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Effect of organic and inorganic agricultural inputs on soil nutrient and mycoflora of cotton field

[1] Gachande BD, *[2] Shaikh NF
[1] Botany Research Laboratory and Plant Disease Clinic, N.E.S. Science College, Nanded, Maharashtra, India
[2] Govt. College of Arts & Science, Aurangabad, Maharashtra, India

Abstract
It is necessary to study soil health in terms of soil nutrient properties, soil microbial activity and diversity in conventionally and organically managed field for sustainable development in agriculture. In present investigation, different fermented organic inputs like farm yard manure, Beejamruth and Jeevamruth on soil nutrient parameters, mycoflora population and species diversity in Cotton field for three successive years.

The soil amendments with organic inputs increased soil nutrient parameters like improvement in organic carbon (OC), Phosphorus (P), Potassium (K), water holding capacity (WHC) and positive decrease in soil pH and electrical conductivity over inorganic farming. The application of organic inputs enhances mycoflora colony forming unit (CFU) and more species diversity as compared to inorganic farming. From result it is confirmed that for maintenance of soil health i.e. soil fertility and microbial diversity, organic inputs is effective alternative to reduce the loss of over use of inorganic inputs towards sustainable and eco-friendly agricultural development for future.

Keywords: soil nutrient properties, mycoflora, cotton, organic & inorganic inputs

1. Introduction

In modern agriculture the quality soil can be measured directly by evaluating soil indicators like physical, chemical, and biological properties, processes, or characteristics of soils. Biomass, community structure, and specific functions of soil microorganisms appear to be of major importance for general soil functions and if detectable could serve as sensitive soil quality indicators. Since microbial soil communities strongly depend on the conditions of the habitat they colonize, microbiological characteristics of a soil may provide indicators, which integrate short-, middle- and long term changes in soil quality.

During past decades, conventionally managed agricultural system has used synthetic fertilizers and pesticides to improve crop productivity. This intensive use of agrochemicals definitely reduced the biodiversity, increase in irreversible soil erosion and reduce soil organic matter (Dick, 1992: Schiavon *et al.*, 1995) [8, 24]. Since chemical fertilizers and pesticides are being widely used by farmers in peri-urban agriculture, it is important to consider their possible impact on soil health. A unique balance of chemical, physical, and biological especially microbial biomass contributes toward maintaining soil health. The soil microflora largely depends on the type of soil, temperature, moisture, plant growth nutrients, pH, and many other factors which may vary between locations but also within a single plot and over very small distances (OECD, 2007) [18].

To overcome the adverse effect of chemical fertilizers, farmers are turning towards organic farming. This system can reduce some negative effects attributed to conventional agriculture and has potential benefits in enhancing soil quality (Mader *et al.*, 2002) [14]. Now a day's organic farming basically runs for cultivation of land and crops as to keep soil fertile by use of organic fertilizers like FYM, biological materials, vermicompost & beneficial microbes to add the nutrients to crops for increased sustainable production.

Several investigations shows application of chicken manure increases bacterial and fungal count than conventional farming (Wang *et al.*, 1995). The soil microbes are always higher in organic field compared to inorganic field (Bolton *et al.*, 1982) [3]. The addition of FYM as an organic fertilizer increases in fungal population (Das and Dkhar, 2010) [6]. Several report shows enhancement in soil microbial composition by organic amendments (Wada and Toyota, 2004) [31]. In organic farming there is 10-26 % increase in microbial biomass (Fraser *et al.* 1994) [10].

The addition of organic fertilizers at various combinations significantly increases rhizosphere microbial population than without organic fertilizers (Das *et al.*, 2010) [7]. The different organic agricultural practice improves biodiversity, biological cycles and biological activity for optimization of natural ecosystem for sustainable development (Samman *et al*., 2008) [22].

Comparative study on organic and inorganic farming in relation to soil physicochemical parameters, soil microbes and yield shows that the organic farming shows positive influence on soil health. While inorganic farming shows negative impact on soil health. The regular crop rotation and absence of synthetic nutrients and pesticides in organic farming results in increase in soil quality and microbial activity in comparison with conventional farming (Shannon *et al.*, 2002) [25]. Organic agriculture fields significantly higher in numbers of bacteria by 70%, actinobacteria by 290%, cultivable filamentous fungi by 110%, yeasts and maltose fermenting bacteria by 190% in comparison to conventional fields (Lelde *et al.*, 2011) [13].

In present investigation different fermented organic inputs like farm yard manure, Beejamruth and Jeevamruth on soil nutrient parameters, mycoflora population and species diversity in cotton field for three successive years.

2. Material and methods

Selection and Location of field (Study) area

Present research work was carried out in agricultural fields' of cotton from Nanded district of Maharashtra, India.

Agricultural inputs treatment details

The selected crop studied in two different fields i.e. organic and inorganic during the year 2010-11, 2011-2012 and 2012-2013. The treatment details are as follows.

Organic inputs treatment

In present investigations, organic treatment includes the dipping of seeds of crop in Beejamruth liquid at the time of sowing. Farm yard manure (10 tons/ha) + Jeevamruth (450 l/ha) applied to the field by Irrigation or through drinching. Jeevamruth has to be applied for selected organic field once in 15 days compulsorily during vegetative stage, flowering stage and grain filling stage (@ 250 ml/plant) and butter milk also sprayed at some interval.

Inorganic inputs treatment

Inorganic treatment to each field includes application of unbalanced recommended dose of NPK (100:50:50)

Physicochemical analysis of soil

The soil samples were collected from organic and inorganic fields to a depth of 0 to 30 cm from selected fields. Soil samples from selected fields were randomly sampled and mixed together to form composite sample. Under laboratory, the collected soil samples were air dried and crushed with the help of mortar and pestle and passed through 2 mm mesh sieve to remove the coarse fragments (>2 mm). Such labeled samples were used for can be used for analysis of physico-chemical properties of soil.

The different soil parameters were analyzed by using different methods such as pH & Electrical conductivity (Agriculture dept. of Maharashtra), Organic carbon (Walkey and Black method 1934), Phosphorus (Olsen's Method 1965), Potassium (Hanway and Heidel 1952), Copper, Iron, Manganese and Zinc (Lindsay & hornvell Method) were conducted Rashtriy chemical and fertilizers soil testing lab Nanded.

Isolation of soil mycoflora

The mycoflora associated with different rhizosphere soil samples of organic and inorganic field were isolated by Serial Dilution method or viable plate count method (Waksman, 1922) [32] on Martins rose Bengal agar and Czapedox-agar media. The fungal colonies on agar plates were observed on incubation of seven days at 28±2°C. The slide was observed under Magnus camera Microscope and Microphotographs of the individual fungal species were also taken.

Identification of soil mycoflora

Identifications of the fungal species were made on the basis of colony colour and morphology of structure of conidiophores, hyphae, spores bearing structures, spore size, colour and shapes also observed. They were compared with the relevant mycological literature and standard works of Nagamani *et al.*, (2006).) [17], Barnett (1975) [1], and Gilman (1957) [11].

Quantitative estimation of soil mycoflora from different crop fields

The quantitative data were analyzed in terms of colony forming unit (CFU) per gram of soil with dilution factor and percentage contribution of each fungal species.

$$\text{CFU/ g dry soil} = \frac{\text{Mean plate count X dilution factor}}{\text{Dry weight of soil}}$$

$$\text{Percentage contribution} = \frac{\text{Total no. of CFU of an individual species}}{\text{Total no. of CFU of all species}} \text{X100}$$

3. Results & Discussion

The results revealed that, in organic field during 2010-13 the average EC content in soil ranged 0.29 to 0.36 ms/cm, organic carbon 0.52 to 0.60 %, pH 7.25 to 7.45, Phosphorus 46.19 to 48.63 Kg/h, Potassium 298.25 to 302.12 kg/h and water holding capacity 66.41 to 67.94%. (Table.1) while in inorganic field during 2010-13 the average EC content in soils ranged from 0.49 to 0.64 ms/cm, organic carbon 0.36 to 0.38 %, pH 8.31 to 8.65, Phosphorus 33.12 to 39.15 Kg/h, Potassium 511 to 512 Kg/h and water holding capacity 63.38 to 63.85. (Table. 1).

Quantitative result of rhizosphere mycoflora population (average) in organic field ranged 39.85×10^{-3} to 44.70×10^{-3} CFU/g of soil and in inorganic field 22.78×10^{-3} to 29.90×10^{-3} CFU/g of soil during 2010-2013. (Table.2)

During 2012-13 the total 892 fungal colonies of different 28 fungal species isolated from rhizosphere. The identified dominant fungal species include *Aspergillus flavus* (117 colonies and 13.11 %), *Aspergillus niger* (80 colonies and 8.96 %), *Aspergillus nidulans* (58 colonies and 6.50%), *Aspergillus fumigatus* (57 colonies and 6.39%), *Aspergillus parasiticus* (48 colonies and 5.38 %), *Penicillium citrinum* (42 colonies and 4.70 %), *Penicillium chrysogennum* (41 colonies and 4.59 %), *Penicillium islandicum* (40 colonies and 4.48 %), *Penicillium cyclopium* (38 colonies and 4.26 %), *Fusarium roseum* (36 colonies and 4.03 %), *Alternaria solani* (35 colonies and 3.92 %), *Trichoderma viride* (34 colonies and 3.81 %), *Fusarium oxysporum* (27 colonies and 3.02 %), *Rhizopus stolonifer* (27 colonies and 3.02%) and *Myrothecium sp.* (26 colonies and 2.91 %) (Table.3).

During 2012-13 the total 390 fungal colonies of different 17 fungal species isolated from rhizosphere. The identified dominant fungal species include *Aspergillus flavus* (74 colonies and 18.97 %), *Aspergillus niger* (54 colonies and 13.85 %), *Aspergillus nidulans* (38 colonies and 9.74 %), *Penicillium chrysogennum* (28 colonies and 7.17 %), *Aspergillus parasiticus* (27 colonies and 6.92 %), *Alternaria solani* (24 colonies and 6.15 %), *Penicillium citrinum* (24 colonies and 6.15 %), *Curvularia polyscens* (21 colonies and 5.38 %), *Penicillium cyclopium* (20 colonies and 5.12 %), *Aspergillus terrus* (17 colonies and 4.35 %), *Aspergillus fumigatus* (16 colonies and 4.10 %), *C.cladosporides* (14 colonies and 3.59 %), *Curvularia lunata* (14 colonies and 3.59 %) and *Alternaria alternata* (7 colonies and 1.79 %).(Table.4).

The results revealed that, in organic field during 2010-11 the rhizosphere fungal species variation ranged from 13 to 19 species. During 2011-12 the rhizosphere fungal species variation ranged from 14 to 21 species. While during 2012-13 the rhizosphere fungal species variation ranged from 17 to 24 species. While, in inorganic field during 2010-11 the rhizosphere fungal species variation ranged from 11 to 18 species. During 2011-12 the rhizosphere fungal species variation ranged from 9 to 13 species. While during 2012-13 the rhizosphere fungal species variation ranged from 8 to 12 species. (Table. 5).

The organic inputs shows changes in soil physico-chemical properties like decrease in Electrical conductivity and pH, increases or maintain soil organic carbon, Phosphorus, Potassium and water holding capacity over inorganic input application. Because this fermented liquid organic inputs prepared from cow dung, urine, curd, gram flour and jaggary. They contain essential macro nutrients, micro nutrients, growth regulator like auxin and giberellic acid, amino acids, vitamins and beneficial microbes (Sreenivasa *et al.*, 2010) [29]. This manure helps in the quick build-up of soil fertility through enhanced activity of soil microflora and fauna (Yadav and Mowade, 2004) [30]. The addition of organic inputs like *Glomus fasciculatum* @5 g/rhizome, *Trichoderma* harzianum 1.5%, Panchgavya @ 3%, Amrit pani @ 3%, Dry residue mulch, Agnihotra ash @ 3%, Jeevamrutha @ 3% and FYM: 2 kg/ m^2 helps improving biochemical properties of soil (Sushma *et al.*, 2012) [30]**.** The organic fermented fertilizer; EM-compost on paddy field decreases EC of soil (El-Shafei *et al.*, 2008) [9]. The combined application of compost (50%) + VC (50%) + GLM (*Gliricidia*) with surface application of Jeevamrutha @ 500 l ha^{-1} recorded significantly higher soil organic carbon by 6.0 g kg^{-1} and Potassium (Channagoudra and Babalad, 2012) [4]. Long term (7 years) application of FYM @ 15 tons per ha results in production of acids were reduces the soil pH (Chaudhary *et al.*, 1981) [5]. Addition of Jeevamruth with panchgaya and biofertilizer increased soil phosphorus (Ravi and Basavarajappa, 2012) [21]. FYM positively increases water holding capacity whereas continuous use of chemical fertilizers decreases in water holding capacity (Bhatia and Shukla 1982; Prasad and Sinha 1980) [2, 20].

The results on soil rhizosphere mycoflora population in organic cropping systems of, Cotton field showed that the application of organic inputs like Farm yard manure, Jeevamruth and Beejamruth had significantly increased the soil mycoflora population colony forming unit (CFU). Compost amendments slightly increases total numbers fungi in the rhizosphere of tomato plants (Marcos *et al.*, 1995) [15]. Organic inputs like panchagavya and beejamruth seed treatment increases rhizosphere microbial population of maize (Shubha *et al.*, 2014) [28]**.** The FYM, alone and in combination with neem cake and *Azolla* increase in population of fungi (15.2 CFU g^{-1}) (Krishnakumar *et al.*, 2005) [12]. Various organic manures enhance higher fungal (37.66 × 10^3CFU/g soil) population of mulberry garden soil (Shashidhar *et al.*, 2009) [26]. The soil fungal populations were more in organic fields than inorganic field (Padmavathy and Poyyamoli 2011) [19].

The number of total colonies and diversity of mycoflora species is more in rhizosphere of organic inputs applied field compare to inorganic managed field. The colonies of *Aspergillus* and *Penicillium* were predominant in all soil samples of eight different crop fields such as Sunflower, Sesame, Capsicum, Rice, Green gram, Sugarcane, Groundnut and Blackgram (Shiny *et al.*, 2013) [27]. *Penicillium* and *Aspergillus* were dominated in both seasons due production of fungal and bacterial antibiotics by *Penicillium* and some kind of toxins such as aflotoxins, achrotoxins by *Aspergillus*, it may prevent the growth of other fungal species (Saravanakumar and Kaviyarasan (2010) [23].

Table 1: Effect of organic and inorganic inputs on soil properties of Cotton field

S. No	Soil properties	Organic field			Inorganic field		
		2010-2011	2011-2012	2012-2013	2010-2011	2011-2012	2012-2013
1	Ec	0.36±0.099	0.34±0.083	0.29±0.063	0.49±0.196	0.62±0.289	0.64±0.254
2	OC (%)	0.52±0.112	0.55±0.081	0.60±0.077	0.37±0.096	0.36±0.111	0.38±0.106
3	pH	7.45±0.26	7.40±0.29	7.25±0.31	8.34±0.16	8.65±0.13	8.31±0.37
4	P (kg/h)	46.19±4.357	47.08±5.732	48.63±5.587	39.15±8.095	37.67±6.469	33.12±8.097
5	K (kg/h)	298.25±32.67	301.5±26.21	302.12±25.82	512.25±75.83	511±45.29	512±55.322
6	WHC (%)	66.44±2.42	66.41±2.387	67.94±2.750	63.38±1.556	63.55±1.591	63.85±2.098

Table 2: Population of rhizosphere mycoflora (x 10^{-3} CFU/g soil) in organic and inorganic Cotton field

S. No	Months	Organic field			Inorganic field		
		2010-2011	2011-2012	2012-2013	2010-2011	2011-2012	2012-2013
1	Jun	39.2	50.4	52.4	26.0	27.2	24.3
2	July	33.6	43.2	46.3	24.0	21.6	22.2
3	Aug	35.6	39.2	42.6	21.6	19.2	18.4
4	Sep	32.8	33.6	38.5	26.8	23.2	22.4
5	Oct	37.6	38.4	39.6	31.2	24.8	26.6
6	Nov	42.0	44.8	47.2	33.6	20.8	22.3
7	Dec	48.0	39.3	43.7	36.8	28.8	24.6
8	Jan	50.0	41.2	47.3	39.2	27.0	21.5
	Average	39.85	41.26	44.70	29.90	24.07	22.78
	S.D	±6.396	±4.996	±4.546	±6.301	±3.434	±2.442

Table 3: Monthly variation in soil rhizosphere mycoflora and percentage contribution in organic Cotton field (2012-2013)

S. No	Mycoflora	Months and No. of colonies								Total colonies	% Contri.
		Jun	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**		
1	*Alternaria solani*	9	8	7	0	0	6	5	0	35	3.92
2	*Aspergillus flavus*	14	18	15	11	16	14	12	17	117	13.11
3	*Aspergillus fumigatus*	16	6	8	6	3	5	5	8	57	6.39
4	*Aspergillus nidulans*	6	8	9	9	4	7	6	9	58	6.50
5	*Aspergillus niger*	12	11	7	10	9	10	12	9	80	8.96
6	*Aspergillus parasiticus*	7	8	7	8	3	4	5	6	48	5.38
7	*Cephalosporium sp.*	4	4	3	2	3	0	0	2	18	2.01
8	*Chaetomium globosm*	0	3	0	2	3	3	4	5	20	2.24
9	*Clado. cladosporides*	0	4	0	5	2	4	0	5	20	2.24
10	*Cladosporium herbarum*	5	0	5	0	4	3	4	0	21	2.35
11	*Cunninghamella echinulata*	0	5	0	3	5	2	2	0	17	1.90
12	*Curvularia lunata*	6	0	0	3	5	3	2	0	19	2.13
13	*Drechslera tetramera*	0	0	4	0	4	3	3	3	17	1.90
14	*Fusarium oxysporum*	0	6	0	4	5	4	5	3	27	3.02
15	*Fusarium roseum*	5	7	5	0	4	6	4	5	36	4.03
16	*Gliocladium sp.*	0	0	0	0	4	2	5	2	13	1.45
17	*Mucor sp.*	5	0	4	0	0	0	0	0	9	1.00
18	*Mycelia sterilia (black)*	0	1	0	1	0	2	0	0	4	0.44
19	*Mycelia sterilia (white)*	0	3	0	0	1	0	0	0	4	0.44
20	*Myrothecium sp.*	8	3	3	3	2	3	4	0	26	2.91
21	*Paecilomyces sp.*	2	0	0	0	2	0	3	2	9	1.00
22	*Penicillium chrysogennum*	9	0	0	6	8	7	6	5	41	4.59
23	*Penicillium citrinum*	0	8	7	7	4	6	4	6	42	4.70
24	*Penicillium cyclopium*	4	7	6	5	0	4	5	7	38	4.26
25	*Penicillium islandicum*	5	0	8	4	5	6	6	6	40	4.48
26	*Rhizoctonia solani*	4	3	0	0	0	4	0	4	15	1.68
27	*Rhizopus stolonifer*	4	3	4	0	3	5	3	5	27	3.02
28	*Trichoderma viride*	6	0	5	7	0	5	4	7	34	3.81
	Total No. of colonies	131	116	107	96	99	118	109	116	892	100
	Total No. of species.	19	21	17	18	22	24	22	20		

Table 4: Monthly variation in soil rhizosphere mycoflora and percentage contribution in inorganic field of Cotton (2012-2013)

S.No	Mycoflora	Months and No. of colonies								Total colonies	% Contri.
		Jun	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**		
1	*Alternaria alternata*	0	4	3	0	0	0	0	0	7	1.795
2	*Alternaria solani*	4	6	5	0	0	5	4	0	24	6.154
3	*Alternaria brassicae*	0	0	0	0	3	0	0	4	7	1.795
4	*Aspergillus flavus*	7	9	10	9	9	8	10	12	74	18.97
5	*Aspergillus fumigatus*	0	4	0	0	5	0	7	0	16	4.103
6	*Aspergillus nidulans*	6	0	5	8	4	4	5	6	38	9.744
7	*Aspergillus niger*	10	8	6	6	7	5	8	4	54	13.85
8	*Aspergillus parasiticus*	6	6	0	5	0	0	6	4	27	6.923
9	*Aspergillus terrus*	0	0	0	4	4	6	0	3	17	4.359
10	*C.cladosporides*	0	0	0	3	4	4	0	3	14	3.59
11	*Cladosporium herbarum*	0	0	0	0	2	3	0	0	5	1.282
12	*Curvularia lunata*	5	0	0	0	4	3	2	0	14	3.59
13	*Curvularia polyscens*	3	3	3	3	3	4	0	2	21	5.385
14	*Mycelia sterilia (brown)*	0	0	0	0	0	0	0	0	0	0
15	*Penicillium chrysogennum*	5	0	0	4	5	5	6	3	28	7.179
16	*Penicillium citrinum*	4	5	4	0	5	0	3	3	24	6.154
17	*Penicillium cyclopium*	3	0	3	4	0	3	2	5	20	5.128
	Total No. of colonies	53	45	39	46	55	50	53	49	390	100
	Total No. of species.	10	8	9	9	12	11	10	11		

Table 5: Monthly variation in rhizosphere fungal species in organic and inorganic Cotton field (2010-2013)

S. No	Months	Organic field			Inorganic field		
		2010-11	2011-12	2012-13	2010-11	2011-12	2012-13
1	Jun	17	17	19	14	12	10
2	July	16	18	21	11	9	8
3	Aug	15	15	17	11	9	9
4	Sep	13	14	18	12	10	9
5	Oct	15	17	22	13	10	12
6	Nov	17	20	24	16	12	11
7	Dec	19	21	22	18	13	10
8	Jan	14	17	20	11	10	11

4. Conclusions
Application of organic inputs like farm yard manure (FYM), Beejamruth and Jeevamruth positively influences on soil nutrient properties which results in increase in soil fertility in terms of increase in the soil organic carbon, phosphorus, potassium and water holding capacity. The application of organic inputs maintains balance of soil pH and electrical conductivity and positively increases population of biocontrol agents like *Trichoderma* sp. The organic inputs applied field shows more fungal species diversity over inorganic field. From above finding it is concluded that use of different combination of organic inputs influences crop field's agricultural properties towards sustainable agriculture.

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