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Chemical properties of agricultural and forest soil of different blocks of Bargarh district, Odisha, India

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Abstract
An experiment was conducted in 2023-2024 to assess the chemical properties of soils of agricultural and forest land of Bargarh district Odisha. Odisha is situated in between the geographical coordinates of 81.27' 87.29" E longitude and 17.49' 22.34 "N latitude. Nine Different villages located in the Bargarh district covering three different blocks such as Attabira, Bheden and Bargarh and one forest area of Debrigarh was selected for the study. The chemical properties like Soil pH, EC(dSm^{-1}) at 25 °C, Percent organic matter, Percent organic carbon, Available soil Nitrogen, Phosphorus and Potassium(Kg ha^{-1}) were analysed by standard procedure following Jackson (1958), Wilcox (1950),Walkley and Black (1947) Subbiah and Asija (1956), Olsen *et al.,* (1954), Toth and Prince (1947) at 0-15, 15-30 and 30-45 cm depth for agricultural soil and 0-15, 15-30, 30-45 and 45-60 cm for forest soil. The recorded pH, EC, Organic carbon, Organic matter and Available NPK were found significant. The data showed the value between the agriculture and forest soil where the soil pH was slightly acidic in nature. The soil analysis shows Low to medium soil organic carbon content and medium percentage of NPK.

Keywords: Agricultural, Bargarh, chemical properties, forest, Odisha, soil analysis

Introduction
Soil is a thin layer that covers most the earth's surface (Bhardwaj *et al.,* 2020) [1]. It is one of the important resources that nature has given us. All the living things depend on plant for the food source and plant depends on soil (Tale *et al.,* 2015) [17]. In the productivity of the soil, the soil Organic Carbon has also played an important factor by contributing on physical, biological and chemical properties of the soil (Bhattacharyya *et al.,* 2000) [2]. Some of the important factors that have been controlled by the Soil Organic Carbon levels are climate, hydrology, vegetation pattern, land use and soil fertility (Bhattacharyya *et al.,* 2000) [2]. Bargarh district is situated in western most part of Odisha (Mishra *et al.,* 2008) [10]. The average rainfall is recorded around 1337.5 mm, which mostly occur in *kharif* season (Subudhi *et al.,* 2019) [15].Bargarh has different variety of soil i.e., Vertisols, Inceptisols and alfasols. There is spatial variability which exist between the amount and distribution of rainfall, land topography and types of soil in different blocks of Bargarh district (Brahmanand *et al.,* 2019) [3]. The topography is mostly of ridges and valleys. Different climate, vegetation and biotic factor indicate the influences in genesis of soil and consequence variation in the soil types (Mishra *et al.,* 2008) [2].

Material and Methods
Soil samples were collected from nine villages which come under Attabira, Bheden and Bargarh district of agricultural land at 0-15, 15-30 and 30-45 cm depth and for forest study 0-15, 15-30, 30-45 and 45-60 cm depth for analysis of chemical properties of the soil. Total 27 soil samples were collected from three random villages from each block from agricultural soils for chemical analysis. For forest soil, the analysis site was selected at Debrigarh forest area and 60 samples were collected for chemical analysis of forest soil. These samples were air dried under shade for one week, to get the constant weight of the soil. It was then further crushed with hammer and was sieved with 0.2 mm sieve to get the composite samples of each depth and each site. The chemical properties like Soil pH, EC (dSm^{-1}) at 25 °C, Percent organic matter, Percent organic

carbon, Available soil Nitrogen, Phosphorus and Potassium Kg ha^{-1} were analysed by standard procedure following Jackson (1958) [7], Wilcox (1950) [20],Walkley and Black (1947) [19], Subbiah and Asija (1956) [14], Olsen *et al.,* (1954) [12], Toth and Prince (1947) [18] at 0-15 cm, 15-30 cm and 30-45 cm for agricultural soil and 0-15, 15-30, 30-45 and 45-60 cm for forest soil. The data observed during the research work was done, as per the method of "Analysis of Variance Technique' which was given by Fisher (1960) [6].

Results and Discussion

The result mentioned in figure 1 shows the soil pH and EC dSm^{-1} at 25 °C at 0-15, 15-30 and 30-45 cm depth for agricultural soil and at 0-15, 15-30, 30-45 and 45-60 cm depth for forest soil (figure 2) were found significant at 5% critical difference. The maximum soil pH 6.36 at 0-15 cm, 6.53 at 15-30 cm, and 6.64 at 30-45 cm depth was found in Attabira for agricultural soil. Maximum soil pH 6.0 at 0-15 cm, 6.1 at 15-30 cm, 6.15 at 30-45 cm and 6.17 at 45-60 cm was observed in Debrigarh. The minimum soil pH 5.1 at 0-15 cm, 5.35 at 15-30 cm, and 5.41 at 30-45 cm depth was found in Bheden and Bargarh for agricultural soil. Minimum pH 5.2 at 0-15 cm, 5.2 at 15-30 cm, 5.1 at 30-45 cm and 5.0 at 45 -60 cm was observed in Debrigarh. The results showed the soil is highly acidic in nature. The Soil acidity appears to be a major crop production constraint in the study area (Digal *et al.,* 2018) [5]. Similar findings have also been reported earlier by Mishra *et al.,* (2017) [9].

Similarly, the maximum soil EC 0.63 at 0-15 cm, 0.69 at 15-30 cm and 0.75 at 30-45 cm depth was found in Bheden for agricultural soil. Maximum soil EC 0.40 at 0-15 cm, 0.43 at 15-30 cm, 0.47 at 30-45 cm and 0.50 at 45-60 cm was observed in Debrigarh. The minimum soil EC 0.21 at 0-15 cm, 0.25 at 15-30 cm, and 0.28 at 30-45 cm depth was found in Attabira and Bheden for agricultural soil. Minimum EC 0.10 at 0-15 cm, 0.11 at 15-30 cm, 0.12 at 30-45 cm and 0.17 at 45 -60 cm was observed in Debrigarh. The Soil under study are safe for all types of crop production with respect to soluble salt content (Digal *et al.,* 2018) [5]. Similar findings have also been reported earlier by Mishra *et al*., (2017) [9].

The percent organic carbon of soil at 0-15, 15-30 and 30-45 cm depth for agricultural soil (Table 1) and at 0-15, 15-30, 30-45 and 45-60 cm depth for forest soil (Table 2) were found significant at 5% critical difference. The maximum percent organic carbon 0.72 at 0-15 cm, 0.68 at 15-30 cm, and 0.63 at 30-45 cm depth was found in Attabira for agricultural soil. Maximum percent organic carbon 1.35 at 0-15 cm, 1.30 at 15-30 cm, 0.91 at 30-45 cm and 0.97 at 45-60 cm was observed in Debrigarh. The minimum percent organic carbon 0.39 at 0-15 cm, 0.35 at 15-30 cm, and 0.32 at 30-45 cm depth was found in Bheden for agricultural soil. Minimum percent organic carbon 0.67 at 0-15 cm, 0.48 at 15-30 cm, 0.44 at 30-45 cm and 0.39 at 45 -60 cm was observed in Debrigarh. The higher percent of organic carbon in the surface soil may be due to the undecomposed and partial decomposed organic substance and lower organic carbon is seen in sub-surface soil which may be due to decomposed organic substances which have undergone chemical and biological changes (Rai *et al.,* 2021) [16]. Similar findings have also been reported earlier by Dash *et al*. (2016) [4].

The percent organic matter of soil at 0-15, 15-30 and 30-45 cm depth for agricultural soil (Table 1) and at 0-15, 15-30, 30-45 and 45-60 cm depth for forest soil (Table 2) were found significant at 5% critical difference. The maximum percent organic matter 1.24 at 0-15 cm, 1.17 at 15-30 cm, and 1.08 at 30-45 cm depth was found in Attabira for agricultural soil. Maximum percent organic carbon 2.35 at 0-15 cm, 2.24 at 15-30 cm, 1.56 at 30-45 cm and 1.67 at 45-60 cm was observed in Debrigarh. The minimum percent organic matter 0.67 at 0-15 cm, 0.6 at 15-30 cm, and 0.55 at 30-45 cm depth was found in Bheden for agricultural soil. Minimum percent organic matter 1.15 at 0-15 cm, 0.82 at 15-30 cm, 0.75 at 30-45 cm and 0.67 at 45 -60 cm was observed in Debrigarh. The Soil Organic matter appears to be a major constraint in the study area (Digal *et al*., 2018) [5]. Similar findings have also been reported earlier by Mishra *et al*., (2017) [9].

The Table 3 shows the available Nitrogen Kg ha^{-1} at 0-15, 15-30 and 30-45 cm depth for agricultural soil and at 0-15, 15-30, 30-45 and 45-60 cm depth for forest soil (Table 4) were found significant at 5% critical difference. The maximum available Nitrogen 336 at 0-15 cm, 313 at 15-30 cm, and 297 at 30-45 cm depth was found in Bheden for agricultural soil. Maximum available nitrogen 226 at 0-15 cm, 223 at 15-30 cm, 220 at 30-45 cm and 217 at 45-60 cm was observed in Debrigarh. The minimum available nitrogen 148 at 0-15 cm, 146 at 15-30 cm, and 142 at 30-45 cm depth was found in Bargarh for agricultural soil. Minimum available nitrogen 180 at 0-15 cm, 148 at 15-30 cm, 141 at 30-45 cm and 134 at 45 -60 cm was observed in Debrigarh. The high nitrogen content in the soil may be due to leaf litter or due to application of organic amendments (Pradhan *et al.,* 2020) [13]. Similar findings have also been reported earlier by Mishra *et al*., (2017) [9], Mohapatra *et al*., (2020) [11].

The Table 3 shows the available phosphorus Kg ha^{-1} at 0-15, 15-30 and 30-45 cm depth for agricultural soil and at 0-15, 15-30, 30-45 and 45-60 cm depth for forest soil (Table 4) were found significant at 5% critical difference. The maximum available Phosphorus 23.05 at 0-15 cm, 19.97 at 15-30 cm, and 21.03 at 30-45 cm depth was found in Bargarh for agricultural soil. Maximum available Phosphorus 29.88 at 0-15 cm, 29.23 at 15-30 cm, 29.32 at 30-45 cm and 24.12 at 45-60 cm was observed in Debrigarh. The minimum available phosphorus 16.12 at 0-15 cm, 15.1 at 15-30 cm, and 13.36 at 30-45 cm depth was found in Attabira for agricultural soil. Minimum available Phosphorus 12.71 at 0-15 cm, 12.50 at 15-30 cm, 11.47 at 30-45 cm and 11.20 at 45 -60 cm was observed in Debrigarh. The availability of phosphorus may be due to the soil pH which is mostly acidic in nature and it often limits the nutrients remains present in the plant nuclei (Kekane *et al.,* 2015) [8]. Similar findings have also been reported earlier by Mishra *et al*., (2017) [9], Mohapatra *et al*., (2020) [11].

The Table 3 also shows the available potassium Kg ha^{-1} at 0-15, 15-30 and 30-45 cm depth for agricultural soil and at 0-15, 15-30, 30-45 and 45-60 cm depth for forest soil (Table 4) were found significant at 5% critical difference. The maximum available potassium 658 at 0-15 cm, 597 at 15-30 cm, and 593 at 30-45 cm depth was found in Bargarh for agricultural soil. Maximum available potassium 739 at 0-15 cm, 658 at 15-30 cm, 597 at 30-45 cm and 593 at 45-60 cm was observed in Debrigarh. The minimum available potassium 193 at 0-15 cm, 181 at 15-30 cm, and 160 at 30-45 cm depth was found in Attabira for agricultural soil. Minimum available potassium 201 at 0-15 cm, 193 at 15-30 cm, 181 at 30-45 cm and 163 at 45 -60 cm was observed in Debrigarh. The availability of potassium appears to be a major constraint in the study area (Digal *et al.,* 2018) [5]. Similar findings have also been reported earlier by Mishra *et al*., (2017) [9], Mohapatra *et al*., (2020) [11].

Table 1: Assessment of Percent Soil organic carbon and Soil organic matter of Agricultural soil

Villages		Organic Carbon			Organic matter		
Attabira	**V1**	**0-15 cm**	**15-30 cm**	**30-45 cm**	**0-15 cm**	**15-30 cm**	**30-45cm**
	V2	1.24	1.17	1.08	0.72	0.68	0.63
	V3	0.86	0.84	0.77	0.5	0.49	0.45
Bheden	V1	0.81	0.67	0.65	0.47	0.39	0.38
	V2	0.67	0.60	0.55	0.39	0.35	0.32
	V3	0.82	0.77	0.72	0.48	0.45	0.42
Bargarh	V1	0.79	0.72	0.67	0.46	0.42	0.39
	V2	0.77	0.70	0.65	0.45	0.41	0.38
	V3	0.99	0.96	0.93	0.56	0.54	0.52
F-test		S	S	S	S	S	S
S. Em. (±)		0.016	0.015	0.016	0.03	0.04	0.05
CD @5%		0.043	0.045	0.046	0.11	0.12	0.13

Table 2: Assessment of Percent Soil organic carbon and Soil organic matter of Forest soil

	Soil Organic carbon (%)				Soil organic Matter (%)			
Forest site	**0-15 cm**	**15-30 cm**	**30-45 cm**	**45-60 cm**	**0-15 cm**	**15-30 cm**	**30-45 cm**	**45-60 cm**
F_1Q_1	2.18	0.89	0.81	0.75	1.27	0.52	0.47	0.44
F_1Q_2	1.81	0.99	0.87	0.67	1.05	0.58	0.51	0.67
F_1Q_3	2.35	2.24	1.56	1.67	1.35	1.30	0.91	0.97
F_1Q_4	2.06	0.91	0.79	0.67	1.20	0.53	0.46	0.39
F_1Q_5	1.67	1.10	0.98	0.91	0.97	0.64	0.57	0.53
F_2Q_1	1.41	0.89	0.75	0.68	0.82	0.52	0.44	0.40
F_2Q_2	1.29	0.99	0.89	0.81	0.75	0.58	0.52	0.47
F_2Q_3	1.93	1.18	0.96	0.87	1.12	0.69	0.56	0.51
F_2Q_4	1.55	1.44	1.10	0.75	0.90	0.84	0.64	0.44
F_2Q_5	1.41	1.29	0.96	0.77	0.82	0.75	0.56	0.45
F_3Q_1	1.75	1.24	1.17	1.08	1.02	0.72	0.68	0.63
F_3Q_2	1.39	0.86	0.84	0.77	0.81	0.50	0.49	0.45
F_3Q_3	1.24	0.93	0.81	0.70	0.72	0.54	0.47	0.41
F_3Q_4	1.15	0.94	0.82	0.86	0.67	0.55	0.48	0.50
F_3Q_5	1.29	0.82	0.77	0.72	0.75	0.48	0.45	0.42
F-test	S	S	S	S	S	S	S	S
S. Em. (±)	0.014	0.012	0.017	0.012	0.04	0.04	0.06	0.05
CD @5%	0.044	0.043	0.046	0.043	0.12	0.12	0.15	0.14

Table 3: Assessment of Soil Organic matter, Available N, Available P, Available K of Agricultural soil

		Available N			Available P			Available K		
Agricultural site	**Village**	**0-15 cm**	**15-30 cm**	**30-45 cm**	**0-15 cm**	**15-30 cm**	**30-45 cm**	**0-15 cm**	**15-30 cm**	**30-45 cm**
Attabira	V1	297	287	282	16.12	15.1	13.36	403	376	336
	V2	238	225	217	19.05	18.31	16.22	600	556	539
	V3	219	203	188	17.25	15.27	13.97	193	181	163
Bheden	V1	235	220	203	21.03	18.64	17.57	300	290	256
	V2	336	313	297	19.85	17.21	15.12	270	210	190
	V3	204	193	182	21.55	19.97	18.99	300	260	160
Bargarh	V1	180	169	157	23.05	22.12	21.03	350	310	280
	V2	163	158	143	20.44	19.36	18.64	604	597	593
	V3	148	146	142	18.34	17.46	15.21	658	470	430
F-test		S	S	S	S	S	S	S	S	S
S. Em. (±)		7.25	7.47	7.36	0.89	0.94	0.94	30.97	30.83	30.72
CD @5%		21.56	22.19	21.88	2.66	2.79	2.80	92.03	91.60	91.28

Table 4: Assessment of Soil Organic matter, Available N, Available P, Available K of Forest soil

	Available N				Available P				Available K			
Forest site	**0-15 cm**	**15-30 cm**	**30-45 cm**	**45-60 cm**	**0-15 cm**	**15-30 cm**	**30-45 cm**	**45-60 cm**	**0-15 cm**	**15-30 cm**	**30-45 cm**	**45-60 cm**
F_1Q_1	250	219	203	188	22.93	20.89	19.58	17.22	524	403	376	336
F_1Q_2	235	233	220	217	28.88	28.29	25.87	19.1	739	600	556	539
F_1Q_3	219	210	188	203	16.56	14.03	13.13	11.2	201	193	181	163
F_1Q_4	235	230	219	203	29.88	29.23	25.87	21.25	295	300	290	256
F_1Q_5	203	201	197	193	25.96	28.17	29.32	24.12	282	270	210	190
F_2Q_1	207	204	193	182	18.97	17.48	13.76	12.36	336	300	260	160
F_2Q_2	188	180	169	157	22.80	20.69	19.49	15.47	470	350	310	280
F_2Q_3	197	163	158	143	23	20.54	18.19	14.96	618	604	597	593
F_2Q_4	188	148	141	134	12.71	12.50	11.47	11.40	510	658	470	430
F_2Q_5	266	224	219	212	18.25	15.10	13.45	16.05	497	430	403	322
F_3Q_1	224	219	215	210	27.65	16.55	15.35	17.13	309	295	282	268
F_3Q_2	204	201	197	188	19.17	18.23	16.96	19.12	322	309	295	282
F_3Q_3	180	177	168	156	18.21	17.12	14.36	18.87	456	430	416	403
F_3Q_4	201	195	180	177	17.11	15.05	13.20	17.44	268	255	241	215
F_3Q_5	226	220	215	210	25.71	13.44	12.22	15.25	255	228	215	210
F-test	S	S	S	S	S	S	S	S	S	S	S	S
S.Em. (±)	7.26	7.48	7.33	7.43	0.87	0.95	0.97	0.96	30.89	30.86	30.77	30.72
CD @5%	21.34	21.45	21.56	21.72	2.55	2.66	2.64	2.83	92.05	92.04	91.43	91.38

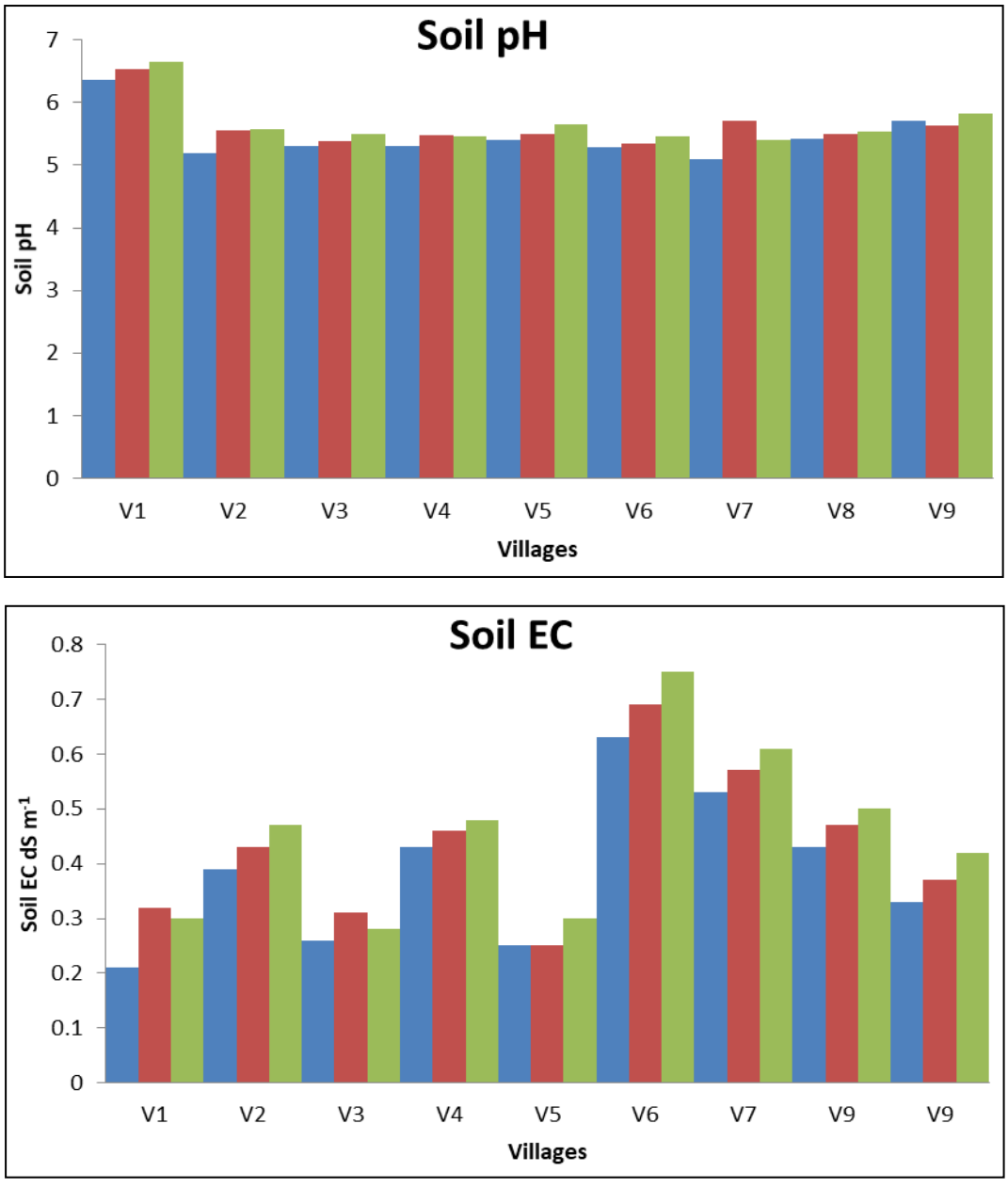

Fig 1: Graphical representation of Soil pH and EC (dSm^{-1}) [1] at 25 °C of depth in different villages of Agricultural land at depth 0-15, 15-30 and 30-45 cm

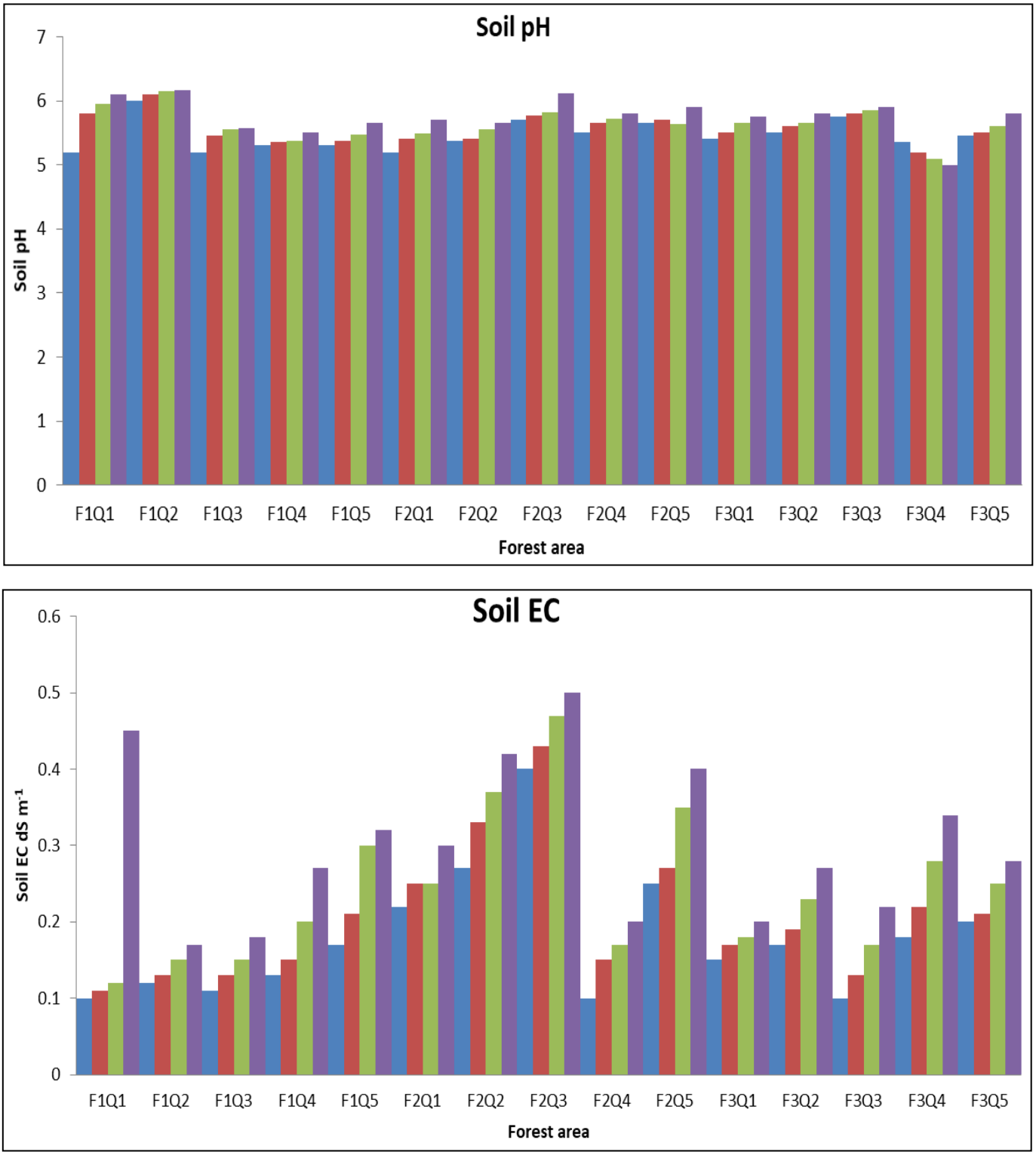

Fig 2: Graphical representation of Soil pH and EC (dSm^{-1}) [1] at 25 °C of soil in different forest site at depth 0-15 cm, 15-30 cm, 30-45cm and 45 -60 cm

Conclusion

During the research it was found that, the soil samples collected from nine different villages of Bargarh district and forest soil of Debrigarh forest area, an increases in the parameters were observed. The soils are slightly acidic in pH, low to medium soil organic carbon content and organic matter. The soil has medium range in Nitrogen, Phosphorus and Potassium. The parameters studied were all in the prescribed limit, but any deficiency in the nutrient content of the soil can be corrected by the application of right amount of fertilizers and organic matter. Awareness among the farmers regarded good cultivation practices must be followed.

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