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EFFECT OF DHAINCHA [*SESBANIA ACULEATE* (L)] ON PHYSICO-CHEMICAL PROPERTIES OF SOIL

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ABSTRACT

Field experiment to assess the effect of dhaincha on physico chemical properties of soil was done at Krishi Vigyan Kendra Farm of Katihar district during two consecutive years of 2015 and 2016. The experiment was laid out in randomized complete block design with three treatments consisting of a fallow soil, deep ploughing and green manure Dhaincha each with eight replication consisting. The percentage change in physico-chemical properties of experimental soil i.e. bulk density, particle density, porosity, pH, ECe, OC, available N, P and K are 1.33, 3.75, 3.35, -1.32, 13.06, 10.28, 11.68, 19.73 and 25.18 percent in treatment T_3 where dhaincha uses as green manure followed by 0.45, 1.07, 0.81, -1.54, 32.01, 2.47, 2.49, 8.29, 5.75 in T_2 where deep ploughing carry out and 0.25 0.41, 0.21, 0.0, 11.61, 0.00, -4.95, -8.65, 0.23 in T_1 where fallow land, respectively. It is clear from data that the use of dhaincha as green manure decrease pH and increased electrical conductivity, organic matter and all fertility status of soil, which consequently resulted in maximum plant nutrients availability from soil.

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INTRODUCTION

Our soils are not delivered sufficient amount of manure long ago. The organic matter deficiency can lead to the deterioration of soil structure and the exhaustion of its fertility. Intensive tillage and current agricultural practices results in a decrease in soil organic matter leading to soil degradation, loss of soil biological fertility and biodiversity (Bahrani *et al.,* 2007). Sustainable crop production can be conducted only on soils with well conserved soil structure and with available nutrient supply (Peter, 2009). Sustaining soil health is of primary importance in terms of cycling plant nutrients and improving soils physico-chemical and biological properties. Lal (2005) calculated that increasing soil organic carbon by 1 Mg/ha/year can increase food grain production by 32 million Mg/year in developing countries.

Green manures, also referred to as fertility building crops, may be broadly defined as crop grown for the benefit of the soil. The benefits of green manuring are multifold. It increases soil organic matter, available nitrogen, concentration of nutrients near the soil surface in available form, and reduces the N losses through leaching and soil erosion. Increases organic matter in soil as a result of green manure improves soil physic-chemical properties by increasing the distribution and stability of soil aggregates and decreasing soil bulk density (McRae and Mehuys, 1988). Vegetative cover prevents the build-up of the aggregates, which could lead to the formation of surface crusts that reduce water infiltration. Green manuring is the most important way to influence topsoil. The soil physical properties that are affected by incorporation of the green manure include the structure, moisture retention capacity, consistency and density. Other properties such as the porosity, aeration, conductivity, hydraulics and infiltration are allied to the modifications to the soil structure. Post-harvest decaying roots, stem and leaves significantly increase macropores in soil. Therefore, the physico-chemical properties of soil improve. However, legumes are superior green manure crops as they fix atmospheric nitrogen and add it to the soil nitrogen pool (Carlson and Huss-Danell, 2003; Mayer, *et al.,* 2003). Legumes are known to improve soil fertility by adding much needed organic matter in the soils. Use of annual forage legumes such as Dhaincha, as green manures, can improve soil fertility and can help increase the productivity of the succeeding crop. Therefore, in order to assess its effect on soil physico-chemical properties, the present study has been undertaken with an objective to study the effect of green manuring on physico-chemical properties of soils in Koshi region of Bihar.

MATERIALS AND METHODS

The experiment was conducted at Krishi Vigyan Kendra, Katihar farm, under Bihar Agriculture University, Sabour and Bhagalpur during two consecutive years of 2015 and 2016 to study the effect of dhaincha on physico-chemical properties of soil. It lies between Latitude 25′N to 26′N, Longitude 87′ to 88′E with an altitude of 32 m above MSL. The climate is sub-tropical and humid having average temperature (Max. & Min.), 42ºC and 4ºC, respectively and the average annual rainfall of the district are about 1298 mm.

Experimental site and soil analysis

The experimental soils were non-calcareous in nature belonging to the Alluvial Tract under Agro ecological zone-II lies between three major rivers Mahananda, Kosi and Ganga. The soil samples were collected from Krishi Vigyan Kendra Farm before the experiment start on and after incorporation and decomposition of the dhaincha crop. The experiment was conducted as a randomized complete block design with three treatments (T_1 = Fallow land, T_2 = Deep ploughing and T_3 = Dhaincha us as green manure) and eight replications. The legumes Dhaincha was used as green manure crops. There was a combination of three treatments consisting of a fallow land, deep ploughing land and green manure dhaincha each with eight treatments consisting. The deep ploughing land was ploughed with double disc in the second half month of April and Dhaincha were sowing in the first week of May after initial soil sample collation. The Dhaincha were sown through broad casting method at the rate of 25 kg/ha. Third week of June (15 to 18) dhaincha were chopped and incorporated into the soil with the help of rotavator. Both years soil samples from depths 0-15 cm were taken before and after incorporation of these Dhaicha crop from each plot at random using double cylinder core samplers with sample holder (inner cylinder) diameter and height of 50 mm high (Black and Hartge, 1986). The sampler was pressed vertically into the soil surface enough to fill the sampler, but not so far to compress the soil in the compound space of the sampler. The sampler and its contents were carefully removed to preserve the natural structure and packing of the soil as best as possible. The two cylinders were sorted, retaining the undisturbed soil in the inner cylinder. The soil extending beyond each end of the sample holder was trimmed to flush with a straight edged knife. The soil sample volume was thus established to be the same as the volume of the sampler holder. The soil cores were wrapped in paper, transported and safely stored in the laboratory safely. Air-dry the soil sample in shade for chemical analysis. Crush the soil and grind with the help of grinder and pass through 0.2 to 0.5 mm sieves before analysis and record. Bulk density (B.D.) of soil was determined by core sampler method (Bodman, 1942), Particle density by Pycnometer method and porosity determined with the help of formula based on BD and PD (Chopra and Kanwar, 1991). Organic carbon content was determined by the Walkley and Black method (1934). Available nitrogen was determined by the alkaline $KMNO_4$ method (Subbaiah and Asija, 1956) and available phosphorous (Olsen's method, 1954) and available potash were determined Flamphotometrically method (Tandon, 1993). The EC and pH of soil were estimated after preparing 1:2 soil water suspension by conducto metrically and electro meterically using glass electrode methods (Piper, 1950), respectively.

Statistical analysis

The data collected on different parameters under the experiment were statistically analyzed to obtain the level of significance using the computer MSTAT package program developed by Russel (1986). The differences between pairs of means were compared by Duncan's multiple range test (DMRT) as stated by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under the following heads

Effect of green manuring on soil physico-chemical properties

The effect of different treatments on soil bulk density was significant and presented in table 1 with fig 1. The percentage change in bulk density lowest was recorded in T_1 (0.26 %) where plots are fallow but maximum withT_3 (1.33 %) in dhaincha use as green manure followed by T_2 (0.45 %) where deep ploughing take place. The higher amount of added biomass from dhaincha and coupled with deep ploughing made soil loose, porous and less squeezed and therefore, the lower bulk density was found and maximum percentage changes take place. These findings are in agreement with the studies of Husunjak *et al.* (2002) and Rahman *et al.* (2007). The soil average particle density ranged from 2.36 to 2.46 g cm^{-3} in the surface layer (0-15 cm) (Table 2). The percentage change in particle density lowest was recorded in T_1 (0.41 %) where plots are fallow but maximum withT_3 (3.75 %) in dhaincha use as green manure followed by T_2 (1.07 %) where deep ploughing take place (fig 2). Its value decreased with the increase of organic matter content of the soil. Green manuring had significant effect on soil porosity (table 3) as it accumulates lot of organic matter in soils. With the addition of more biomass in soil by dhaincha the porosity also increased up to 3.35 % (fig 3) with the reduction of bulk density and particle density. These findings are agreement with the findings of Nayak *et al.* (2015).

Table 1: Effect of Green Manuring on Bulk Density (g/cm³) of Soil under Studies

Plot Name	T_1 = Fallow land			Plot	T_2 = Deep ploughing			Plot	T_3 = Dhaincha us as green manure		
	Initial	Final	% Change	Name	Initial	Final	% Change	Name	Initial	Final	% Change
H4	1.41	1.41	0.00	F2	1.40	1.39	0.71	B	1.41	1.39	1.42
H5	1.38	1.38	0.00	G1	1.39	1.39	0.00	D1	1.39	1.36	2.16
I	1.36	1.36	0.00	G2	1.36	1.35	0.74	E1	1.38	1.36	1.45
I1	1.41	1.40	0.71	G5	1.40	1.39	0.71	E2	1.42	1.40	1.41
I2	1.40	1.40	0.00	G7	1.40	1.40	0.00	E3	1.41	1.40	0.71
I3	1.42	1.42	0.00	H1	1.43	1.43	0.00	E4	1.42	1.39	2.11
J2	1.42	1.41	0.70	H2	1.39	1.38	0.72	E5	1.41	1.40	0.71
J10	1.44	1.43	0.69	H3	1.42	1.41	0.70	B1	1.42	1.41	0.70
Total	11.24	11.21	2.11	Total	11.19	11.14	3.59	Total	11.26	11.11	10.67
Mean	1.41	1.40	0.26	Mean	1.40	1.39	0.45	Mean	1.41	1.39	1.33
CD (0.05)	NS	NS	ND		NS	NS	ND		NS	0.02	ND

Table 2: Effect of Green Manuring on Particle Density (g/cm³) of Soil under Studies

Plot Name	T_1 = Fallow land			Plot	T_2 = Deep ploughing			Plot	T_3 = Dhaincha us as green manure		
	Initial	Final	% Change	Name	Initial	Final	% Change	Name	Initial	Final	% Change
H4	2.45	2.45	0.00	F2	2.48	2.45	1.21	B	2.45	2.35	4.08
H5	2.44	2.43	0.41	G1	2.45	2.44	0.41	D1	2.41	2.30	4.56
I	2.45	2.45	0.00	G2	2.46	2.41	2.03	E1	2.34	2.30	1.71
I1	2.43	2.41	0.82	G5	2.44	2.4	1.64	E2	2.48	2.40	3.23
I2	2.42	2.42	0.00	G7	2.48	2.44	1.61	E3	2.52	2.39	5.16
I3	2.41	2.40	0.41	H1	2.42	2.42	0.00	E4	2.5	2.41	3.60
J2	2.38	2.36	0.84	H2	2.41	2.39	0.83	E5	2.48	2.40	3.23
J10	2.45	2.43	0.82	H3	2.46	2.44	0.81	B1	2.47	2.36	4.45
Total	19.43	19.35	3.30	Total	19.60	19.39	8.55	Total	19.65	18.91	30.02
Mean	2.43	2.42	0.41	Mean	2.45	2.42	1.07	Mean	2.46	2.36	3.75
CD (0.05)	NS	NS	ND		NS	0.01	ND		NS	0.03	ND

Table 3: Effect of Green Manuring on Porosity (per cent) of Soil under Studies

Plot Name	T_1 = Fallow land			Plot	T_2 = Deep ploughing			Plot	T_3 = Dhaincha us as green manure		
	Initial	Final	% Change	Name	Initial	Final	% Change	Name	Initial	Final	% Change
H4	42.45	42.45	0.00	F2	43.55	43.27	0.65	B	42.45	40.85	3.76
H5	43.44	43.21	0.54	G1	43.27	43.03	0.54	D1	42.32	40.87	3.44
I	44.49	44.49	0.00	G2	44.72	43.98	1.64	E1	41.03	40.87	0.38
I1	41.98	41.91	0.16	G5	42.62	42.08	1.27	E2	42.74	41.67	2.52
I2	42.15	42.15	0.00	G7	43.55	42.62	2.13	E3	44.05	41.42	5.96
I3	41.08	40.83	0.60	H1	40.91	40.91	0.00	E4	43.20	42.32	2.03
J2	40.34	40.25	0.20	H2	42.32	42.26	0.15	E5	43.15	41.67	3.43
J10	41.22	41.15	0.18	H3	42.28	42.21	0.15	B1	42.51	40.25	5.31
Total	337.14	336.45	1.67	Total	343.21	340.37	6.52	Total	341.44	329.92	26.82
Mean	42.14	42.06	0.21	Mean	42.90	42.55	0.81	Mean	42.68	41.24	3.35
CD (0.05)	0.01	0.01	ND		0.02	0.05	ND		0.08	0.07	ND

Table 4: Effect of Green Manuring on pH and ECes of Soil under Studies

Plot Name	T_1 = Fallow land				Plot	T_2 = Deep ploughing				Plot	T_3 = Dhaincha us as green manure			
	pH		EC (d Sm^{-1})		Name	pH		EC (d Sm^{-1})		Name	pH		EC (d Sm^{-1})	
	Initial	Final	Initial	Final		Initial	Final	Initial	Final		Initial	Final	Initial	Final
H4	6.5	6.5	0.07	0.08	F2	6.8	6.7	0.10	0.11	B	8.2	8.0	0.18	0.19
H5	7.7	7.7	0.15	0.15	G1	6.6	6.6	0.11	0.10	D1	8.3	8.1	0.13	0.16
I	6.7	6.7	0.07	0.07	G2	6.8	6.8	0.13	0.12	E1	6.8	6.8	0.21	0.22
I1	7.4	7.4	0.18	0.18	G5	5.8	5.8	0.07	0.07	E2	6.9	6.8	0.18	0.2
I2	6.7	6.7	0.14	0.11	G7	6.4	6.2	0.12	0.15	E3	8.0	7.9	0.13	0.16
I3	6.8	6.8	0.32	0.32	H1	7.4	7.4	0.10	0.10	E4	6.8	6.7	0.15	0.17
J2	6.9	6.9	0.01	0.02	H2	5.7	5.2	0.03	0.10	E5	6.8	6.8	0.17	0.19
J10	6.7	6.7	0.04	0.04	H3	7.9	7.9	0.22	0.23	B1	8.3	8.2	0.17	0.19
Total	55.38	55.38	0.98	0.97		53.33	52.60	0.88	0.98		60.11	59.28	1.32	1.48
Mean	6.92	6.92	0.12	0.12		6.67	6.58	0.11	0.12		7.51	7.41	0.17	0.19
CD (0.05)	NS	NS	0.02	0.02		NS	NS	0.01	0.03			0.01	NS	0.02

Effect of green manuring on soil pH

The pH of initial and final soil samples collected from different experimental plot have been presented in table 4 and percentage change in fig 4. It is evident from the table that the pH of initial experimental soil samples ranges from 5.8 to 8.3 but analysis of soil samples after incorporation and decomposition of dhaincha, maximum pH changes take place in T_3 (dhaincha cultivated plot) where average pH 7.51 becomes 7.41 followed by T_2 (deep ploughing plot) 6.67 to 6.58 and T_1 (fallow land) 6.92 to 6.92. The soil pH reduced significantly in the treatments due to the fact that green manuring crops produces lot of organic acids which helps in reduction of soil pH (Singh *et al.,* 2009).

Effect of green manuring on soil electrical conductivity

The data in table 4 revealed that the ECe of initial and final soil samples collected from different experimental plot ranges from 0.01 to 0.98 but analysis of soil samples at final stage maximum ECe changes take place in T_3 (dhaincha cultivated plot) where average ECe 0.17 becomes 0.19 followed by T_2 (deep ploughing plot) 0.11 to 0.12 and T_1 (fallow land) 0.12 to 0.12 (fig 5). The soil ECe increased significantly in the treatments where dhaincha was grown and incorporated to soil and green manure crop produces different organic acids due to that cations becomes active and soil ECe increased (Singh *et al.*, 2009).

Table 5: Effect of Green Manuring on organic carbon and nitrogen of Soil under Studies

Plot Name	T_1 = Fallow land				Plot Name	T_2 = Deep ploughing				Plot Name	T_3 = Dhaincha us as green manure			
	OC (%)		N (kg ha^{-1})			OC (%)		N (kg ha^{-1})			OC (%)		N (kg ha^{-1})	
	Initial	Final	Initial	Final		Initial	Final	Initial	Final		Initial	Final	Initial	Final
H4	1.70	1.70	603	588	F2	0.26	0.28	193	202	B	0.11	0.13	162	193
H5	0.36	0.36	209	204	G1	0.14	0.15	161	164	D1	0.23	0.25	186	204
I	0.19	0.19	174	178	G2	0.21	0.20	180	176	E1	0.32	0.33	212	221
I1	0.12	0.12	154	150	G5	0.30	0.30	206	196	E2	0.28	0.28	199	217
I2	0.30	0.30	206	196	G7	0.14	0.15	161	170	E3	0.22	0.25	184	203
I3	0.23	0.23	186	172	H1	0.12	0.12	154	166	E4	0.21	0.24	180	201
J2	0.30	0.30	206	178	H2	0.14	0.14	161	162	E5	0.2	0.22	167	195
J10	0.21	0.21	180	165	H3	0.39	0.40	119	126	B1	0.14	0.16	161	182
Total	3.41	3.41	1918	1831		1.70	1.74	1334	1362		1.71	1.86	1451	1616
Mean	0.43	0.43	239	228		0.21	0.22	166	170		0.21	0.23	181	202
CD (0.05)	1.70	1.70	8.00	6.00		0.26	0.28	5.00	4.00		0.11	0.13	4.00	4.00

Table 6: Effect of Green Manuring on phosphorous and potas of Soil under Studies

Plot Name	T_1 = Fallow land				Plot Name	T_2 = Deep ploughing				Plot Name	T_3 = Dhaincha us as green manure			
	P_2O_5 (kg ha^{-1})		K_2O (kg ha^{-1})			P_2O_5 (kg ha^{-1})		K_2O (kg ha^{-1})			P_2O_5 (kg ha^{-1})		K_2O (kg ha^{-1})	
	Initial	Final	Initial	Final		Initial	Final	Initial	Final		Initial	Final	Initial	Final
H4	36	32	67	72	F2	17	19	134	145	B	27	34	134	165
H5	21	20	67	71	G1	47	51	67	68	D1	18	28	202	215
I	13	14	134	135	G2	44	45	67	68	E1	49	52	67	118
I1	36	32	134	135	G5	59	45	134	141	E2	51	52	491	540
I2	31	30	67	71	G7	30	38	538	568	E3	20	28	67	82
I3	32	30	67	71	H1	25	26	470	490	E4	41	44	76	95
J2	49	41	67	68	H2	31	37	134	141	E5	43	49	67	85
J10	29	22	403	305	H3	19	22	134	156	B1	43	46	67	76
Total	247	221	1008	928		271.6	283	1680	1777		292	333	1171.80	1376
Mean	30.88	27.63	126	116		33.95	35.38	210	222.13		36.50	41.63	146.48	172
CD (0.05)	0.82	0.74	0.45	0.65		0.54	1.22	0.62	0.77		0.96	0.98	0.45	0.86

Table 7: Physical properties of Dhaincha Crops

Plot Name	Plant height (cm)	Branches /plant	Nodules / Plant	Nodule weight (g/plant)	Biological yield (t/ha)
B	108.00	4.3	35.30	0.13	7.65
D1	112.00	4.5	38.52	0.13	7.92
E1	115.00	5.2	39.30	0.13	8.46
E2	107.00	4.7	32.12	0.12	7.10
E3	108.00	4.8	33.00	0.12	7.78
E4	108.00	4.8	32.54	0.11	7.78
E5	103.00	4.2	32.00	0.12	6.83
B1	106.00	4.6	30.63	0.11	7.37
Total	867.00	37.10	273.41	0.97	60.89
Mean	108.38	4.64	34.18	0.12	7.61
CD (0.05)	5.21	0.04	0.33	0.45	0.57

Effect of green manuring on soil organic carbon

Data related to organic carbon has been presented in table 5 and percentage changes in fig 6. It is clear from the data that initial soil samples rages from 0.12 to 1.70 percent in T_1, 0.12 to 0.39 percent in T_2 and 0.11 to 0.32 percentage in T_3 but soil samples analysis after final stage samples rages from 0.12 to 1.70 percent in T_1, 0.12 to 0.40 percent in T_2 and 0.13 to 0.33 percentage in T_3. It is clear from the data that oxidizable organic carbon increased with the use of dhaincha as green manuring crops; this may be due to the fact that green manuring crops accumulates lot of biomass in soil which increases the oxidizable organic carbon of the soil, which confirms the findings of Day and Nath (2015).

Effect of green manuring on soil available nitrogen

Tables 5 revealed that the amount of available nitrogen in initial soil samples collected from different treatments was varied between 154 and 603 kg ha^{-1} in T_1, 119 and 206 kg ha^{-1} in T_2 and 161 and 212 kg ha^{-1} in T_3. After chopped and decomposition of dhaincha crops in soil the final nitrogen status was determined and ranged found is 150 to 588 kg ha^{-1} in T_1, 126 to 202 kg ha^{-1} in T_2 and 182 to 221 kg ha^{-1} in T_3. It is also clear from fig 7 that green manures are often grown to add nitrogen to the soil. In organic systems this represents the main source of nitrogen through nitrogen fixation from

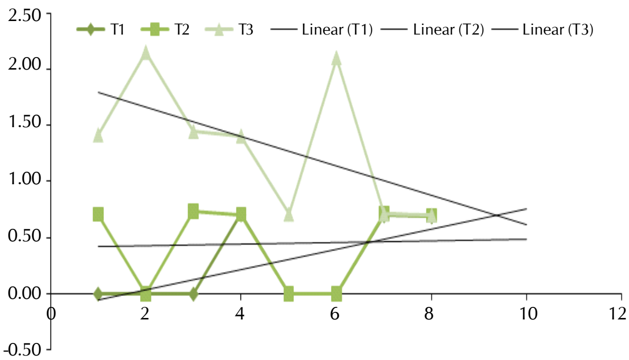

Figure 1: Percentage change in bulk density (g/cm³)

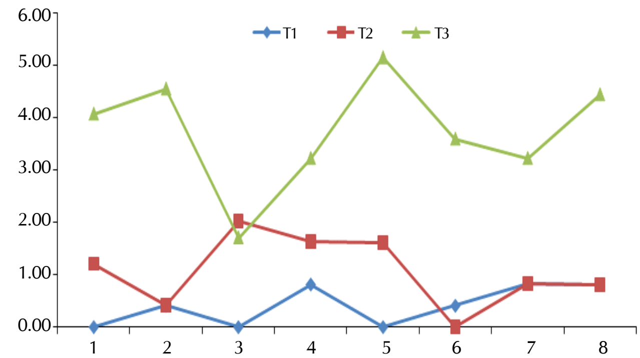

Figure 2: Percentage change in particle density (g/cm³)

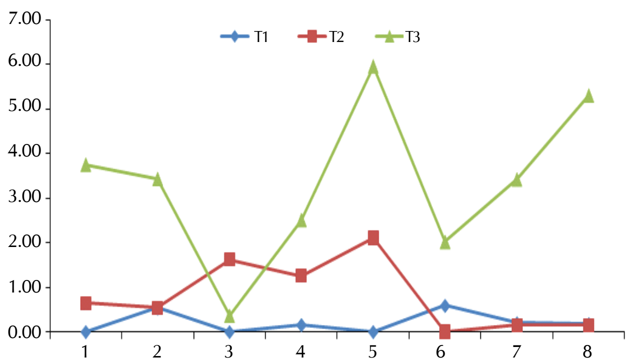

Figure 3: Percentage change in porocity

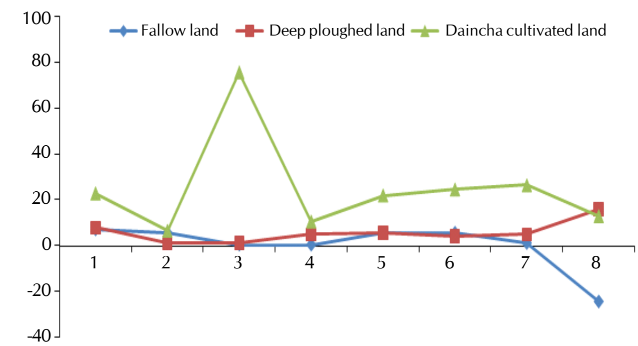

Figure 4: Percentage change in pH of soil

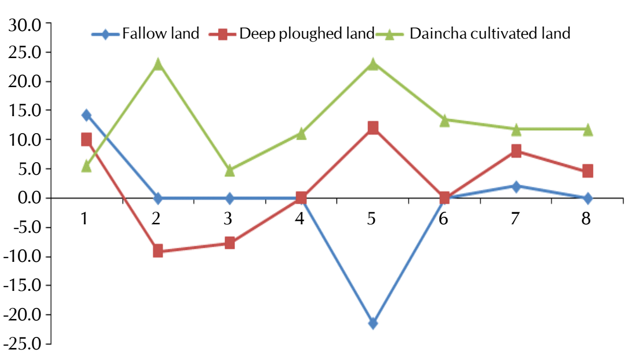

Figure 5: Percentage change in ECe (dS/m) of soil

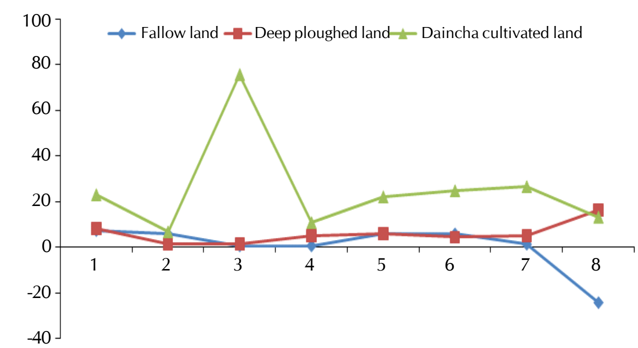

Figure 6: Percentage change in organic carbon of soil

atmosphere and increased organic carbon after decomposition of dhaincha, whilst for conventional growers; it can be away of minimizing fertilizer inputs (Chikowo, *et al.,* 2004 and Malik, *et al.,* 2002.). In the present study also the green manuring crops increased the available nitrogen of the soil due to its capacity to fix atmospheric nitrogen. Available nitrogen status increased to 11 percent in case of dhaincha chopped, incorporated and decomposed in soil.

Effect of green manuring on soil available phosphorus (P_2O_5)

It is clear from the data presented in table 6 and percentage change in fig 8 that the soil under study were average to high in available phosphorous. The amount of average phosphorus in different treatment varied from 30.88, 32.88 and 36.50 kg ha^{-1} in T_1, T_2 and T_3 respectively. After final soil samples analyzed the average phosphorous in different treatments significant and positively changed and varied from 27.63, 35.25 and 41.63 kg ha^{-1} respectively in treatment T_1, T_2 and T_3. In treatment T_3 where daincha were grown, chopped and incorporated to soil for decomposition, increased organic carbon results in production of organic acids which is responsible for decreased soil pH and increased in the available soil phosphorus may be due to the reduction of phosphate fixation by formation of chalets with iron and aluminium (Ogoke, *et al*, 2004). Thus, it has been observed that soil available phosphorus increased to 14.04 per cent in case of dhaincha.

Effect of green manuring on soil available potassium (K_2O)

The distribution of available potassium in experimental soil

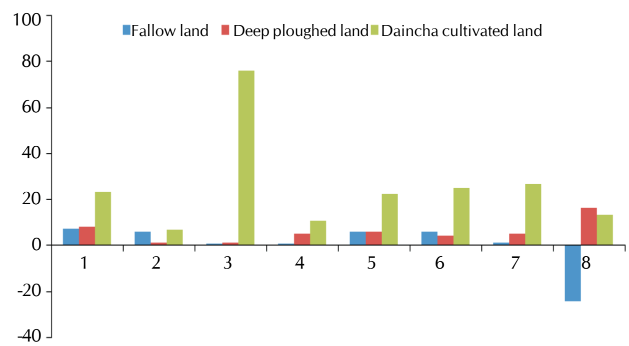

Figure 7: Per centage change in available nitrogen in soil

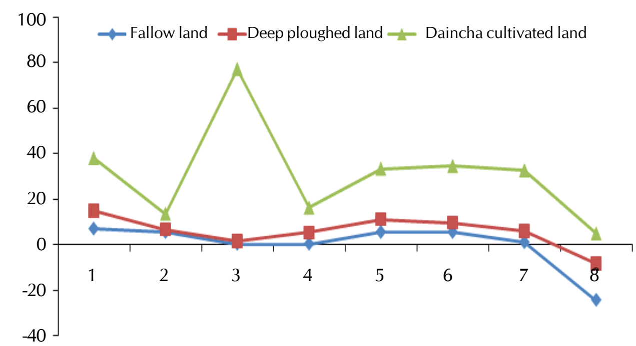

Figure 8: Percentage change in available Phosphorous in soil

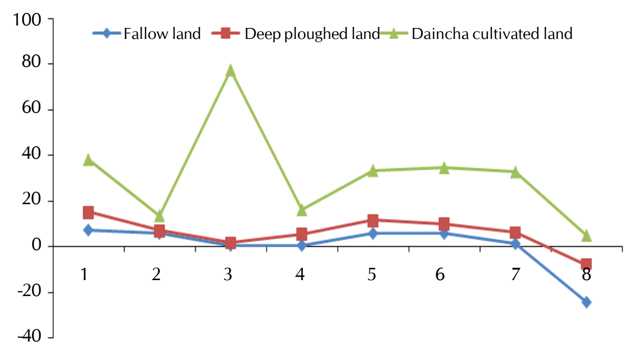

Figure 9: Percentage change in available potas in soil

has been presented in table 6 and percentage change in fig 9. It is clear from the data that the amount of average potassium in different treatment varied from 126, 210 and 160 kg ha^{-1} in T_1, T_2 and T_3, respectively. After final soil samples analyzed the average phosphorous in different treatments significant and positively changed and varied from 116, 222 and 172 kg ha^{-1} respectively in treatment T_1, T_2 and T_3. In case of dhaincha soil available potassium increased to 7.03 per cent, deep plough soil increased 5.77 per cent and in case of fallow land it decreased to 8.62 per cent (Dey and Nath, 2015). It is possible due to increase of organic carbon in soil with dhaincha crop and crop residues mixed to soil.

Characteristics of Dhaincha crops

The data related to growth attributes of dhaincha (*Sesbania aculeate*) have been presented in table 7. It is clear from the data that the plant height at 40 days after sowing varies from 103 to 112 cm, no of branches 4.2 to 5.2, nodules per plant 30.63 to 39.52, nodules weight 0.11 to 0.13 gram per plant and herbage yield 6.83 to 8.46 tons per hectare. Due to the incorporation of all herbage in soil the increases soil organic matter, available nitrogen, concentration of nutrients near the soil surface in available form, and reduces the N losses through leaching and soil erosion. Increases organic matter in soil as a result of green manure improves soil physico-chemical properties by increasing the distribution and stability of soil aggregates and decreasing soil bulk density (McRae and Mehuys, 1988). Vegetative cover prevents the build-up of the aggregates, which could lead to the formation of surface crusts that reduce water infiltration. Dhaincha has nodules (*Rhizobia bacteria*) to use fix nitrogen from the atmosphere (Gangaiah, *et al., 2014*). Therefore, it is clear from the present study the dhaincha manuring is the most important way to influence top soil with improve the soil fertility status for the succeeding crops and considerable improvement could be expected within a few years if such little improvement continues unabated year after year.

DISCUSSION

Sustainable agricultural management practices are known to influence soil physico-chemical properties to maintain functional capacity of soil for crop growth (Ekwue,1990; Islam and Weil, 2000-a; Min, *et al*,. 2003; Scott, *etal.,* 1994). A significant decrease in bulk density with an associated increase in total porosity of soil under Dhaincha is probably related to greater amount of organic matter deposition and loosening of soil by root action (Haynes, 2000; Lampurlanes and Cantero-Martinez, 2003). Bulk density is inversely related to total porosity, which provides a measure of the porous space left in the soil for air and water movement (Min *et al.,* 2003; Tester, 1990). Lower bulk density implies greater pore space and improved aeration, developing a suitable environment for biological activity (Islamand Weil, 2000-b; Min, *et al.,* 2003; Werner, 1997). Green manuring crops, like Dhaincha specifically influence soil structural properties by enmeshing soil primary particles and micro aggregates into macro aggregation through direct physico-chemical action of roots, and production of cementing agents from enhanced microbial activities. These aggregation processes and properties may reduce soil bulk density and increase porosity with greater water retention and transmission capacities (Goldhamer, *et al*., 1994; Hargrove, *et al*., 1989; Islamand Weil, 2000-b; Min, *et al.,* 2003; Tester, 1990; Werner,1997). Likewise Chikowo, *et al.* (2004) reported that incorporation of woody legumes into the soil reduces bulk density and increases soil granulation and porosity. The positive effect of P application in increasing biomass production of legumes has been widely reported (Azad,*et al*., 1988; Bhadoria, *et al.,* 2004; Hundal and Biswas,1988; Nayyar and Chhibba, 2000; Ogoke, *et al.*,2004). The overall increase in biomass production is attributed to increases in P application that in turn triggers better root development and there by increases nutrient absorption. Significant differences in volume fractions of pore space suggest that Dhaincha amended soil pore space is much higher than other treatments on a volume basis. It means there was arrange of pore size in soils under green manures continuity.

This is very important for the air and water balance of soil since aeration critically depends upon pore size distribution (Aon, *et al.,* 2001). Increased total porosity, soil organic matter and other nutrients of soils under Dhaincha suggests that Dhaincha is able to increase larger pores and the soil is far more likely to be regulated by macropores over micropores. The use of Dhaincha as green manure consistently increased macro and mesopores, and maintained micropores with fertility status resulted in greater plant nutrients available capacity. It may be concluded from the field study that green manuring leguminous crops (Dhaincha), reduced soil bulk density and salinity, enhanced total porosity, organic carbon and nutrient availability.

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