farms (farmer's field) from Kalmeshwar, Saoner and Mauda tehsil of Nagpur district.

A soil sample of (0-20 cm) depth, the soil samples were dried in shade and gently grind with mortar and pestle and sieved through 2 mm sieve. These samples were stored in polythene bags and were subsequently analyzed for available N (alkaline permanganate method given by Subbiah and Asija, 1956) [17], P by Olsen's method using spectrophotometer (Olsen's and Sommer, 1982) [10], K by neutral ammonium acetate solution and determined using flame photometer (Jackson, 1973) [7], S by turbidimetric method given by Chesnin and Yien (1951) [2]

For determination of microbial count, soil samples at depth 0-10 cm depth were collected from different location. Soil microbial count was determined by serial dilution plate technique (Dhingra and Sinclair, 1993) [5]. In this technique one gram of soil sample was taken under aseptic condition in 10 ml sterile test tube and added 9 ml distilled water, shaked thoroughly for uniform mixing and form suspension. Then 1 ml suspension transferred in a 10 ml test tube and added 9 ml distilled water in it, shake the test tube well and diluted 10 times by distilled water to get desired water level of 10^{-5}, 10^{-6}, 10^{-7}, 10^{-8} and 10^{-9} dilutions. After dilution transferred 1 ml of suspension in petridish in particular media for specific growth of micro-organism. For bacteria nutrient agar media, for fungi potato dextrose media and for actinomycetes was used.

Protein was determined by Kjeldahl's method given by Jackson (1973) [7]. Oil was determined by using Soxhlet's apparatus method by Piper (1966). Ascorbic acid was determined by Rapid titration method given by Ranganna (1987) [13]. The yield was recorded from farmers of different crops according to location of Nagpur district.

Results and discussion

Influence of organic inputs on fertility status of soils

The data pertaining to fertility status of soils are presented in table-1.

Table 1: Effect of organic sources on fertility status of soil after harvest of different crops

Location	Crops		Source	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})	Available S (mg kg^{-1})
Selu	1)	Mandarin ^{e}	Organic	375.91	15.12	422.06	14.75
	2)	Mandarin	Fertilizer	243.04	17.47	365.80	11.37
	3)	Tomato ^{e}	Organic	238.38	19.26	454.45	15.25
	4)	Tomato	Fertilizer	188.19	24.19	408.37	12.50
Kalmeshwar	1)	Fenugreek+ Spinach ^{d}	Organic	313.65	12.09	358.43	14.25
	2)	Inorganic	Fertilizer	235.43	17.69	339.68	13.12
Gangner	1)	Mandarin ^{e}	Organic	388.54	14.56	416.81	15.37
	2)	Mandarin	Fertilizer	275.72	18.66	370.41	13.19
	3)	Rice ^{b}	Organic	351.23	20.83	376.27	14.85
	4)	Soybean ^{d}	Organic	295.71	23.87	358.93	11.32
	5)	Inorganic	Fertilizer	323.76	16.80	333.68	12.87
Saoner	1)	Pigeonpea ^{c}	Organic	243.28	22.96	321.56	10.75
	2)	Pigeonpea	Fertilizer	286.51	20.38	384.89	12.99
	3)	Wheat ^{a}	Organic	223.47	24.25	369.58	11.45
	4)	Sweet orange ^{e}	Organic	350.80	17.92	427.24	13.62
	5)	Inorganic	Fertilizer	293.03	21.02	394.83	11.75
Chacher	1)	Rice ^{b}	Organic	401.43	22.64	415.52	12.25
	2)	Rice	Fertilizer	290.89	24.72	404.94	11.78
	3)	Mandarin ^{e}	Organic	351.22	20.60	425.63	13.57
	4)	Soybean ^{c}	Organic	288.14	22.76	411.69	12.52
	5)	Inorganic	Fertilizer	383.67	12.32	358.48	14.37
Chinchbhavan	1)	Mandarin ^{e}	Organic	303.69	16.04	342.47	12.24
	2)	Sorghum (Maldandi) ^{b}	Organic	386.83	21.17	396.82	11.25
	3)	Onion ^{a}	Organic	337.50	25.56	389.61	10.64
	4)	Inorganic	Fertilizer	263.09	15.44	384.46	13.36

a = 10 t FYM ha^{-1}, *b* = 5 t FYM ha^{-1}, *c* = 2.5 t FYM ha^{-1},
d = Jivamrut @ 500 lit ha^{-1}, *e* = Ghanjivamrut @ 500 kg ha^{-1}

Available nitrogen of soil (kg ha^{-1})

The available nitrogen content in soil after harvest of crop is presented in table-1. The data indicated that, the available nitrogen in soil varied from 188.19 to 420.74 kg ha^{-1}. The application of organic inputs from 8 to 18 years resulted in maximum available N content of soil by 2.08 to 44.18 per cent over the application of inorganic fertilizer alone. The maximum increase of available N (44.18%) is recorded in soybean crop where Jivamrut @ 500 lit ha^{-1} was applied. The increase in available N content of soil might be attributed to the more N fixation in soil on account of higher microbial population, leaving to better mineralization of organic N with other nutrient application. Sharma *et al*., (2013) [14] observed that, available N status in soil increased with application of organic sources along with fertilizers.

Available phosphorus of soil (kg ha^{-1})

The available phosphorus content of soil after harvest of crops varied from 12.09 to 25.56 kg ha^{-1}under the application of organic and inorganic fertilizers. In the present study, there was decreased in available phosphorous content in soil with the use of organic inputs upto 37-43 per cent over the application of chemical fertilizers alone. Balanced inorganic fertilizer and crop residues helps in increasing the phosphorous content in solution and solubelization of native soil phosphorous. Chesti and Ali (2012) [3] revealed that, soil available P recorded an increased between 16 to 24 per cent due to application of 30 to 60 kg P_2O_5 ha^{-1}, respectively.

The build-up of available P with the application of inorganic fertilizer and crop residue was ascribed to the release of organic acid, during decomposition which in turn helped in releasing native phosphorous through solubilizing action of the acids and thus reduces the P fixing capacity of soil which ultimately helps in release of sufficient quantity of plant available phosphorous (Sharma and Subehia, 2014) [15].

Available potassium of soil (kg ha^{-1})

The data on available potassium in soil after harvest of crop is presented in table-1. The magnitude of available K ranged from 321.56 to 454.45 kg ha^{-1}.The data further revealed that, the application of inorganic fertilizers alone (NPK) recorded an increased in available K content in soil by 1.26 to 11.95 per cent. The increasing available K in soil due to addition of organic sources may be ascribed to the reduction of K fixation and released of K due to interaction of organic material with clays besides the direct K addition in the soil (Subehia and Sepehya, 2012) [18].

Available sulphur of soil (kg ha^{-1})

Sulphur is considered as fourth major nutrient for plant growth. The data regarding the available sulphur in the soil is presented in table 1. The variation of available S was observed between the continuous use of organic sources and inorganic inputs applied. The higher amount of available S was recorded due to application of inorganic fertilizer than the use of organic source alone. It may be due to inorganic fertilizer containing sulphur and incorporation of organic carbon content in soil. The increased in available sulphur might be due to addition of 18:18:10 and 18:46 which content about 18 kg N and 46 kg P. Patel and Das (2009) [11] reported that, total S (0.32%) was obtained with sample of FYM.

Influence of organic inputs on microbial population of soils

The data pertaining to microbial population of bacteria, fungi and actinomycetes are presented in table-2. Bacterial population showed higher as compared to fungi and actinomycetes in the organic and inorganic cultivation.

The range of bacterial count observed from 15.75 to 25.00 X 10^{7} cfu g^{-1} at all location. The bacteria count was increased by the application of organic inputs. The higher level of NPK produced favourable influence on bacteria. These results are in line with the findings of Deshpande *et al.* (2010) [4] reported that, higher population of soil micro-flora *viz.*, bacteria, fungi, actinomycetes, free living nitrogen fixers and PSB at different growth stages of both greengram and *rabi* sorghum with combined application of organic manures along with panchagavya.

The fungal population was recorded upto 15.75 X 10^{5} cfu g^{-1} in organic field. Application of organic material to field was found increasing in the fungal count over the application of inorganic fertilizers. The fungal count was recorded between 9.00 to 15.75 X 10^{5} cfu g^{-1}. The maximum fungal count was found in tomato field when FYM @ 10 t ha^{-1} was applied. This could be ascribed to the FYM which supplied large amount of readily available carbon, resulting in more diverse and dynamic microbial system than in inorganically fertilized soil. The actinomycetes count was recorded between 7.50 to 14.75 X 10^{5} cfu g^{-1}. Similarly the count of actinomycetes was found more in organic input applied field than the fertilizers applied field. Ingle *et al.* (2014) [6] recorded that, the bacterial, fungal and actinomycetes was 22.5 X 10^{7} cfu g^{-1}, 12.50 X 10^{4} cfu g^{-1} and 13 X 10^{4} cfu g^{-1} respectively in FYM @ 10 t ha^{-1} applied field, where as the count of bacteria, fungi and actinomycetes was 15.5 X 10^{7} cfu g^{-1}, 11.25 X 10^{4} cfu g^{-1} and 11.75 X 10^{4} cfu g^{-1} recorded respectively in 100 per cent NPK applied field which was less than FYM applied field.

Table 2: Effect of various organic sources on microbial count (cfu g^{-1}) of soil

Location	Crops		Source	Bacteria (X 10^{7} cfu g^{-1})	Fungi (X 10^{5} cfu g^{-1})	Actinomycetes (X 10^{5} cfu g^{-1})
Selu	1)	Mandarin^{e}	Organic	24.50	15.75	12.75
	2)	Mandarin	Fertilizer	17.75	11.25	7.50
	3)	Tomato^{e}	Organic	24.25	14.50	14.25
	4)	Tomato	Fertilizer	19.75	11.25	10.25
Kalmeshwar	1)	Fenugreek+ Spinach^{d}	Organic	23.25	14.25	11.75
	2)	Inorganic	Fertilizer	18.75	9.75	8.50
Gangner	1)	Mandarin ^{e}	Organic	19.50	13.25	12.75
	2)	Mandarin	Fertilizer	15.75	10.50	9.75
	3)	Rice ^{b}	Organic	24.50	14.00	14.50
	4)	Soybean^{d}	Organic	19.75	12.50	10.75
	5)	Inorganic	Fertilizer	21.25	13.25	8.50
Saoner	1)	Pigeonpea^{c}	Organic	17.75	10.75	8.75
	2)	Pigeonpea	Fertilizer	23.75	14.50	13.25
	3)	Wheat ^{a}	Organic	19.25	11.25	9.75
	4)	Sweet orange ^{e}	Organic	19.75	13.75	14.25
	5)	Inorganic	Fertilizer	17.25	10.25	10.50
Chacher	1)	Rice ^{b}	Organic	23.75	14.50	13.75
	2)	Rice	Fertilizer	20.25	12.50	10.25
	3)	Mandarin^{e}	Organic	22.50	14.25	13.25
	4)	Soybean ^{c}	Organic	18.75	12.75	11.75
	5)	Inorganic	Fertilizer	25.25	15.00	14.75
Chinchbhavan	1)	Mandarin ^{e}	Organic	20.00	12.25	11.50

	2)	Sorghum (Maldandi) [b]	Organic	23.25	14.75	11.00
	3)	Onion [a]	Organic	18.50	10.25	9.75
	4)	Inorganic	Fertilizer	22.75	12.50	14.25

a = 10 t FYM ha^{-1}, *b* = 5 t FYM ha^{-1}, *c* = 2.5 t FYM ha^{-1},
d = Jivamrut @ 500 lit ha^{-1}, *e* = Ghanjivamrut@ 500 kg ha^{-1}.

Yield of different crops

The data regarding yield of different crops is presented in table- 3 as influenced by use of organic and inorganic sources.

Table 3: Effect of various organic sources and fertilizer on yield (t ha^{-1}) of various crops

Location	Crops		Source	Organic source applied since	Yield (t ha^{-1})
Selu	1)	Mandarin[e]	Organic	12 Years	Yield (t ha^{-1})
	2)	Mandarin	Fertilizer		16.5
	3)	Tomato[e]	Organic		19
	4)	Tomato	Fertilizer		26
Kalmeshwar	1)	Fenugreek+ Spinach[d]	Organic	9Years	30.5
	2)	Inorganic	Fertilizer		2.4
Gangner	1)	Mandarin [e]	Organic	8 Years	3
	2)	Mandarin	Fertilizer		4.5
	3)	Rice [b]	Organic		5.2
	4)	Soybean[d]	Organic		17
	5)	Inorganic	Fertilizer		18.8
Saoner	1)	Pigeonpea[c]	Organic	10 Years	16
	2)	Pigeonpea	Fertilizer		17.5
	3)	Wheat [a]	Organic		2.4
	4)	Sweet orange [e]	Organic		2.7
	5)	Inorganic	Fertilizer		1.6
Chacher	1)	Rice [b]	Organic	14 Year	2.1
	2)	Rice	Fertilizer		1.2
	3)	Mandarin[e]	Organic		1.5
	4)	Soybean [c]	Organic		1.8
	5)	Inorganic	Fertilizer		2.2
Chinchbhavan	1)	Mandarin [e]	Organic	18 years	12
	2)	Sorghum (Maldandi) [b]	Organic		13.5
	3)	Onion [a]	Organic		2.3
	4)	Inorganic	Fertilizer		2.5

a = 10 t FYM ha^{-1}, ***b*** = 5 t FYM ha^{-1}, ***c*** = 2.5 t FYM ha^{-1},
d = Jivamrut @ 500 lit ha^{-1}, ***e*** = Ghanjivamrut@ 500 kg ha^{-1}.

Yield of Mandarin (t ha^{-1})

The yield of mandarin was recorded from 15 to 18.50 t ha^{-1}. The results revealed that, decreased the yield of Nagpur mandarin of 16.50, 17.50, 15.0 and 15.50 t ha^{-1} at location of Selu, Gangner, Chacher and Chinchbhavan respectively, when these farmers applied organic input since 8-18 years over the inorganically produced mandarin (19 t ha^{-1}).

Yield of sweet orange (t ha^{-1})

The yield of sweet orange recorded 14.50 t ha^{-1} with the application of Ghanjivamrut @ 500 kg ha^{-1} since 10 years, at Saoner location. The yield of sweetorange found also higher as compare to productivity of sweet orange at Vidharbha and national level.

Yield of Wheat (t ha^{-1})

The grain yield of wheat is presented in table-3. The grain yield of wheat was 1.8 t ha^{-1} where the continuous use of 10 t FYM ha^{-1} at Saoner. In the present study, trend of grain yield of wheat under organic sources was found more as compared to yield of wheat under conventional farming (1.5 t ha^{-1}) as reported by Ramesh *et al.* (2010) [12]. Singh *et al.* (2014) [16] reported that, the grain yield of wheat were increased when 120 kg N ha^{-1} + FYM @ 6 t ha^{-1} (5.87 t ha^{-1}) whereas grain yield of wheat (5.11 t ha^{-1}) was obtained with 120 kg N ha^{-1} alone under tillage condition. The increase in grain yield of wheat may be ascribed to the better availability of nutrients leaving to better minerlization and also stimulate the enzymatic and microorganism activity resulted an increased the yield of wheat.

Yield of Pigeonpea (t ha^{-1})

Result indicated that, the application of organic and inorganic sources found sustainable grain yield of pigeonpea (table-3). The grain yield of pigeonpea varied from 1.2 to 1.5 t ha^{-1} with the management of organic and inorganic sources. The application of chemical fertilizer resulted maximum grain yield of pigeon pea (1.5 t ha^{-1}) as compared to application of organic source. At Saoner recorded grain yield of pigeonpea 1.2 t ha^{-1} when they applied FYM @ 2.5 t ha^{-1} from 10 years.

Yield of Rice (t ha^{-1})

The grain yield of Rice as influenced by different organic sources is presented in table-2. The grain yield of rice was recorded between 2.4 and 2.3 t ha^{-1} where the continuous use of 5 t FYM ha^{-1} at Gangner and Chacher locations, respectively. The grain yield of rice recorded more in field where inorganic fertilizer was applied. Similar observations were reported by Nishan *et al.* (2016) [9] that loss the grain yield of the rice to the tune of 15.25 per cent in organically grown rice.

Yield of vegetables (t ha^{-1})

Results indicated that, the application of organic and inorganic sources found sustainable yield of vegetable (table-2). The yield of vegetables varied from 26-28 and 4.5 t ha^{-1} of tomato and fenugreek + spinach, respectively with the management of organic sources. In Selu the yield was found more in inorganically produced tomato 30.5 t ha^{-1}. Chaudhary and Tehlan (2014) [1] observed that, the yield of fenugreek 1.78 and 1.80 t ha^{-1} when the application of poultry manure (1.5 t $acre^{-1}$) and FYM t $acre^{-1}$ whereas 2.07 t ha^{-1} with 15:20:10 NPK $acre^{-1}$. Kumar *et al*. (2014) [8] revealed that, the application of FYM + panchagavya (3%) was found effective and showed better performance on growth and bulb yield of onion (17.4 t ha^{-1}).

Quality of crops influenced by organic sources

The data on quality parameter of crops is furnished in table-4. The quality parameter such as protein content and oil content in fruit was analyzed.

Table 4: Quality of crops influenced by organic sources

Location		Crops	Source	Protein (%)
Gangner	1)	Rice [b]	Organic	7.40
Chacher	2)	Rice [b]	Organic	7.15
	3)	Rice	Fertilizer	6.88
Saoner	1)	Wheat [a]	Organic	11.06
	2)	Wheat	Fertilizer	10.73
Gangner	1)	Soybean [d]	Organic	40.78
	2)	Soybean	Fertilizer	39.12
Location		Crops	Source	Oil (%)
Gangner	1)	Soybean [d]	Organic	18.25
	2)	Soybean	Fertilizer	18.69

a = 10 t FYM ha^{-1}, *b* = 5 t FYM ha^{-1}, *c* = 2.5 t FYM ha^{-1},
d = Jivamrut @ 500 lit ha^{-1}, *e* = Ghanjivamrut @ 500 kg ha^{-1}.

Protein (%)

From the data, protein per cent of rice, wheat and soybean grain varied from 6.88 to 7.40, 10.73 to 11.06 and 39.12 to 40.78. The highest protein per cent of rice grain observed in Gangner location when FYM @ 5 t ha^{-1} applied. The result showed that, the higher protein concentration was in organically grown crops. Tiwari *et al.* (2001) [19] observed that application of 10 tone FYM ha^{-1} produce higher protein content of rice grain.

Oil (%)

The data about oil content in soybean depicted in table-3 The oil percent in soybean ranges from 18.25 to 18.69 percent. The maximum oil percent was recorded in inorganically grown soybean but it was nearly same of organically grown soybean.

Conclusion

From the study it can be concluded that, the application of organic inputs improve the biological properties of soil.

In case of yield due to organic inputs littilbit decreased. Therefore organic and inorganic fertilizers in balanced form are efficiently sustain and enhance the fertility status of soil and maintained the yield and nutritional quality of various crops.

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