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Physical properties of the soil as influenced by different soil and water conservation measures and sources of nutrients in cashew

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ABSTRACT : The experiment plants were seven year old (during first year of study) cashew grafts of Ullal-1 variety with row and intra row space of 8m x6m. Application of recommended dose of chemical fertilizers recorded significantly high bulk density, less soil moisture content and low water holding capacity. Combined application of recommended dose of inorganic nutrients along with organic nutrient sources recorded low bulk density, high soil moisture content and water holding capacity than inorganic source alone.

KEY WORDS : Water conservation efficiency, Soil conservation efficiency, Soil moisture content, Bulk density, Water holding capacity

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Cashew (*Anacardium occidentale* L.) belonging to the family Anacardiaceae, is one of the most important commercial plantation and foreign exchange earning crop of the country. It is believed to be the native of lower Amazon region of Northeastern Brazil. Most of the farmers are cultivating this crop under low fertile soils and they are very rarely applying fertilizers and farmyard manures to cashew garden. In recent days cashew is grown under organic farming system with partial utilization of naturally decomposed cut weed biomass and cashew leaf litter deposited in the garden thereby productivity is very low (Yadukumar, 2001). The study was conducted to test the effect of soil and water conservation techniques coupled with organic and inorganic manures in cashew on physical properties of the soil.

METHODOLOGY

The study was conducted in Ariyapu village which is situated in the coastal zone (Zone No-10) with an operational area of Taluk Puttur of Dakshina Kannada, District. The experiment was laid out in split plot design with three replications having 108 plants in interaction between soil and water conservation measures and nutrient levels were imposed in normal planting in 2009 and 2010. The experiment plants were seven year old (during first year of study) cashew grafts of Ullal-1 variety with row and intra row space of 8mx6m. During study period improved growth, yield parameters, nutrient losses, soil loss and runoff losses observations were recorded and data were statistically analyzed by following Fisher method of analysis of variance.

Main plot: Soil and water conservation measures (M) :

M_1 = Individual tree terracing with crescent bund (Terrace of 2.0 m radius around the plant with crescent shaped bund of size 6.0 m length, 0.5 m height and 1.0 m width at base).

M_2= Trenches across the slope in between two rows (Trenches of size 2.0 m length, 0.45 m width and 0.45 m depth in between two rows).

M_3 = Trenches across the slope on four sides (Trenches of size 2.0 m length, 0.45 m width and 0.30 m depth at 2.0 m radius around the tree).

M_4 = Preparation of basin around the tree (Trenches of size 2.0 m radius around the plant with catch pit of size (0.45 m depth x 0.3 m width around the tree).

M_5 = Mulching of basin around the tree (Mulching of waste green manure and cashew dry leaves are incorporated in 2.0 m radius around the plant).

M_6 = Control plot (Without any soil and water conservation practices).

Sub plot : Sources of nutrient (S) :

S_1= Recommended dose of inorganic fertilizer (1000g N: 600 g P_2O_5: 200 g K_2O)

S_2= Recommended dose of organic manure (FYM @ 80kg/ tree/ year)

S_3= Recommended dose of inorganic fertilizer and recommended organic manures

(*i e*., 1000g N: 600 g P_2O_5: 200 g K_2O + FYM @ 80kg/ tree/ year)

Soil sampling :

Soil samples were collected under each different soil and water conservation measures plot and control to a depth of 30, 60 and 90 cm during 2008-09 and 2009-10 of *Kharif* and *Rabi* seasons.

Preparation of soil sample :

The representative soil samples were collected, air dried under shade, powered using a wooden pestle and mortar and passed through 2.0 mm sieve. The samples were stored in polythene bags free from moisture, fume and latter used for laboratory analysis.

Soil physical properties :

Soil samples were collected and analysed for various physical properties using standard procedures listed in Table1.

Statistical analysis and interpretation :

The data collected on different characters during the course of investigation were subjected to Fishers method of analysis of variance technique for interpretation of the data as given by Panse and Sukhatme (1967). The level of significance used in 'F and't' test was p = 0.05. Critical difference (C.D.) values were calculated for the p = 0.05 probability level wherever 'F' test was found significant.

RESULTS AND DISCUSSION

The data pertaining to soil physical properties were recorded at 0-30, 30-60 and 60-90 cm in the cashew field after adoption of different soil and water conservation measures during 2008-09 and 2009-10.

The soil bulk density was estimated using standard procedures. Minimum soil bulk density (1.46, 1.49 and 1.51 mg/m^3 during 2008-09 and 1.44, 1.47 and 1.51 g/cc during 2009-10) was recorded in trenches across the slope on four sides, followed by preparation of basin around the tree (1.48, 1.50 and 1.52 during 2008-09, 1.47, 1.50 and 1.52 during 2009-10) and mulching of basin around the tree 1.50, 1.51 and 1.52 and 1.49, 1.50 and 1.53 mg/m^3, respectively during 2008-09 and 2009-10 (Table 2).

Soil bulk density did not show significant influenced by sources of nutrient application, combined application of RDF plus FYM (80kg/tree) recorded significantly lowest soil bulk density (1.46, 1.49 and 1.50 during 2008-09 and 1.49, 1.51 and 1.53 mg/m^3 during 2009-10. The maximum soil bulk density (1.60, 1.63 and 1.66 during 2008-09 and 1.60, 1.61 and 1.62 mg/ m^3 during 2009-10) was observed where no soil and water conservation measures.

The interaction between main plot and sub treatments was not significant. Higher soil bulk density was noticed in case of application of RDF alone (1.54, 1.55, and 1.56 during 2008-09 and 1.53, 1.54 and 1.55 mg/m^3 during 2009-10).

Application of recommended dose of in organic nutrients along with organic nutrient sources recorded low bulk density contents than inorganic alone followed by organic alone. The reason for low bulk density in case of combined use of organic and inorganic nutrient sources could be attributed to the steady increase in the organic matter content due to addition of organic manure and plant residues. The decomposition products of organic materials helped the granulation of soil particles which in turn increased the porosity leading to lower bulk density (Prasad *et al.*, 1983). The maximum soil bulk density was recorded in control where no conservation measures were adopted during both the years. This might be due to the fact that no adoption of conservation measures increased the nutrient losses from control plot when compared to treated plots. The findings in this study concurred with the results supported by Manivannan and Korikanthimath (2007). Soil bulk density contents recorded higher in upper surface than subsurface.

The soil moisture was estimated at 0-30, 30-60 and 60-90 cm depth by using standard procedures during 2008-09 and 2009-10 (Table 3). Among different conservation measures, maximum soil moisture (45.54, 46.24 and 47.49 per cent during 2008-09 and 45.52, 46.41and 46.99 per cent during 2009-10) was recorded in M_3 (Trenches across the slope on four sides) at different depths of 0-30, 30-60 and 60-90 cm, respectively. It was followed by preparation of basin around the tree (45.00, 42.82 and 45.58 per cent during 2008-09 and 44.12, 42.67, and 45.05 per cent during 2009-10) and mulching of basin (44.17, 45.31 and 46.51 per cent during 2008-09 and, 44.12, 45.23 and 46.51 per cent during 2009-10), respectively.

Minimum soil moisture at all soil depths (32.91, 33.91 and 34.53 per cent during 2008-09 and 34.12, 35.21 and 37.89

Table 1: Methods used for physical properties of soil

Sr. No.	Parameters	Methods	References
1.	Bulk density (mg/m^3)	Keen Raczkowski cup method	Piper (1966)
2.	Maximum water holding capacity (%)	Keen Raczkowski cup method	Piper (1966)

Table 2 : Soil bulk density (mg/m^3) as influenced by different conservation measures and sources of nutrients

Treatments	2008-09			2009-10		
Main (Soil and water conservation measures)	0-30	30-60	60-90	0-30	30-60	60-90
M_1	1.50	1.53	1.57	1.52	1.52	1.57
M_2	1.51	1.53	1.55	1.51	1.51	1.56
M_3	1.46	1.49	1.51	1.44	1.47	1.51
M_4	1.48	1.50	1.52	1.47	1.50	1.52
M_5	1.50	1.51	1.52	1.49	1.50	1.53
M_6	1.60	1.63	1.66	1.60	1.61	1.62
F-test	NS	NS	NS	NS	NS	NS
S.E. $\pm$	0.026	0.039	0.025	0.024	0.037	0.062
C.D. (0.05)	-	-	-	-	-	-
C.V. (%)	5.07	7.69	5.07	5.01	7.66	12.06
Sub (Nutrient levels)						
S_1	1.54	1.55	1.56	1.53	1.54	1.55
S_2	1.52	1.53	1.53	1.51	1.50	1.52
S_3	1.47	1.49	1.51	1.49	1.51	1.53
F-test	NS	NS	NS	NS	NS	NS
S.E. $\pm$	1.022	0.018	0.026	1.020	0.016	0.039
C.D. (0.05)	-	-	-	-	-	-
C.V. (%)	6.19	5.10	7.17	6.15	5.08	10.72
Interactions (Main x Sub)						
$M_1 S_1$	1.57	1.59	1.59	1.55	1.57	1.58
$M_1 S_2$	1.52	1.48	1.57	1.52	1.47	1.57
$M_1 S_3$	1.49	1.51	1.55	1.48	1.50	1.55
$M_2 S_1$	1.50	1.52	1.50	1.51	1.51	1.50
$M_2 S_2$	1.49	1.51	1.49	1.48	1.50	1.49
$M_2 S_3$	1.46	1.48	1.48	1.47	1.49	1.47
$M_3 S_1$	1.49	1.52	1.51	1.48	1.51	1.52
$M_3 S_2$	1.47	1.50	1.49	1.48	1.49	1.47
$M_3 S_3$	1.59	1.48	1.48	1.58	1.47	1.46
$M_4 S_1$	1.53	1.55	1.60	1.52	1.56	1.59
$M_4 S_2$	1.51	1.52	1.58	1.50	1.51	1.57
$M_4 S_3$	1.50	1.51	1.56	1.50	1.49	1.55
$M_5 S_1$	1.55	1.57	1.55	1.54	1.55	1.56
$M_5 S_2$	1.53	1.55	1.50	1.52	1.54	1.52
$M_5 S_3$	1.48	1.51	1.48	1.47	1.50	1.53
$M_6 S_1$	1.61	1.62	1.55	1.60	1.63	1.54
$M_6 S_2$	1.60	1.63	1.52	1.61	1.62	1.53
$M_6 S_3$	1.60	1.65	1.51	1.62	1.66	1.52
F-test	NS	NS	NS	NS	NS	NS
S.E. $\pm$	0.055	0.045	0.063	0.052	0.043	0.095
C.D. (0.05)	-	-		-	-	-

Table 3 : Soil moisture (%) as affected by different soil and water conservation measures and nutrient sources

Treatments	2008-09			2009-10		
Main (Soil and water conservation measures)	0-30	30-60	60-90	0-30	30-60	60-90
M_1	42.11	44.28	45.57	42.41	45.98	42.52
M_2	43.33	45.24	46.49	43.98	45.88	46.88
M_3	45.54	46.24	47.49	45.52	46.41	46.99
M_4	45.00	42.82	45.58	44.12	42.67	45.05
M_5	44.17	45.31	46.51	44.12	45.23	46.51
M_6	32.91	33.91	34.53	34.12	35.21	37.89
F-test	**	**	NS	**	**	**
S.E. $\pm$	1.660	0.634	0.025	1.657	0.631	0.672
C.D. (0.05)	5.230	1.999	-	5.225	1.898	2.119
C.V. (%)	11.74	4.44	5.07	11.73	4.38	4.64
Sub (Nutrient levels)						
S_1	42.77	42.63	43.53	42.66	42.75	43.45
S_2	46.77	47.51	48.40	45.85	47.52	49.10
S_3	48.48	48.50	49.94	48.75	49.0	50.55
F -test	**	*	NS	**	*	NS
S.E. $\pm$	0.656	0.446	0.026	0.647	0.441	0.915
C.D. (0.05)	1.913	1.302	-	1.910	1.298	-
C.V. (%)	6.56	4.42	7.17	6.51	4.40	8.93
Interactions (Main x Sub)						
$M_1 S_1$	44.46	45.64	44.59	44.42	45.61	40.78
$M_1 S_2$	45.87	46.25	45.57	45.67	46.20	41.88
$M_1 S_3$	46.00	46.95	44.55	46.12	46.75	44.89
$M_2 S_1$	44.64	45.74	43.50	44.45	45.71	45.32
$M_2 S_2$	45.98	46.12	45.49	45.87	46.00	46.00
$M_2 S_3$	46.00	46.85	43.48	46.20	46.75	46.32
$M_3 S_1$	42.56	43.00	46.51	42.47	43.12	44.64
$M_3 S_2$	43.32	43.23	45.49	43.27	43.20	45.00
$M_3 S_3$	44.12	44.12	45.48	44.11	44.11	45.32
$M_4 S_1$	41.46	42.39	46.60	41.37	42.29	44.84
$M_4 S_2$	42.46	42.54	43.58	42.42	42.44	45.00
$M_4 S_3$	42.40	43.54	45.56	42.37	43.45	45.32
$M_5 S_1$	42.53	44.35	45.55	42.51	44.25	41.00
$M_5 S_2$	44.67	45.00	46.50	44.57	45.12	42.18
$M_5 S_3$	45.32	46.58	47.48	45.45	46.49	43.00
$M_6 S_1$	31.45	30.45	32.55	31.25	30.42	39.72
$M_6 S_2$	34.32	32.64	33.52	34.20	32.65	40.64
$M_6 S_3$	36.00	35.64	36.51	35.95	35.58	41.00
F-test	NS	NS	NS	NS	NS	NS
S.E. $\pm$	-	1.092	0.063	-	1.085	2.242
C.D. (0.05)	1.606	-		1.606	-	-

Table 4 : Soil water holding capacity (%) as affected by different soil and water conservation and nutrient sources measures

Treatments	2008-09			2009-10		
Main (Soil and water conservation measures)	0-30	30-60	60-90	0-30	30-60	60-90
M_1	46.80	48.47	51.20	48.63	49.89	51.55
M_2	47.23	48.85	52.45	50.34	50.35	52.25
M_3	51.85	52.62	53.54	46.70	47.05	49.25
M_4	50.86	51.70	52.00	50.67	51.65	52.00
M_5	48.56	51.78	53.64	50.55	51.87	52.88
M_6	39.48	41.32	42.15	38.68	39.41	41.83
F- test	*	*	**	*	*	**
S.E. $\pm$	1.972	1.916	0.635	1.955	1.948	0.896
C.D. (0.05)	6.214	6.037	2.002	6.210	6.032	2.824
C.V. (%)	12.38	11.95	3.88	12.32	11.93	5.42
Sub (Nutrient levels)						
S_1	46.77	47.51	48.40	45.85	47.62	49.10
S_2	48.14	48.23	48.95	48.20	48.95	49.28
S_3	49.85	50.23	51.43	50.00	51.45	51.89P
F -test	NS	NS	NS	NS	NS	NS
S.E. $\pm$	0.753	0.483	0.600	0.748	0.583	0.521
C.D. (0.05)	-	-	-	-	-	1.521
C.V. (%)	6.69	4.26	5.18	6.51	4.22	4.45
Interactions (Main x Sub)						
$M_1 S_1$	47.31	48.95	50.64	46.88	48.65	51.00
$M_1 S_2$	49.00	49.20	51.00	48.99	49.32	51.66
$M_1 S_3$	49.87	50.25	51.95	49.68	50.52	52.00
$M_2 S_1$	49.98	50.64	51.64	49.98	50.54	53.00
$M_2 S_2$	50.35	51.64	52.72	49.32	51.46	52.84
$M_2 S_3$	51.00	51.75	53.00	50.00	51.57	53.64
$M_3 S_1$	46.46	47.00	45.64	46.75	47.35	46.47
$M_3 S_2$	46.95	47.00	46.00	46.89	47.12	47.00
$M_3 S_3$	46.98	47.21	47.97	46.95	47.22	48.72
$M_4 S_1$	49.96	49.98	51.00	49.85	49.89	51.64
$M_4 S_2$	50.45	51.12	51.95	49.38	51.25	51.84
$M_4 S_3$	51.00	51.00	52.00	50.00	51.32	52.72
$M_5 S_1$	49.45	51.00	49.84	49.51	51.13	51.64
$M_5 S_2$	52.11	52.00	50.00	51.99	52.12	50.64
$M_5 S_3$	51.00	52.35	52.00	50.21	52.53	53.35
$M_6 S_1$	37.45	37.50	41.62	37.99	37.21	40.88
$M_6 S_2$	40.00	38.45	42.00	38.00	38.89	41.72
$M_6 S_3$	41.00	39.00	42.74	38.55	39.25	42.88
F -test	NS	NS	NS	NS	NS	NS
S.E. $\pm$	1.845	1.184	1.469	1.745	1.178	1.276
C.D. (0.05)	-	-		-	-	-

per cent) during 2009-10 was noticed in treatments without soil and water conservation measures (M_6) compared to other conservation measures.

Soil moisture was significantly influenced by the sources of nutrient application. Combined application of RDF plus FYM (80kg/tree) recorded significantly highest soil moisture of 48.48, 48.50 and 49.94 per cent during 2008-09 and 48.75, 49.00 and 50.55 per cent during 2009-10, respectively at 0-30, 30-60 and 60-90 cm depth.

The minimum soil moisture (42.77, 42.63 and 43.53 per cent during 2008-09 and 42.66, 42.75 and 43.45 per cent during 2009-10) was observed in treatments with the application of RDF alone.

The interaction between main plot and sub treatments did not showed any significant difference among different soil and water conservation measures with respect to soil moisture content.

The reason for high soil moisture content in case of combined use of organic and in organic nutrient sources could be attributed to the combined positive effects of organic matter decomposition helped in the formation of soil aggregation resulted in increase in both capillary and non capillary porosity of the soil (Mishra and Sharma, 1997). The minimum soil moisture content was recorded in control where no adoption of conservation measures during both the years. The findings in this study concurred with the results supported by Manivannan and Korikanthimath (2007).

The maximum water holding capacity of soil at 30, 60 and 90 cm depths were monitored at periodical intervals after cessation of monsoon and the mean data for two years are given in Table 4.

Among different conservation measures, maximum water holding (51.85, 52.62 and 53.54 per cent during 2008-09 and 46.70, 47.05 and 49.25 per cent) during 2009-10 was recorded in trenches across the slope on four sides followed by the treatment that received preparation of basin around the tree (50.86, 51.70 and 52.00 per cent during 2008-09 and 50.67, 51.65 and 52.00 per cent during 2009-10) and mulching of basin around the tree (48.56, 51.78 and 53.64 per cent during 2008-09 and, 50.55, 51.87 and 52.88 per cent during 2009-10).

Minimum water holding capacity (39.48, 41.32 and 42.15 per cent during 2008-09 and 38.68, 39.41 and 41.83 per cent during 2009-10), was noticed in treatment without soil and water conservation measures compared to other conservation measures.

Water holding capacity significantly influenced by different sources of nutrient application, combined application of RDF plus FYM (80 kg/tree) recorded significantly highest Water holding capacity (49.85, 50.23 and 51.43 and 50.00, 51.45 and 51.89 per cent, respectively) during 2008-09 and 2009-10.

Among sub treatments the minimum water holding capacity (46.77, 47.51 and 48.40 per cent during 2008-09 and 45.85, 47.62 and 49.10 per cent during 2009-10) was observed in the treatment that received application of RDF alone. The interaction between main plot and sub treatments did not showed any significant difference with respect to soil maximum water holding capacity.

Conclusion :

Application of recommended dose of chemical fertilizers recorded significantly high bulk density, less soil moisture content and low water holding capacity. Combined application of recommended dose of inorganic nutrients along with organic nutrient sources recorded low bulk density, high soil moisture content and water holding capacity than inorganic source alone.

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