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Effect of integrated nutrient management practices on soil physical properties and productivity of groundnut (*Arachis hypogaea* L.) under rain fed and protective irrigated condition

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Abstract
Statistical disparity was not observed with respect to physical properties of soil viz., bulk density and aggregate stability during the two consecutive years of study both under rain fed and protective irrigated condition. Whereas, slightly higher and lower values of bulk density and aggregate stability were observed with control (T_1) respectively. Supply of 100 per cent N through organic manures *viz.*, FYM, sheep penning leaf compost, sheep manure, enriched groundnut shells (T_4, T_9, T_6, T_8 and T_{10}) recorded significantly higher water holding capacity and infiltration rate over substitution of 50 per cent N through urea with the above organic manures (T_3, T_5, T_7 and T_{11}) and recommended dose of fertilizers (T_2) both under rain fed and protective irrigated condition. The deflated stature of above said parameters were recorded with control (T_1). At all the stages of the crop growth, significantly highest moisture content in the soil was recorded with supply of 100 per cent nitrogen through FYM (T_4), which was at par with application of 100 per cent nitrogen through sheep penning (T_9), leaf compost (T_6), sheep manure (T_8) and enriched groundnut shells (T_{10}) *i.e.*, where 100 per cent N was supplied through organics. However, it was comparable with substitution of 50 per cent nitrogen through sheep manure (T_7) during the second year of investigation under both the situations.
Supply of 100 per cent of nitrogen through sheep penning (T_9) recorded significantly higher pod and haulm yield of groundnut, which was however comparable with 50 per cent nitrogen through urea + 50 per cent nitrogen through FYM (T_3) and recommended dose of fertilizer (T_2) under rain fed situation. Whereas under protective irrigation, which was in turn comparable with supply of 50 per cent nitrogen through urea + 50 per cent nitrogen through leaf compost (T_5).

Keywords: INM, soil physical properties, groundnut productivity

1. Introduction
Groundnut (*Arachis hypogaea* L.) is the premier oilseed crop contributing 40 per cent of the total oil seed production in India, but its production and productivity needs to be significantly enhanced to meet the national shortage of availability of edible oil in India, which is about 14.10kg head^{-1} year^{-1} against the balanced nutritional requirement of 14.80kg head^{-1} year^{-1}. The productivity of *kharif* groundnut is low and highly fluctuating in *alfisols* of drylands mainly due to low organic matter content, poor fertility status, imbalanced use of high analysis chemical fertilizers accompanied by restricted use of organic manures, which made the soils not only deficient in secondary and micronutrients, but also deteriorated the soil health (Akbari *et al.*, 2011) [1].
To alleviate the problem, the effective and integrated use of locally available organic resources such as the farm yard manure, leaf compost, groundnut shells, sheep manure along with inorganic sources are the suitable strategies to improve the yield and quality of groundnut. Apart from the integrated use of nutrient sources, the exploration of the predominant practice of sheep penning in the region is at most necessary to build the soil fertility for enhanced groundnut productivity in the rain fed alfisols of Andhra Pradesh (Reddy *et al.*, 2010) [13]. The nutrient management with organic and inorganic sources along with protective irrigation at critical crop growth stages despite the vagaries of rainfall will sustain the production system. Keeping this in view, the present investigation was carried for two consecutive years (*kharif*, 2014 and 2015) at Agricultural Research Station, Ananthapuramu to study the effect of

integrated nutrient management practices on soil physical properties and productivity of groundnut (*Arachis hypogaea* l.*)* under rain fed and protective irrigated condition

Materials and methods

The experiment was carried out during *kharif* seasons of 2014 and 2015 at Agricultural Research Station, Ananthapuramu located between 14º 41' 104"N latitude, 77º 40' 281"E longitude with an altitude of 350 m above mean sea level, which falls under semi-arid tropics (SAT). The experiment was laid out in completely randomized block design with three replications in two separate blocks *viz*; purely rain fed block and with protective irrigation block. Each block with eleven same treatments *viz*; T_1 : Control (no organics and inorganics), T_2 : Recommended dose of fertiliser (RDF) (20kg N ha^{-1}: 40kg P_2O_5 ha^{-1}: 40kg K_2O ha^{-1}), T_3 : 50% nitrogen through urea + 50% nitrogen through FYM,T_4 : 100% nitrogen through FYM, T_5 : 50 % nitrogen through urea + 50 % nitrogen through leaf compost, T_6 : 100 % nitrogen through leaf compost, T_7 : 50% nitrogen through urea + 50 % nitrogen through sheep manure, T_8 : 100% nitrogen through sheep manure, T_9: 100 % nitrogen through sheep penning, T_{10} : 100% nitrogen through enriched groundnut shells and T_{11} : 50% nitrogen through urea + 50% nitrogen through enriched groundnut shell. The soil type is *alfisols* with pH 6.42, EC 0.42dS m^{-1}, low available nitrogen (198kgha^{-1}), medium available P_2O_5 (48kgha^{-1}), low available K_2O (191kgha^{-1}) and organic carbon (0.38%). Organics were applied two weeks before sowing of the crop. The FYM, well-rotted gliricidia leaf compost, sheep manure was applied as per treatments on equivalent nitrogen basis to meet the nitrogen requirement of the crop. Enriched groundnut shells were prepared by spreading the groundnut shells overnight on the floor of the cattle shed so that groundnut shells were trampled well and mixed with the cattle dung and urine. In the following day, the enriched groundnut shells along with dung and urine were collected and applied to the experimental plots as per the treatments. The sheep penning plots were temporarily netted to keep the flock uniformly in the allocated plots overnight. The droppings of both urine and fecal matter falling the soil were incorporated to a shallow depth of the soil by running a blade harrow. Nitrogen, phosphorus and potassium were applied in the form of urea, single super phosphate and muriate of potash respectively at the time of sowing. During the crop period of first year (2014), a total rainfall of 234.6 mm was received in 16 rainy days as against the decennial average of 363.7 mm of rainfall received in 22 rainy days for the corresponding period and second year (2015), a total rainfall of 318mm was received in 23 rainy days. Whereas the decennial mean rainfall for the corresponding period was 371.8mm in 23 rainy days. During 2014 *kharif* season under protective irrigation, 2 times protective irrigation was given at 55 DAS and at 75 DAS and during 2015 *kharif* protective irrigation given at 75 DAS. Each time 20 mm of irrigation was given. Variety Kadiri-6 was sown. All observations were statistically analyzed as suggested by Gomez and Gomez (1984). The soil samples were collected by using the core sampler for the determination of bulk density and expressed as grams per cubic centimeter (gcm^{-3}).Water stable aggregates were determined by soaking fifty grams of soil aggregates of 5-8mm size in water for 5minutes and sieved in a nest of standard sieves (5.0, 2.0, 1.0, 0.50, 0.25mm mesh size) for 10 minutes with a frequency of 30 cycles min^{-1} and a stroke length of 3.8 cm. Percentage of water stable aggregates (>0.25mm) was calculated after correction for sand particles (Gupta and Dakshinamoorthy, 1981) [4]. Water holding capacity (WHC) was determined by pressure plate apparatus method and expressed in percentage. Steady state infiltration rate was measured by using double ring infiltrometer and expressed as cm hr^{-1}. Soil moisture up to 40 cm depth was measured by using Delta T PR2 profile probe and HH2 handheld data logger. The soil moisture in per cent volume recorded at each depth was added and expressed as total soil moisture percent volume (% vol.).

Results and discussion

Soil physical properties

Bulk density

Use of either organic, inorganic alone or in combination failed to exert a significant influence on bulk density of the soil during two consecutive years of study under both the farming situations (Table 1). However, numerically and comparatively lower values were registered with 100 per cent nitrogen through FYM (T_4) followed by 100 per cent nitrogen through enriched groundnut shells (T_{10}) and 100 per cent nitrogen through leaf compost (T_6). Whereas, slightly higher bulk density was observed in control plot (T_1). Under rain fed as well as in protective irrigation and also among the different treatments the reduction in bulk density was marginal during first year and further, slight decrease was noticed in the second year of experimentation. The results indicated that the organic treatments did not influence much on bulk density as compared to control treatment. The similar results were observed even under the long term manurial experiments as reported by Brar *et al.* (2015) [3] and Meena *et al.* (2016) [7]. The slight decrease in bulk density with application of 100 per cent N through organic manures under both the situations was attributed to the simultaneous increase in the organic matter content in the soil, as organic matter plays a vital in improving the soil physical health and resilience (Anderson, 2003) [2]. Similar results were also reported by Indoria *et al.* (2016) [6] in groundnut.

Aggregate stability

Aggregate stability of the soil was not statistically traceable with application of organic and inorganic sources of nutrients during the two consecutive years of experimentation both under rain fed and irrigated condition (Table.1). The slightly higher values of aggregate stability were observed with 100 per cent nitrogen through sheep penning (T_9) and 100 per cent nitrogen through FYM (T_4) both under rain fed as well as protective irrigated condition compared to control. The slight increase in aggregate stability might be due to certain types of organic substances released from the roots and produced by microorganisms. The roots themselves can move and bind soil particles together and form aggregates. Further, Sheep penning and FYM application might have resulted in higher soil organic carbon and acted as binding agent which improved the soil aggregate stability. The experimental site being slightly acidic in nature influenced the improvement in aggregates even though it is not significant among different treatments. The similar trend was also reported by Simmansky and Bajcan (2014) [14].

Water holding capacity

Significantly higher water holding capacity of the soil was recorded in the 100 per cent nitrogen through sheep penning (T_9) (Table 2), which was however comparable with the application of 100 per cent nitrogen either through FYM (T_4), leaf compost (T_6), sheep manure (T_8) and enriched groundnut shells (T_{10}), which in turn maintained parity with each other under both the farming situations during both the years of the study. Increase in water holding capacity with applications of organics was attributed to the fact that organic manure improved the organic carbon content thereby increase in capillary porosity under both rain fed as well as protective irrigated condition. The increase in water retention is not only due to organic matter addition alone but also due to its added advantages with respect to improved soil aggregation and lowering of bulk density under the existing soil management practices. The results are in confirmation with Rao *et al.* (2011) [11].

Infiltration rate

Significantly higher infiltration rate of water in the soil was recorded in 100 per cent nitrogen through FYM (T_4) (Table2), which was at par with the application of 100 per cent nitrogen through leaf compost (T_6), 100 per cent nitrogen through sheep manure (T_8) and 100 per cent nitrogen through sheep penning (T_9) in the order of descent which maintained parity with each other during *kharif*, 2014 both under rain fed and protective irrigated conditions. But in *kharif*, 2015, it was in turn comparable with application of 100 per cent nitrogen through enriched groundnut shells (T_{10}). Significantly the lowest infiltration rate of water into the soil was recorded in the control (T_1). The increase in the infiltration rate under both the situations with application of nitrogen solely through organic sources may be attributed to better soil aggregation, increased soil porosity which was reflected through bulk density, as a result of added soil organic matter through different organic sources of nutrients. Soil organic carbon was significantly and positively correlated with infiltration rate (Brar *et al*., 2015) [3]. This created the favorable conditions for better root proliferation, living conditions for soil microorganisms and improved soil structure among different treatments in both rain fed and protective irrigated conditions. Further, the increase in infiltration rate may be due to increase in micro and macro pores in the soil resulting from better aggregation by cementing of soil particles together resulted in higher soil organic matter and favorable living conditions for soil microorganisms. These results were corroborated with findings of Brar *et al.* (2015) [3] and Nitin *et al.* (2015) [8].

Moisture content

At all the growth stages of crop, under both the situations, significantly the highest moisture content in the soil was recorded with 100 per cent nitrogen through FYM (T_4), which was at par with the application of 100 per cent nitrogen through sheep penning, leaf compost, sheep manure and enriched groundnut shells (T_9, T_6, T_8 and T_{10}) *i.e.*, where 100 per cent nitrogen was supplied through organics during the first year of the study. Whereas, during the second year, which was in turn comparable with 50 per cent nitrogen through urea + 50 per cent nitrogen through sheep manure (T_7) (Table. 3 &4). The next best treatment which registered the higher moisture content in the soil was supply of 50 per cent nitrogen through urea + 50 per cent nitrogen either through FYM (T_3) or leaf compost (T_5) or enriched groundnut shells (T_{11}), which were statistically on par with each other and followed by recommended dose of fertilizer (T_2). Significantly the lowest soil moisture content was recorded in the control plot (T_1). The soil organic matter content appears to be an important factor in higher retention of soil moisture under varied treatment combinations under both rain fed and protective irrigated conditions. This may be related to the fact that, the structure forming effect of organic matter is influencing the water retention close to field capacity and permanent wilting point. The result is more pronounced with sole application of organics followed by integrated use of organics and inorganics as compared to recommended dose of fertilizers. These findings are in close conformity with Indoria *et al.* (2016) [6]. The lower soil moisture content recorded with control (T_1) might be due to poor soil organic matter content of the rain fed alfisols.

Yield

Pod yield

Under rain fed condition during *kharif*, 2014 and 2015, the highest pod yield (842 and 1530kgha^{-1}) of groundnut was recorded with supply of 100 per cent nitrogen through sheep penning (T_9), which was at par with 50 per cent nitrogen through urea + 50 per cent nitrogen through FYM (T_3) and recommended dose of fertilizer (T_2) (Table 5). Application of 100 per cent nitrogen through sheep penning (T_9) resulted in 69 and 89 per cent higher pod yield during 2014 and 2015 respectively, over control. Pod yield of groundnut is a function of yield attributes, which was significantly higher with these nutrient management practices. Application of 50 per cent nitrogen through urea + 50 per cent nitrogen either through leaf compost (T_5) or FYM (T_4), or sheep manure (T_7) or enriched groundnut shells (T_{11}) were the next best treatments and were comparable among themselves. Under protective irrigation during *kharif*, 2014 and 2015, the highest pod yield of groundnut was recorded with supply of 100 per cent nitrogen through sheep penning (T_9), which was in parity with 50 per cent nitrogen through urea + 50 per cent nitrogen through FYM (T_3), recommended dose of fertilizer (T_2) and 50 per cent nitrogen through urea + 50 per cent nitrogen through leaf compost (T_5). Application of 100 per cent nitrogen through sheep penning (T_9) resulted in 83 and 57 per cent higher pod yield during 2014 and 2015 respectively over control. Pod yield recorded with 100 per cent nitrogen through FYM (T_4), 50 per cent nitrogen through urea + 50 per cent nitrogen either through sheep manure (T_7) or enriched groundnut shells (T_{11}) were comparable among themselves. The lowest pod yield was recorded with control (T_1). Groundnut respond well to organic sources of nutrients under protective irrigation as compared to rain fed situation. Higher pod yield under protective irrigation might be due to coincidence of protective irrigation with critical stages *i.e.*, at pod formation and pod development stage. Protective irrigation at pod formation and pod development might have resulted in better moisture, nutrient availability and thereby regaining photosynthetic efficiency of the plant, which in turn results in elevated stature of yield attributes owing to higher pod yield of groundnut. Under arid and semi-arid conditions, crop yields are strongly influenced by rainfall and there is a strong correlation between the pod yield and the soil moisture at the critical stages of the crop growth *viz.*, pegging, pod formation and pod development (Rao *et al.*, 2012) [12]. Similar results were also reported by Patil *et al.* (2015) [9] and Rahevar (2015) [10]. The lowest pod yield recorded control (T_1) was due to deflated stature of growth parameters, yield attributes and finally lower yields.

Haulm yield

Under rainfed condition during *kharif*, 2014 and 2015, the highest haulm yield of groundnut was recorded with supply of 100 per cent nitrogen through sheep penning (T_9), which was at par with recommended dose of fertilizer (T_2) and 50 per cent nitrogen through urea + 50 per cent nitrogen through FYM (T_3) (Table 4). Among the other organic sources tried, 50 per cent nitrogen through urea + 50 per cent nitrogen through leaf compost (T_5) recorded higher haulm yield, which was however, comparable with 100 per cent nitrogen through FYM (T_4), 50 per cent nitrogen through urea + 50 per cent nitrogen through sheep manure (T_7) and 50 per cent nitrogen through urea + 50 per cent nitrogen through enriched groundnut shells (T_{11}) in the order of descent with no significant disparity between one another. The lowest haulm yield was registered with control (T_1). Under protective irrigation during both the years of the study, the highest haulm yield of groundnut was recorded with supply of 100 per cent nitrogen through sheep penning (T_9), which was however comparable with 50 per cent nitrogen through urea + 50 per cent nitrogen through FYM (T_3) recommended dose of fertilizer (T_2) and 50 per cent nitrogen through urea + 50 per cent nitrogen through leaf compost (T_5). The next best treatment was application of 100 per cent nitrogen through FYM (T_4) among the various organic sources tried. Obviously the lowest haulm yield in groundnut was registered with control (T_1). Comparatively higher haulm yield of groundnut under protective irrigation as compared to rain fed situation might be due to better availability of moisture and nutrients thereby higher dry matter production. The increase in biological yield is also attributed to increase in plant population, number of leaves and higher dry matter accrual under protective irrigation. The present findings are in agreement with results of Patil *et al.* (2015) [9]. When nitrogen was not supplied either through organic or inorganic source, crop has to depend obviously upon soil nitrogen, which is not sufficient to produce even reasonable haulm yields. In the present study, non-supply of nitrogen through any source in control (T_1) resulted in poor performance of the crop which could be noticed by the lowest values of all the growth parameters, yield attributes, nutrient uptake and pod yield.

Table 1: Bulk density (gm cm^{-3}) and aggregate stability (%) of soil as influenced by organic and inorganic sources of nitrogen during *kharif,* 2014 and 2015

Treatments	Rainfed condition				Protective irrigation			
	Bulk density (gm cm^{-3})		Aggregate Stability (%)		Bulk density (gm cm^{-3})		Aggregate Stability (%)	
	2014	2015	2014	2015	2014	2015	2014	2015
T_1	1.45	1.45	34.22	34.83	1.46	1.46	35.00	35.17
T_2	1.44	1.44	35.48	35.67	1.44	1.43	36.00	36.33
T_3	1.42	1.40	37.23	39.50	1.41	1.39	38.00	40.17
T_4	1.39	1.38	38.17	40.00	1.38	1.37	39.17	41.00
T_5	1.41	1.40	37.17	39.00	1.40	1.39	38.20	39.67
T_6	1.40	1.38	38.00	39.17	1.39	1.38	38.70	40.00
T_7	1.42	1.41	36.33	38.00	1.41	1.40	37.00	38.33
T_8	1.41	1.40	37.50	39.33	1.39	1.39	38.17	40.00
T_9	1.41	1.39	39.17	41.50	1.40	1.38	40.17	42.00
T_{10}	1.40	1.40	36.67	38.17	1.40	1.40	37.50	39.17
T_{11}	1.42	1.42	36.00	37.83	1.41	1.41	37.17	38.33
SEm ±	0.04	0.047	1.484	1.575	0.04	0.052	1.426	1.66
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS

Table 2: Water holding capacity (%) and infiltration rate (cm hr^{-1}) of soil as influenced by organic and inorganic sources of nitrogen during *kharif,* 2014 and 2015

Treatments	Rainfed condition				Protective irrigation			
	Water holding capacity (%)		Infiltration rate of soil (cm hr^{-1})		Water holding capacity (%)		Infiltration rate of soil (cm hr^{-1})	
	2014	2015	2014	2015	2014	2015	2014	2015
T_1	24.43	24.50	0.94	0.93	24.83	25.17	0.92	0.92
T_2	26.03	26.57	0.97	0.99	26.73	27.00	0.95	0.97
T_3	29.83	31.33	1.04	1.05	30.30	32.83	1.02	1.04
T_4	34.83	36.50	1.09	1.10	35.37	37.19	1.07	1.08
T_5	30.50	31.13	1.03	1.04	30.07	32.08	1.01	1.03
T_6	33.57	35.83	1.08	1.09	34.27	36.18	1.06	1.06
T_7	29.33	31.17	1.03	1.04	30.50	32.10	1.02	1.02
T_8	34.00	35.00	1.06	1.08	34.83	36.15	1.05	1.06
T_9	35.67	37.18	1.07	1.08	36.33	38.17	1.04	1.05
T_{10}	33.00	34.88	1.06	1.07	34.10	36.08	1.03	1.04
T_{11}	30.17	31.25	1.02	1.03	30.06	32.01	1.01	1.01
SEm ±	1.12	1.18	0.01	0.01	1.11	1.06	0.01	0.01
CD (P=0.05)	3.34	3.51	0.03	0.03	3.30	3.15	0.04	0.04

Table: 3: Soil moisture content (% vol.) as influenced by organic and inorganic sources of nitrogen under rainfed condition during *kharif,* 2014 and 2015

Treatments	15 DAS		30 DAS		45 DAS		60 DAS		75 DAS		90 DAS		At harvest	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
T_1	21.10	20.65	20.63	34.69	58.49	30.69	24.71	61.12	25.89	32.43	23.73	57.36	59.39	22.55
T_2	21.82	20.97	21.06	35.40	59.52	31.08	25.87	61.98	26.94	32.98	24.41	58.07	60.11	23.29
T_3	23.31	23.20	22.34	40.34	67.92	36.53	33.09	69.66	34.46	37.36	33.49	67.56	68.39	26.56

T_{4}	24.05	24.82	23.09	44.08	73.54	41.30	39.05	74.96	40.13	44.37	39.27	72.66	74.06	32.42
T_{5}	22.96	23.18	22.21	39.23	65.98	35.46	32.30	68.94	33.52	36.82	32.74	66.08	66.64	25.51
T_{6}	23.94	24.27	22.92	43.33	72.08	40.33	37.27	74.40	38.03	43.22	37.07	71.26	73.17	31.82
T_{7}	23.18	23.64	22.28	42.29	66.96	39.40	31.75	72.31	32.98	42.78	31.89	69.24	67.37	30.80
T_{8}	23.90	24.33	22.87	42.44	71.38	40.28	36.41	73.69	37.96	43.69	36.86	71.75	72.48	31.60
T_{9}	23.99	24.75	23.01	43.83	72.54	40.95	38.65	74.58	39.55	44.05	38.69	72.11	73.49	32.23
T_{10}	23.83	24.01	22.76	42.17	70.97	39.95	35.84	73.37	36.41	42.94	35.36	69.69	71.72	31.08
T_{11}	22.71	22.98	22.19	38.77	64.17	33.78	31.51	65.15	32.14	36.23	31.47	65.02	65.69	25.11
SEm ±	0.23	0.47	0.11	0.67	0.92	0.49	1.10	0.94	1.40	0.73	1.83	1.17	1.52	0.58
CD (P=0.05)	0.69	1.41	0.33	2.00	2.74	1.45	3.27	2.80	4.18	2.19	5.45	3.46	4.52	1.74

Table 4: Soil moisture content (% vol.) as influenced by organic and inorganic sources of nitrogen under protective irrigation during *kharif*, 2014 and 2015

Treatments	15 DAS		30 DAS		45 DAS		60 DAS		75 DAS		90 DAS		At harvest	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
T_{1}	21.54	20.76	20.45	34.12	57.88	31.16	41.81	62.12	31.02	36.76	26.44	58.27	58.54	23.03
T_{2}	22.14	21.12	21.53	35.16	58.44	31.85	42.44	62.64	32.19	37.73	27.72	58.95	59.76	24.20
T_{3}	23.64	23.78	22.21	40.45	67.04	36.97	49.76	70.34	40.13	44.21	36.78	68.15	68.07	27.14
T_{4}	24.32	25.08	23.01	44.32	73.01	41.52	56.64	75.20	48.28	51.61	42.20	73.54	73.60	33.08
T_{5}	23.52	23.60	22.17	40.39	64.96	35.67	48.86	69.73	39.78	43.77	35.12	67.08	66.10	26.02
T_{6}	24.28	24.93	22.54	43.54	71.58	40.70	53.19	75.01	47.08	50.26	40.67	72.26	72.59	32.04
T_{7}	23.28	23.98	22.12	43.12	66.31	39.99	49.41	73.83	38.41	50.76	34.96	70.20	67.02	31.24
T_{8}	24.22	24.68	22.75	42.70	71.08	40.55	52.45	74.61	45.42	51.17	39.08	72.34	71.89	32.14
T_{9}	24.30	25.02	22.93	43.92	72.01	41.45	53.40	75.12	47.46	51.29	41.39	72.80	73.17	32.51
T_{10}	23.98	24.33	22.39	42.38	70.60	40.18	51.72	73.97	46.80	50.15	40.38	70.46	71.23	31.30
T_{11}	23.25	23.18	22.07	39.02	65.13	33.95	47.71	66.21	38.16	42.70	31.47	65.98	65.15	25.35
SEm ±	0.25	0.39	0.25	0.69	1.50	0.63	1.66	0.92	1.02	0.57	1.29	1.18	1.55	0.63
CD (P=0.05)	0.76	1.16	0.76	2.05	4.47	1.89	4.95	2.73	3.03	1.71	3.83	3.51	4.61	1.88

Table 4: Pod and haulm yield (kg ha^{-1}) of groundnut as influenced by organic and inorganic nitrogen

Treatments	Rainfed condition				Protective irrigation			
	Pod yield		Haulm yield		Pod yield		Haulm yield	
	2014	2015	2014	2015	2014	2015	2014	2015
T_{1}	497	807	1018	1746	698	1284	1530	2236
T_{2}	780	1429	1550	2823	1119	1951	2675	3320
T_{3}	801	1496	1496	2738	1209	1997	2763	3401
T_{4}	739	1290	1437	2530	1070	1768	2507	3097
T_{5}	758	1319	1471	2612	1098	1879	2641	3231
T_{6}	638	1074	1209	2243	842	1437	2184	2840
T_{7}	709	1228	1418	2490	1012	1715	2361	3004
T_{8}	671	1104	1260	2302	869	1528	2291	2961
T_{9}	842	1530	1696	2944	1280	2013	2807	3441
T_{10}	611	1020	1187	2198	817	1395	2156	2750
T_{11}	697	1167	1391	2430	997	1603	2340	3021
SEm ±	22.1	61.0	69.0	100.2	66.5	77.9	56.8	85.7
CD (P=0.05)	65	181	205	298	197	231	169	254

Conclusion

In conclusion, it can be inferred from the investigation that the application of 100 per cent nitrogen through any organic source *viz.*, sheep penning, FYM, glyricidia leaf compost, sheep manure and enriched groundnut shells improved the soil physical properties such as bulk density, aggregate stability, water holding capacity and infiltration rate both under rain fed and protective irrigated condition in *alfisols* and best performance of groundnut with highest pod yield and sustained soil health were realized with supply of 100 per cent nitrogen through sheep penning or 50 per cent nitrogen through urea + 50 per cent nitrogen through FYM.

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