J. Soils and Crops 30 (1) 153-158, June 2020

ISSN 0971-2836 (Print)
ISSN 2582-2756 (Online)
NAAS Rating - 4.46
Scientific Journal Impact Factor - 7.375

IMPACT OF FARMERS ORGANIC FARMING PRACTICES ON PHYSICO-CHEMICAL STATUS OF SOILS UNDER VEGETABLES IN NAGPUR DISTRICT

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ABSTRACT

A research work was carried out on farmer's field of Nagpur district during the year 2018-19 with the objective to evaluate the physico-chemical behaviors of soil and yield of vegetables under different organic inputs. The values of hydraulic conductivity and infiltration rate have increased by addition of FYM. The application of FYM 10 t ha^{-1} has increased the WHC to the tune of 6.97 per cent at subsurface level over inorganic fertilizer alone and the highest value of infiltration rate 1.15 cm hr^{-1} was recorded with FYM @ 10 t ha^{-1} whereas, lower value 0.65 cm hr^{-1} was in surface soil with field treated with inorganic fertilizers. Mean weight diameter has improved by increasing the organic treated soil under long term. Organic carbon was recorded between 4.8 to 8.07 g kg^{-1} under the study which an increased by 16.64 to 27.18 per cent at different locations over chemical fertilizers. Since the continuous application of FYM @ 10 t ha^{-1} has increased the available N by 19.24 per cent over the use of inorganic fertilizers alone, whereas, maximum available P was recorded 24.89 kg ha^{-1} with the application of inorganic fertilizers. The value of soil available K varied from 358.4 to 402.8 kg ha^{-1} in surface and 349.1 to 397.1 kg ha^{-1} in subsurface soil which resulted under very high status. Maximum yield of brinjal and okra was obtained with the application of FYM 10 t ha^{-1}, which an increased by 17.8 and 18.8 per cent over chemical fertilizers, however, the yield of spinach and fenugreek increased by 7.0 and 30.04 per cent with chemical fertilizers alone over FYM 10 t ha^{-1}, respectively. Soil properties of WHC, MWD, available phosphorus and infiltration rate of soil were positively correlated with yield of vegetable crops.

(Key words: Physical properties, vegetable crops, organic farming, yield)

INTRODUCTION

Management and use of nutrient enriched inputs has become an important component of sustainable agriculture and received much interest in the recent years as a means of increasing soil organic carbon and serves as the potential source of nutrients to play great role for promoting growth and providing immunity in plant growth system. Soil organic matter is responsible for maintenance of not only the soil's physical conditions but also supplies essential plant nutrients for successful crop production. Awareness of soil health and environmental issues in agriculture promotes production of organic food which is emerging as an attractive source of rural income generation. 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. Various workers have tried different types of organic resources to find out their effectiveness, efficiency and cost benefits impacts as compared to the inorganic fertilizers. Very little work has been reported on impact of various liquid and solid organic inputs and its quantity on physical behaviours of soils and yield of organic vegetables. Considering the above facts, the present study was done on farmer's field to understand the evaluation of various organic resources on soil physical and chemical sustainability and yield of vegetables.

MATERIALS AND METHODS

The locations of organic vegetables growing farmer's field of Nagpur district were selected for assessment of soil physical and chemical fertility and yield of vegetables. The quantity of organic manure and organic

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liquids used by the farmers from 11-18 years continuously. Soil samples of 0-15 and 15-30 cm depth were collected after harvest of vegetables crop from each organic farms and from nearby conventional farms (adjacent to organic farms) having similar soils. Saturated hydraulic conductivity of soil was estimated by constant water head method (Richards, 1954).Infiltration rate was determined by double ring infiltrometer method (Parr and Bertrand, 1960).Mean weight diameter of soil was estimated by wet sieving method (Yoder,1936). Organic carbon was assessed by wet oxidation method (Walkley and Black, 1934). Available nitrogen was analysed using Kjeldahl's method(Subbiah and Asija,1956),phosphorus was estimated using vanado molybdate yellow colour method (Jackson,1973) and potassium was estimated from diacid extract using flamephotometer (Jackson,1973).The doses of organic manure or liquid fertilizers were not applied similar at the studied locations. Organic manures was applied in soil before sowing and liquid fertilizer applied 3–4 times during growth period through spraying. Dose of nitrogen, phosphorus and potassium were applied through DAP (18:46:00), Urea (46:00:00) and SSP(00:16:00). Organic fertilizers was applied between @10 t ha^{-1} through FYM, Ghanjivamrut @ 500 kg ha^{-1} and Jivamrut @ 500 lit. ha^{-1}.

Preparation of Jivamrut: It was prepared with cow dung 10 kg + cow urine 10 litre+ Jaggary 2 kg + gram flour 2 kg and half kg soil from bunds(organic rich soil) with 100 litre water. Above mixture were poured in the plastic drums and mixing all materials continue until they are thoroughly mixed. It was stirred properly 2-3 times with wooden stick in a day for increasing aeration and enhancing microbial activity and keep it for one week. It was diluted in 100 litre water with 10 litre jivamrut and applied @ 500 litre ha^{-1}.The whole process was made and left in shade for increase the activity of microorganism.(prepared by farmers)

Preparation of Ghanajimrut: Pit size of 10:5:2.5 feet dimension was prepared.500 kg fresh FYM and 50 litre jivamrut in the pit was added and it was covered with straw material available for decomposition of material. After one week mixture of FYM and jivamrut was added and same procedure was followed for 3-4 times at an interval of one week. If procedure is followed properly, 40-45 days are required to get ghanajivamrut.

RESULTS AND DISCUSSION

Physico-chemical properties of soils

Soil pH varied from 6.97 to 8.21 under different sources of treatment applied at locations which indicates that, the soils indicates neutral to moderately alkaline in soil reaction.

The data pertaining to physico-chemical properties of soil are presented in table1.The value of bulk density of soil varied from 1.16 to 1.40 Mg m^{-3} and 1.28 to 1.43 Mg m^{-3} in surface and subsurface soil, respectively. In the present study, the result of hydraulic conductivity of soil exhibited difference between the continuous application of organic sources and chemical fertilizer alone. Increase in hydraulic conductivity of soil is associated with decrease in bulk density and organic sources which influence on the amount of water and also air present in soil. The value of hydraulic conductivity increases ascribed to better aggregation and increased infiltration rate by addition of FYM which directly influenced hydraulic conductivity of soil. Similar result was found by Gunjal and Chitodkar (2017), where FYM treatments had a significant effect on hydraulic conductivity of soil. Nawlakhe and Mankar (2009) reported that a reduction in bulk density and improvement in field capacity from 35.5 to 37.5 per cent was noticed with organic manures compared to the treatment without organic manures.

The highest value of WHC 65.9 per cent was recorded under okra crop treated with Ghanajivamrut @ 500 kg ha^{-1} and FYM @ 10 t ha^{-1} whereas, lowest value 56.1 per cent was recorded for spinach crop treated with inorganic fertilizers. The application of FYM 10 t ha^{-1} increased the WHC to the tune of 6.97 per cent at subsurface level over the application of inorganic fertilizer alone.Tadesse *et al*.(2013) reported that application of 15 t ha^{-1} FYM increased the soil organic matter and WHC by about 2.16 and 17.6 per cent, respectively. The more value of WHC for sub surface soil because of increase in clay content downwards the soil which greatly influence the water availability and moisture holding capacity.

The MWD is a sensitive index of the aggregation status of soil; it has physical significance as it gives an estimate of the average size of the soil aggregation. The mean weight diameter ranged from 0.97 mm to 1.25 mm in overall locations. MWD is improved by increasing the organic treatment or organically treated soil. Mitran *et al*. (2017) reported that the structural indices were resulted higher in the soils receiving organic amendments as compared to minimum chemical fertilizer doses. The highest value (1.15 cm hr^{-1}) of infiltration rate was recorded the plot treated with FYM 10 t ha^{-1} whereas, lower value (0.65 cm hr^{-1}) was obtained in surface soil with the application inorganic fertilizers treated plot adjacent to FYM plot. The trend of variation of infiltration rate among the treatments might be attributed to the variation in the improvement of soil structure with application of manure and fertilizers.

Available N, P, K and S of soil, kg ha^{-1}

The application of FYM 10 t $ha^{-1}$for long period had increased the available N in soil by 19.24, 4.46 and 4.50 per cent over the application of inorganic fertilizer, Jivamrut @ 500 lit. ha^{-1} and Ghanajivamrut @ 500 kg ha^{-1} respectively, at surface level. The maximum available nitrogen (318.4 kg ha^{-1}) in soil was recorded plot treated with FYM @ 10 t ha^{-1}.The observed value of available N content of soil among the locations resulted under low to moderate in range. The increase in available N of soil in organic manure treated plot 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.

Table 1.Effect of various organic sources on physical properties of soil at harvest of different crops

Crops	Treatments	Depth (cm)	Bulk density ($Mg\ m^{-3}$)	Hydraulic conductivity ($cm\ hr^{-1}$)	WHC (%)	Infilteration rate ($cm\ hr^{-1}$)	MWD (mm)
Fenugreek		0-15 cm	1.31	1.03	56.2	0.66	0.97
		15-30 cm	1.38	0.82	59.9		
Spinach		0-15 cm	1.25	1.10	58.1	0.75	1.05
	Jivamrut	15-30 cm	1.32	0.88	62.3		
Okra	(500 litre ha^{-1})	0-15 cm	1.26	1.12	57.3	0.85	0.98
		15-30 cm	1.36	0.86	61.7		
Brinjal		0-15 cm	1.22	1.08	60.0	1.00	1.02
		15-30 cm	1.32	0.93	64.5		
		0-15 mean	1.26	1.00	57.9	0.81	1.00
		15-30 mean	1.34	0.87	62.1		
Fenugreek		0-15 cm	1.20	1.32	57.1	0.98	1.09
		15-30 cm	1.38	1.09	60.7		
Spinach		0-15 cm	1.16	1.23	58.6	0.95	1.18
	Ghanajivmrut	15-30 cm	1.28	1.13	63.2		
Okra	(500 kg. ha^{-1})	0-15 cm	1.20	1.27	62.4	1.00	1.14
		15-30 cm	1.32	1.10	65.4		
Brinjal		0-15 cm	1.29	1.22	59.8	1.12	1.08
		15-30 cm	1.35	1.08	65.9		
		0-15 mean	1.21	1.26	59.4	1.01	1.12
		15-30 mean	1.33	1.10	63.8		
Fenugreek		0-15 cm	1.27	1.27	57.3	0.89	1.04
		15-30 cm	1.34	1.08	63.5		
Spinach		0-15 cm	1.21	1.25	59.3	0.85	1.15
	FYM	15-30 cm	1.33	1.11	64.4		
Okra	(10 t ha^{-1})	0-15 cm	1.22	1.32	58.9	1.15	1.10
		15-30 cm	1.30	1.07	65.7		
Brinjal		0-15 cm	1.27	1.32	60.6	1.12	1.25
		15-30 cm	1.32	0.94	64.6		
		0-15 mean	1.24	1.29	59.0	1.00	1.13
		15-30 mean	1.32	1.05	64.5		
Fenugreek	Control	0-15 cm	1.35	0.82	56.7	0.67	1.10
	(46:0:0 N:P:K kg ha^{-1})	15-30 cm	1.42	0.70	60.3		
Spinach	Control	0-15 cm	1.31	0.85	56.1	0.65	1.02
	(46:0:0 N:P:K kg ha^{-1})	15-30 cm	1.40	0.73	59.2		
Okra	Control	0-15 cm	1.40	0.77	56.3	0.67	1.17
	(64:46:0N:P:K kg ha^{-1})	15-30 cm	1.42	0.61	60.2		
Brinjal	Control	0-15 cm	1.39	1.02	57.1	0.70	1.14
	(64:54:0N:P:K kg ha^{-1})	15-30 cm	1.43	0.74	60.5		
		0-15 mean	1.36	0.86	56.55	0.67	1.10
		15-30 mean	1.41	0.69	60.05		

Table 2. Effect of various organic sources on chemical properties of soil at harvest of different vegetable crops

Crops	Treatments	Depth (cm)	Soil pH	Organic Carbon (g ha^{-1})	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})	Available S (mg ha^{-1})
Fenugreek		0-15 cm	7.53	6.60	308.4	18.84	362.2	13.61
		15-30 cm	7.71	5.91	278.1	16.81	350.5	11.32
Spinach		0-15 cm	7.55	7.12	301.3	19.04	369.7	15.03
	Jivamrut	15-30 cm	7.80	6.23	288.5	18.83	361.6	13.81
Okra	(500 litre ha^{-1})	0-15 cm	7.49	7.09	275.2	18.25	361.4	11.63
		15-30 cm	7.67	6.59	266.4	16.35	350.0	9.80
Brinjal		0-15 cm	7.60	6.84	282.2	20.56	370.5	12.66
		15-30 cm	7.81	6.20	268.4	17.52	355.1	12.24
		0-15cm mean	7.54	6.91	291.7	19.17	365.9	13.23
		15-30cm mean	7.74	6.23	275.3	17.37	354.7	11.80
Fenugreek		0-15 cm	7.52	7.17	318.2	20.80	402.2	17.21
		15-30 cm	7.71	6.90	297.2	18.91	397.2	16.24
Spinach		0-15 cm	7.30	7.33	301.1	19.83	379.3	17.70
	Ghanajivamrut	15-30 cm	7.54	6.84	285.5	17.24	367.5	16.62
Okra	(500 kg ha^{-1})	0-15 cm	6.98	7.35	278.7	17.90	382.4	14.98
		15-30 cm	7.30	7.03	267.3	14.69	370.1	14.22
Brinjal		0-15 cm	7.31	7.70	269.4	21.56	379.2	15.65
		15-30 cm	7.54	7.11	258.8	16.50	369.4	13.42
		0-15cm mean	7.27	7.38	291.8	20.02	386.5	16.38
		15-30cm mean	7.52	6.97	277.1	16.83	376.0	15.12
Fenugreek	FYM (10 t ha^{-1})	0-15 cm	7.08	8.02	316.5	20.37	393.2	18.61
		15-30 cm	7.44	7.37	282.2	18.92	388.2	14.21
Spinach		0-15 cm	6.97	8.07	301.2	18.73	380.9	15.32
	FYM (10 t ha^{-1})	15-30 cm	7.53	7.46	292.1	17.33	368.4	14.82
Okra		0-15 cm	7.19	7.69	285.7	19.89	389.1	17.71
		15-30 cm	7.28	7.20	267.8	16.67	365.3	12.91
Brinjal		0-15 cm	7.22	7.88	318.4	21.25	378.3	18.64
		15-30 cm	7.39	7.18	275.3	18.12	363.1	15.23
		0-15 cm mean	7.11	7.91	305.4	20.06	385.4	17.57
		15-30 cm mean	7.41	7.30	279.3	17.76	371.3	14.29
Fenugreek	Control	0-15 cm	7.60	5.87	250.4	12.20	363.2	11.23
	(46:0:0 N:P:Kkg ha^{-1})	15-30 cm	8.11	5.43	228.2	11.77	353.2	10.33
Spinach	Control	0-15 cm	7.77	5.70	252.2	13.08	365.8	10.24
	46:0:0 N:P:K kg ha^{-1})	15-30 cm	8.14	5.18	217.5	11.61	359.4	8.89
Okra	Control	0-15 cm	7.73	5.34	245.7	22.68	367.4	15.62
	(64:46:0 N:P:K kg ha^{-1})	15-30 cm	7.81	4.95	233.4	20.15	355.5	13.32
Brinjal	Control	0-15 cm	8.13	6.13	238.3	24.89	358.4	16.32
	(64:54:0 N:P:K kg ha^{-1})	15-30 cm	8.21	4.80	228.9	22.69	349.1	14.24
		0-15 cm mean	7.80	5.76	246.6	18.21	363.7	13.35
		15-30 cm mean	8.06	5.09	227.0	16.55	354.3	11.69

Table 3. Correlation matrix between various soil properties and yield of vegetables

	Yield	B. D.	WHC	HC	IR	MWD	pH	O. C.	N	P	K	S
Yield	1											
B.D.	0.242	1										
WHC	0.412*	-0.567	1									
HC	0.137	-0.760	0.626**	1								
IR	0.388*	-0.632	0.750**	0.823**	1							
MWD	0.452*	-0.033	0.415*	0.224	0.309	1						
pH	0.180	0.675**	-0.632	-0.713	-0.613	-0.215	1					
O.C.	0.107	-0.712	0.619**	0.933**	0.757**	0.151	-0.817	1				
N	-0.175	-0.674	0.260	0.737**	0.446*	0.012	-0.620	0.745**	1			
P	0.474*	0.064	0.175	0.346	0.326	0.325	0.097	0.238	0.132	1		
K	-0.161	-0.628	0.338	0.754**	0.657**	0.241	-0.638	0.654**	0.630**	0.186	1	
S	0.249	-0.273	0.305	0.678**	0.549	0.587*	-0.401	0.587*	0.525*	0.685*	0.662**	1

****Significant at 1% level (0.606) * Significant at 5% level (0.380)**

Table 4.Yield of vegetables under different treatments

Crops	Treatments				
	Jivamrut (500 litre ha^{-1})	**Ghanajivamrut (500 kg ha^{-1})**	**FYM (10 t ha^{-1})**	**Control (N:P:K kg ha^{-1}) (control)**	**Inorganic fertilizers**
	Yield (q ha^{-1})			**farmers applied**	
Spinach	43.4	55.4	67.1	72.0	46:0:0 NPK kg ha^{-1}
Fenugreek	28.7	35.6	45.4	64.9	46:0:0 NPK kg ha^{-1}
Brinjal	185.3	210.2	310.6	255.4	64:54:0 NPK kg ha^{-1}
Okra	54.7	75.8	93.5	75.9	64:46:0 NPK kg ha^{-1}

Available P in soil was observed higher value 24.89 kg ha^{-1}under the application of inorganic fertilizers to brinjal crop with application of 64: 54: 0 kg N:P:K kg ha^{-1}.In the present study, there was a decrease in available phosphorus in soil with the use of organic inputs over the application of chemical fertilizers alone to okra and brinjal. Balanced inorganic fertilizer and crop residues helps in increasing the phosphorus content in solution and solublization of native soil phosphorus. Similar result was also found by Riba *et al.*(2018) where application of fertilizer along with FYM (5 t ha^{-1}, 10 t ha^{-1}) caused increase in available phosphorus that ranged between 16.5 to 21 kg ha^{-1} as compared to alone application of FYM (5t ha^{-1}, 10 t ha^{-1}) which caused reduction in availability of phosphorus i.e., 13.5 and 16.5 kg ha^{-1}, respectively. The magnitude of available K ranged from 358.4 to 402.8 kg ha^{-1} in surface and from 349.1 to 397.1 kg ha^{-1}in subsurface soil which found very high in range.

The data further revealed that, the application of organic fertilizers (FYM @ 10 t ha^{-1}) recorded an increase in available K content in soil by 5.60 and 4.85 per cent at surface and subsurface level, respectively over inorganic fertilizer as no potassium was applied to plot of inorganic fertilizer in the present study. The available sulphur in soil had increased by 24.01 per cent with the application of FYM @ 10 t ha^{-1} over inorganic fertilizer at surface level.

Yield of vegetables

The yield of different vegetable crops is represented in table 4. Yield of spinach increased to the tune of 17.44 to 35.32 per cent with the application of FYM 10 t ha^{-1} over Jivamrit 500 lit. ha^{-1}.Vethamoni *et al.*(2018) found that among the various organic treatments the yield of Palak obtained under the range of 48.95 q ha^{-1} to 68.02 q $ha^{-1}$and he also reported that application of Vermicompost @ 4 tonnes ha^{-1} + liquid nitrogen Biofertilizer (Azospirillum @ 200 ml $acre^{-1}$) + foliar spray of Vermiwash (3%) resulted in increased yield $plot^{-1}$.The yield of fenugreek was obtained between 28.7 to 64.9 q ha^{-1} with the use of different nutrient sources with mean of 43.65 q ha^{-1}. The maximum yield (64.9 q ha^{-1}) was obtained with chemical fertilizers. With the use of inorganic fertilizer the yield of fenugreek increased by 55.7, 45.14 and 30.04 per cent over application of Jivamrut 500 lit. ha^{-1},Ghanajivamrut 500 kg ha^{-1} and FYM 10 t ha^{-1} respectively. Nilesh *et al.* (2016) observed that significantly highest yield of spinach was obtained under 20 kg P and 30 kg K ha^{-1}.The highest yield of okra 93.5 q ha^{-1} was obtained with the application of FYM @ 10 t ha^{-1}.The yield of okra increased by 41.49, 18.93 and 18.82 per cent with the use of FYM @ 10 t ha^{-1} over Jivamrit 500 lit. ha^{-1}, Ghanajivamrut 500 kg ha^{-1} and control respectively. Premsekhar and Rajashree (2009) revealed that among the different organic manure treatments, okra showed significantly higher values of growth characters and yield attributes by the application of FYM @ 20 t ha^{-1}. Highest yield of 310.6 q $ha^{-1}$was obtained with the application of FYM 10 t ha^{-1} in brinjal.

Correlation matrix between soil properties and yield of vegetable crops

Yield of vegetables was positively correlated with water holding capacity (r = 0.412*), mean weight diameter (r = 452*), available P (r = 0.474*) and infiltration rate (0.388*). It also give an idea about positive correlation of infiltration rate with hydraulic conductivity of soil (r = 0.823**) and WHC (r = 0.750**).Data showed that, mean weight diameter was significantly and positively correlated with WHC (r = 0.415*)and positive correlation of organic carbon with WHC (r = 0.619*), HC (r = 0.933**) and Infiltration rate (r= 0.757**).Cotching *et al.*(2002) reported a significant correlation between the SOC pool and yields of spring vegetables.

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Rec. on 01.06.2020 & Acc. on 20.06.2020