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Residual effect of tillage systems coupled with organics on soil physical properties after groundnut (var Co 2) in a sandy clay loam having sub soil hard pan

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Abstract : A field experiment was conducted to study the residual effect of tillage practices and organics on physical properties in a Typic Haplustalf having hard pan at shallow depth on groundnut crop after sorghum as the main crop. The results revealed that the bulk density was increased to 1.84 Mg m^{-3} at harvest from the initial value of 1.67 Mg m^{-3} after the harvest of main crop of sorghum. Neither the different tillage treatments nor the organics influenced the hydraulic conductivity of soil. The depth alone influenced the parameter and the surface layer registered significantly higher value than the sub surface layers. Different tillage and organic treatments did not influence the total porosity. However, an increase in porosity was evident registering the highest value of 50.23 per cent in the surface layer (0-15 cm) which was significantly superior over other depths. *(Key words: Tillage practices, Organic manures, Bulk density, Hydraulic conductivity, Pore size distribution)*

Soil physical constraints affecting the retention and movement of soil moisture, soil aeration, soil nutrient movement, soil temperature, seed germinaiton, seedling establishment, root penetration and proliferation have been well documented (Ghildyal and Gupta, 1991). Even judicious application of all the required plant nutrients at times fails to yield good results due to the poor soil physical environment. Among the various constraints, sub soil hard pan at shallow depth is one which occurs in red soil area due to illuviation of clay in the subsoil horizon coupled with cementing action of oxides of Fe, Al and $CaCO_3$ which limits the crop growth to a greater extent. It lowers the infltration and percolation rates, nutrient movement and free air transport within the soil profile and the contribution of sub soil fertility to crop growth is hampered (Larson *et al.* 1994). To overcome this problem, the chisel ploughing to a depth of 45 - 50 cm at 0.5 m interval criss cross was found to be effective. However, the tillage effect is expected to depend upon the crop growth and season. With this in view, the present investigation was carried out to study the effect of tillage and organics on the succeeding crop of groundnut after sorghum.

Materials and Methods

A field experiment was conducted for two seasons in succession to study the residual effect of tillage and organics on sandy clay loam (Pichanur series - Typic Haplustalf), reddish brown soil having sub soil hard pan at shallow depth (at 15 cm) in the farmer's field at Nachipalayam village of Madukkarai block of Coimbatore district on groundnut crop after the harvest of the sorghum crop. The initial soil samples collected before start of the experiment were analysed for important physical, chemical and physico-chemical properties using standard methods. The results of undisturbed soil samples showed that the bulk density was 1.45 Mg m^{-3} in surface layer, whereas the bulk density was much higher in 15 - 30 cm (1.81 Mg m^{-3}) and 30 - 45 cm (1.84 Mg m^{-3}) depths. Contrary to this, the hydraulic conductivity was very high in surface layer (2.38 cm h^{-1}) compared to other two depths. The infiltration rate was found to be 0.62 cm h^{-1}. The mechanical analysis of the initial soil revealed that it contained 23.42 per cent clay, 12.28 per cent silt, 9.78 per cent fine sand and 52.68 per cent coarse sand. Teh following treatments were imposed in a split plot design and the 27 treatment combinations were replicated thrice. The main plot treatments (type of tillage) *viz.* T_1 - Country ploughing twice ; T_2 - Mould board ploughing twice ; T_3 - Chisel ploughing once + country ploughing twice ; Source of organics *viz.* M_1 - No organics ; M_2 - Farm yard manure @ 12.5 t ha^{-1} ; M_3 - Composted coir pith @ 12.5 t ha^{-1}. The sub plot treatments were N_1 - No nitrogen ; N_2-75 per cent of the recommended N ; N_3 - 100 per cent of the recommended N.

Tillage was done with a tractor drawn Chisel plough to break open the sub soil hard pan in dry soil before pre-sowing irrigation. Conventional tillage was done after the pre sowing irrigation when the soil was moist and friable. At the time of seeding, 50 per cent of N, full dose of P and K in the form of urea, single super phosphate and muriate of potash respectively were applied basally. The remaining half the dose of N was top dressed on 45 days after sowing. The farm yard manure and composted coir pith were applied basally and incorporated thoroughly in the top soil @ 12.5 t ha^{-1} as per the treatment schedule 15 days before sowing for the first crop of sorghum and harvested. The post harvest soil samples were analysed for physical properties.

After the harvest of sorghum crop, two country ploughings alone was given to the entire field without altering the lay out plan and groundnut crop was raised adopting the spacing of 30 x 15 cm. Neither the tillage treatments nor the organics applied to the sorghum (main) crop was altered since the aim was to study the residual effect of tillage treatments as well as organics. Gypsum was applied @ 400 kg ha^{-1} on 30th day after sowing and the undisturbed core samples were collected at 45 and 90 days after sowing (DAS) and at harvest in 3 depths *viz.* 0-15 cm (D_1), 15-30 cm (D_2) 30-45 cm (D_3) to monitor the residual effect of treatments and the data collected were subjected to statistical scrutiny (Panse and Sukhatme, 1978).

Results and Discussion

Pod yield of groundnut (Table 1).

The statistical scrutiny of the pod yield data revealed that chiseled plots registered significantly superior pod yield than other two tillage treatments *viz.* mould board ploughing and country ploughting. Among the sources of manures, both the organics *viz.* composted coir pith and farm yard manure at the rate of 12.5 t ha^{-1} had markedly influenced the pod yield than non application of organics treatment (control) and were comparable among themselves. As for as N levels are concerned, N_3 registered significantly higher yield followed by N_2 level which inturn showed significantly higher pod yield than control (N_1). The interaction effect of M x N indicated that, irrespective of manurial sources, higher levels of N registered statistically higher yield than the preceeding levels of N. At all the N levels, composted coir pith and farm yard manure behaved similarly. The pod yield under these treatments was significantly superior over non application of organic manure (M_1).

Physical properties of post harvest soil of sorghum (Table 2,3 & 4)

The bulk density values of the post harvest soil samples revealed that the lowest bulk density of 1.54 Mg m^{-3} was registered in the chiseled plots which was significantly lower value than other tillage treatments.

Table 1. Effect of tillage, organics and levels of N on pod yield of groundnut (kg ha^{-1})

Treat-ments	T_1				T_2				T_3				Grand Mean
	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	
N_1	558	943	957	819	578	963	961	834	760	1162	1175	1032	967
N_2	1020	1303	1276	1200	1035	1271	1271	1192	1231	1396	1418	1348	1257
N_3	1121	1377	1395	1298	1088	1395	1404	1296	1310	1503	1528	1447	1264
Mean	900	1208	1209	1036	900	1210	1212	1112	1100	1354	1374	1276	
		T			M		N		M on N			N on M	
SEd		12			12		12		21			21	
CD (0.05)		28			28		25		45			44	

Table 2. Effect of tillage and organics on the bulk density of soil at different depths (Mg m^{-3}) at harvest (sorghum)

Treat-ments	T_1				T_2				T_3				Grand Mean
	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	
0 - 15 cm	1.455	1.395	1.375	1.408	1.455	1.425	1.395	1.425	1.435	1.390	1.385	1.403	1.412
15 - 30 cm	1.865	1.845	1.875	1.862	1.840	1.845	1.845	1.843	1.670	1.660	1.685	1.672	1.792
30 - 45 cm	1.750	1.760	1.765	1.758	1.785	1.760	1.775	1.773	1.735	1.720	1.725	1.727	1.753
Mean	1.690	1.667	1.672	1.676	1.693	1.677	1.672	1.681	1.613	1.590	1.598	1.601	
		T			M		D		T *on* D			D *on* T	
SEd		0.009			-		0.018		0.026			0.030	
CD (0.05)		0.021			NS		0.037		0.056			0.064	

Table 3. Effect of tillage and organics on the hydraulic conductivity of soil at different depths (cm h^{-1}) at harvest (sorghum)

Treatments	T_1				T_2				T_3				Grand Mean
Depth(cm)	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	
0 - 15 cm	1.950	3.150	3.100	2.733	2.060	3.220	3.250	2.843	2.085	3.425	3.315	2.942	2.839
15 - 30 cm	0.350	0.355	0.335	0.347	0.335	0.385	0.325	0.348	1.720	2.000	1.970	1.897	0.864
30 - 45 cm	0.410	0.380	0.380	0.390	0.355	0.385	0.360	0.367	0.365	0.350	0.370	0.362	0.373
Mean	0.903	1.295	1.272	1.157	0.917	1.330	1.312	1.186	1.390	1.925	1.885	1.733	
		T		M	D		T *on* D		D *on* T	M *on* D		D *on* M	
SEd		0.044		0.044	0.041		0.074		0.064	0.074		0.064	
CD (0.05)		0.102		0.102	0.083		0.152		0.131	0.152		0.131	

Table 4. Effect of tillage and organics on the total porosity of soil at different depths (%) at harvest (sorghum)

Treatments	T_1				T_2				T_3				Grand
Depth(cm)	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	Mean
0 - 15 cm	45.06	48.28	49.67	47.67	45.20	49.62	49.81	48.21	47.90	49.56	48.37	48.37	48.08
15 - 30 cm	39.60	39.67	39.11	39.46	39.88	39.26	40.20	39.78	44.01	43.17	43.64	43.64	40.96
30 - 45 cm	41.01	39.98	40.63	40.54	40.36	40.57	40.59	40.50	41.58	42.00	41.93	41.93	40.99
Mean	41.89	42.64	43.14	42.56	41.81	43.15	43.53	42.83	44.16	44.91	44.86	44.65	
		T		M		D		T *on* D		D *on* T			
SEd		0.32		0.32		0.27		0.49		0.46	0.49	0.46	
CD (0.05)		0.73		0.73		0.56		1.08		0.97	1.08	0.97	

Table 5. Effect of tillage and organics on the bulk density of soil at different depths (Mg m^{-3}) at harvest (groundnut)

Treatments	T_1				T_2				T_3				Grand
Depth(cm)	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	Mean
0 - 15 cm	1.390	1.395	1.380	1.388	1.415	1.370	1.420	1.402	1.410	1.380	1.375	1.388	1.393
15 - 30 cm	1.860	1.840	1.840	1.847	1.870	1.860	1.830	1.853	1.860	1.865	1.805	1.843	1.848
30 - 45 cm	1.750	1.755	1.765	1.757	1.765	1.775	1.695	1.745	1.740	1.765	1.735	1.747	1.749
Mean	1.667	1.663	1.662	1.664	1.683	1.668	1.648	1.666	1.670	1.735	1.638	1.681	
			T			M					D		
SEd			-			-					0.021		
CD (0.05)			N.S			N.S					0.043		

Table 6. Effect of tillage and organics on the hydraulic conductivity of soil at different depths (cm h^{-1}) at harvest (groundnut)

Treatments	T_1				T_2				T_1				Grand
Depth(cm)	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	Mean
0 - 15 cm	2.230	2.670	2.535	2.478	2.200	2.490	2.590	2.427	2.235	2.790	2.710	2.578	2.494
15 - 30 cm	0.340	0.440	0.400	0.393	0.360	0.430	0.445	0.422	0.410	0.395	0.495	0.433	0.416
30 - 45 cm	0.490	0.515	0.560	0.522	0.445	0.450	0.510	0.468	0.475	0.530	0.530	0.512	0.501
Mean	1.020	1.208	1.165	1.131	1.002	1.133	1.182	1.106	1.040	1.238	1.245	1.174	
						M					D		
SEd			-			-					0.114		
CD (0.05)			N.S.			N.S					0.241		

Table 7. Effect of tillage and organics on the total porosity of soil at different depths (%) at harvest (groundnut)

Treatments	T_1				T_2				T_1				Grand Mean
Depth(cm)	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	
0 - 15 cm	49.20	50.82	51.00	50.41	50.97	50.33	49.85	50.38	51.15	50.09	51.14	50.79	50.23
15 - 30 cm	39.43	38.98	38.12	38.84	39.66	40.11	48.76	39.51	39.17	38.60	39.13	38.97	39.11
30 - 45 cm	41.61	40.49	39.32	40.73	39.74	40.25	40.23	40.07	39.43	39.13	39.54	39.36	39.97
Mean	43.49	43.43	42.81	43.24	43.46	43.56	42.95	43.32	43.25	42.61	43.27	43.04	
T			M			D							
SEd			-			0.72							
CD (0.05)			N.S			N.S					1.52		

The highest bulk density (1.67 Mg m^{-3}) was observed in country ploughing treatment. Among depths, significantly higher bulk densities were recorded in subsoil layers than in surface soil. The interaction effect of T x D indicated that chiseled plots alone registered comparable bulk density values in both the subsurface layers, whereas in other tillage treatments, the second depth registered sigificantly higher values followed by third depth. Irrespective of tillage treatments, the surface layer registered significantly lower bulk density values. In second depth, the bulk density values were significantly lower due to chiseling, whereas the other two tillage treatments did not alter the bulk density in subsurface layers.

The hydraulic conductivity values of the core samples collected on 45 DAS indicated that chiseling increased the hydraulic conductivity value to 2.189 cm h^{-1} which was significantly superior over other two tillage treatments. The organics *viz.* composted coir pith and farm yard manure at 12.5 t ha^{-1} also significantly improved the hydraulic conductivity compared to contorl. The interaciton of T x D indicated that irrespective of tillage treatments, the surface layer registered the highest values. In chiseled plots, the hydraulic conductivity was significantly higher in second depth (15-30 cm) than third depth, whereas in other two tillage treatments, the subsurface depths were comparable. At first depth the hydraulic conductivity values of chiseling were comparable with mould board ploughing treatment which in turn comparable with country ploughing treatment. In second depth (15-30 cm), chiseling recorded markedly higher values than other two treatments. In third depth, the tillage treatments did not influence the hydraulic conductivity.

The statistical scrutiny of the data on total porosity revealed that chiseling increased the total porosity markedly than other two tillage treatments. Organic manuring at the rate of 12.5 t ha^{-1} found to increase the total porosity compared to control. The effect was comparable among composted coir pith and farm yard manure treatments. The top layer was found to have significantly higher total porosity than the subsurface layers. The interaction effect was also found to be significant with respect to T x D and M x D. The T x D interaction showed that irrespective of the tillage treatments, the total porosity was found to be significantly higher in first layer followed by second depth. The lowest values were observed in the third depth. In the top layer, all the tillage treatments behaved similarly. The values were not markedly different from each other. In the second depth, the chiseling treatment had significantly increased the total porosity followed by mould board ploughing and the lowest value of 39.49 per cent was registered under country ploughing treatment. In the third layer, chiseling had influenced the total porosity which was significantly superior over other two tillage practices which were on par with each other.

Physical properties at post harvest soil of groundnut

Bulk density (Table 5)

The bulk density values of the post harvest soil revealed that the tillage treatments had no significant effect on bulk density. In the residual crop of groundnut, a trend of increase was noticed from 1.67 Mg m^{-3} after the harvest of sorghum to 1.84 Mg m^{-3} at the harvest of groundnut. This gradual increasing trend gives testimony to the earlier conclusions indicating the resettling of clay and sesquioxides for the above phenomena and again in accordance with the findings of Gupta and Abrol (1993).

In the present study, however the bulk density in the subsurface layers were not influenced due to application of organic manures *viz.* farm yard manure and composed coir pith. This might probably be due to the incorporation of organic manure only in the top layer prior to sowing. Irrespective of the stage of crop, the interaction effect of manures with tillage was not significant indicating that the effect of organic manures on the sustenance of soil physical properties are possible only, if the organic manures incorporated to the depth of chiseling (35-50 cm).

Hydraulic conductivity (Table 6)

The results of hydraulic conductivity at harvest stage of groundnut revealed that neither the different tillage treatments nor the organics influenced the hydraulic conductivity of soil. The depth alone influenced the parameter. The surface layer registered significantly higher value than the subsurface layers. All the interaction effects were found to be not significant.

The hydraulic conductivity of the surface layer did not alter much due to tillage treatments. However, significant increase in hydraulic conductivity was observed in subsoil due to chiseling. During the residual crop of groundnut, it steeply reduced to 0.43 cm h^{1} at harvest stage from 1.90 cm h^{-1} at post harvest stage of sorghum. This trend again confirmed the earlier conclusions on the effect of irrigation or rainfall on the resettling of clay and sesquioxides. As was true in bulk density, the effect of organic manures was seen only in the surface layer (Anderson *et al.* 1990). They have also reported the positive influence of various organics on hydraulic conductivity. However, in the present study, the organic manures did not affect the hydraulic conductivity of soil over the entire cropping sequence.

Porosity (Table 7)

The statistical analysis of the data with respect to total porosity of core samples collected at post harvest stage of groundnut indicated that neither the different tillage practices nor the sources of organic manures significantly influenced the total porosity. Among the different depths, the surface layer (0-15 cm) was found to register the highest value of 50.23 per cent which was significantly superior over other depths (15-30 and 30-45 cm). The second and third depths were comparable among themselves.

The pore size distribution of the soil at different depths indicated that there was a positive influence due to chiseling at all depths, whereas the effect was observed only in the surface layer due to other tillage treatments. As in the case of bulk density and hydraulic conductivity, the pore size distribution also attained its original value at the end of the residual crop due to the reasons attributed earlier. This results is in accordance with the report of Gupta and Abrol (1993). Application of organics favourably influenced the pore size distribution of the surface soil (Anderson *et al.* 1990). However, the effect was not observed in subsurface layers possibly due to the incorporation of organic manures only in the top layer prior to sowing.

The favourable physical environment created by chiseling was more pronounced in the first crop of sorghum. As the sequence of cropping advanced, due to the gradual settling of soil particles, a tendency of reverting back to the original physical condition was found as evidenced from the scrutiny of the results of the residual crop of groundnut.

It is worthwhile to mention here that the effect of organic manures sustained only for one season is favourably influencing the soil physical properties. This result adds evidence to the already existing recommendation of application of organics to individual crops. This practice gradually vanished due to non-availability of organics, but in the recent times, an awakening on the addition of organics and recycling of available wastes either from agriculture are from industry for a sustainable agriculture as well as to protect the environment is emphasised.

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Heterosis and inbreeding depression in sesame (*Sesamum indicum* L.)

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Abstract : Hybridization was effected between twenty lines and four testers and the resultant eighty F_1 hybrids were selfed to obtain F_2 seeds. The F_1s and F_2s were evaluated along with their parents. Observations were recorded for six quantitative traits namely days to maturity, plant height, number of capsules, test weight, seed yield and oil content. Two hybrids namely Si.3214 x SVPR 1 and TMV 6 x SVPR 1 recorded significant heterosis over standard check Co 1. In general, crosses with significant heterosis expressed significant inbreeding depression in F_2. The F_2 progenies of cross Si.3214 x SVPR 1 showed high heterosis with non-significant inbreeding depression for seed yield. ***(Key words:** Heterosis, Inbreeding depression, Sesame.)*

Crop improvement in sesame *(Sesamum indicum* L.), so far has been mostly confined to selection or hybridization followed by selection and in this way only marginal improvement could be effected. Therefore, to have a quantum jump in yield, exploitation of hybrid vigour and heterosis breeding is gaining importance. In addition, for enhancing yield potential of hybrids it is necessary to reshuffle the genes by crossing and study the heterotic effects in F_1 and its maintenance in F_2 generation. Hence, attempts were made to study the heterosis and inbreeding depression in sesame. This study will have a direct bearing on the breeding methodology to be emplyed for rapid genetic improvement in sesame.

Materials and Methods

Hybridization was effectd between twenty lines *viz.* S.0613, Si. 102, Si.1577 Si.3232, S.0626, NL 4, IVTS 18-94, JLSC.50, TNAU 137, Si.1576, S.0651, TNAU 72, TNAU 65, TMV 6, TMV 4, Si.3214, Si.1071, Si.1671 and Si.9091 and four testers *viz.* Annamalai 1, TMV 3, Co 1 and SVPR 1 in line x tester model (Kempthorne, 1957). The resultant eighty F_1 hybrids along with their 24 parents were raised in a randomized block design with three replications during *rabi*-1995. A portion of the seeds of F_1 (Fresh crosses) were preserved for sowing in the next season (*kharif*-1996). Each entry was grown in single row of three metre long with a spacing of 30 x 30 cm. The F_1's were selfed to obtain F_2 seeds. Simultaneously the parents were selfed to maintain their purity. The generated materials *viz.* F_1 and F_2 of eighty crosses were grown along with their parents in a randomized block design with three replications during *kharif* 1996. In each replication the parents and F_1's were raised in three rows (each 3-m long) and F_2's in ten rows by adopting 30 x 30 cm spacing. Observations were recorded on ten randomly selected healthy plants in parents and F_1 and 50 plants in F_2 in each replications for six quantitiative traits namely days to maturity, plant height, number of capsules per plant test weight, seed yield per plant and oil content. The cultivar Co 1 was used as standard check. The overall mean values for each character in each parent and hybrid were taken to estimate heterosis and inbreeding depression as given below.

i. Standard heterosis $(d_{iii}) = \frac{F_1\text{-}SC}{SC} \times 100$

where, F_1 = Mean of F_1 hybrids

SC = Mean of standard check Co1