FARMYARD MANURE EFFECTS ON CARBON SEQUESTRATION POTENTIAL AND SOIL TOTAL NITROGEN IN FODDER MAIZE (*Zea mays* L.) CROP FIELD OF INDIA

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ABSTRACT

A field experiment was conducted to assess the influence of inorganic fertilizer and the combined effect of farmyard manure (organic) with inorganic fertilizer on soil organic carbon (SOC), carbon sequestration potential (CSP) and soil total nitrogen (STN) in Fodder Maize (Zea mays L.) crop field in North Eastern and Western Zones of Tamil Nadu, India during summer season of 2012. In Western zone two districts viz., Coimbatore and Erode districts and in North Eastern Zone Tiruvannamalai and Vellore districts were selected for the field experiments. From each district, two villages were randomly selected for field experiments totaling to eight experimental sites for the study. The SOC on 30th day of the experimental period varied from 0.28% to 0.44% for treatment 1 (T1) and 0.30% to 0.49% for treatment 2 (T2) in the experimental zones. The SOC on 60th day varied from 0.36% to 0.53% for T1 and 0.40% to 0.58% for T2. Carbon sequestration potential in the soil for the fodder maize crop varied from 1.28 to 2.27 t/ha on 60th day of the trial period. Soil total nitrogen for fodder maize crop on 30th day varied between 181.67 to 207.33 kg/acre and from 190.50 to 218.17 kg/acre for treatment 1 and 2 in the study zones. On the other hand, on 60th day soil total nitrogen varied from 165.50 to 193.17 kg/acre for treatment 1 and 178.67 to 206.33 kg/acre for treatment 2. The results recommended that integrated use of farm yard manure could be a viable option to sequester carbon than inorganic fertilizer alone which has a definite impact on carbon mitigation.

Key Words: Carbon sequestration, Farm yard manure, Fodder Maize, Inorganic fertilizer, Soil total nitrogen

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INTRODUCTION

Agriculture activities serve both as sources and sinks for greenhouse gases. Agriculture sinks of greenhouse gases are reservoirs of carbon which have been removed from the atmosphere through the process of biological carbon sequestration. Carbon sequestration is the process of removal of carbon di-oxide from atmosphere in to green plants and plays an important role in carbon capture, storage mediating stabilization and consequently mitigating greenhouse gas emission (Watson et al., 2000). Carbon in the form of carbon di-oxide is accumulating in the atmosphere at a rate of about 3.5 billion metric tons per annum through fossil fuel combustion, tropical deforestation and forest fuel combustion (Jina et al., 2008). In the past few decades with increased industrialization and reduction of carbon pools, the carbon di-oxide concentration has increased rapidly. Also intensive agriculture had negative effects on the soil environment over the past decades due to loss of soil organic matter, soil erosion and water pollution (Zhao et al., 2009). Poor soil management or cropping practices deteriorate soil quality along with emission of carbon in to the atmosphere (Lal, 2002). There is an increased concern for mitigating the increased carbon load through enhancement of soil carbon. Hence, management methods which decrease requirements for agricultural chemicals are needed in order to avoid adverse environment impacts.

Farm yard manure plays an important role in enhancement of soil organic carbon, which in turn sequesters more carbon from the atmosphere in to the plants as well as soil. Combined organic and inorganic fertilization could enhance carbon storage in soils and reduce emission from nitrogen fertilizer use, while contributing to high productivity in agriculture (Pan et al., 2009). To improve soil physical properties, addition of various organic materials could be undertaken and combined use of inorganic fertilizer (NPK) and farmyard manure (FYM) increases soil organic matter compared to application of NPK through inorganic fertilizers (Bhattacharya et al., 2008). Promoting soil carbon sequestration is an effective strategy for reducing atmospheric carbon di-oxide and improving soil quality. Hence the study was planned to assess the influence of inorganic fertilizer (NPK) and combined effect of organic (farmyard manure) and inorganic fertilizer (NPK) on soil organic carbon (soil C_{Org}), soil total nitrogen (STN) and also to assess the carbon sequestration potential (CSP) in Fodder Maize in North Eastern and Western Zone of Tamil Nadu, India.

MATERIALS AND METHODS

Composite soil samples were collected (0 - 15 cm depth) from all the experimental villages prior to the study and analysed for physicochemical properties and presented in Table 1**.** Field experiments were carried out using the Annual fodder crop, Fodder Maize *(Zea mays* L.*)* in two different agro climatic zones of Tamil Nadu, India viz., Western and North Eastern zone. Two districts from each zone viz., Coimbatore and Erode districts (Western Zone) and Tiruvannamalai and Vellore districts (North Eastern zone) were selected for the trial and in turn from each district, two villages were randomly selected for field experiments totaling to eight experimental sites for the study during the summer season of 2012.

In Coimbatore district the 2 experimental sites were located at Kondaiyampalayam (V1) (11º32' (N) latitude, 77º31' (E) longitude and 679 ft above mean sea level) and Idigarai (V2) (11º07'(N) latitude, 76º53'(E) longitude and 1398 ft above mean sea level). In Erode district, the experimental sites were located at Velankattuvalasu (V3) (11º14'(N) latitude, 77º44' (E) longitude and 685 ft above mean sea level) and Velliyampalayam (V4) (11º27' (N) latitude, 77º28' (E) longitude and 733 ft above mean sea level). In the North Eastern Zone of Tiruvannamalai district, the selected experimental sites were Vannankulam (V5) (12º42' (N) latitude, 79º09' (E) longitude and 627 ft above mean sea level), Kolathur village (V6) (12º10' (N) latitude, 79º12' (E) longitude and 467 ft above mean sea level) and in Vellore district, Saduperi (V7), (12º53' (N) latitude, 79º06' (E) longitude and 714 ft above mean sea level) and Thirumani (V8) (12º36' (N) latitude, 79º21' (E) longitude and 726 ft above mean sea level) were selected for the study purpose.

The land was ploughed twice by a tractor with chisel ploughing followed by harrowing in all the experimental fields. The field was brought to fine tilth, leveled with a wooden plank and laid out in to the proper plot size (6 x 4 m).The experiment was laid out with six replications per treatment in all the study fields. Fodder maize was planted at 60 x 30 cm intervals on either side of the ridges. The experiment consisted of two treatments viz., Treatment 1 (T1) which is control with recommended dose of NPK fertilizers (60 N, 40 P_2O_5 and 20 K_2O kg/ha) alone and Treatment 2 (T2) which included Farmyard Manure (Organic – Recommended dose - 12.5 t/ha) along with NPK fertilizer (inorganic – Recommended dose). The fertilizers were applied in the form of urea (N), Di-ammonium Phosphate (P_2O_5) and Muriate of Potash (K_2O). In all, 50 per cent of nitrogen and entire dose of P_2O_5 and K_2O were applied at the time of sowing and remaining 50 per cent of nitrogen was top dressed in the form of urea at 30 days after sowing (DAS) in all the experimental sites. . The necessary after care operations such as hand weeding were done as per the requirement. The plant protection measures have been adopted to control the pest and disease. Irrigation was carried out immediately after sowing (0th day), on 3rd day and thereafter once in 7 days. All the cultural practices were followed as per the recommended package of practices for the Fodder Maize crop.

Soil Sampling

Soil samples were collected from the experimental plots at 30 days interval during the crop growth at a depth of 15 cm on 0th, 30th and 60th day (Harvest). The soil samples were dried in oven (at 80°C) overnight, ground in wooden pestle and mortar to pass through < 2 mm mesh and subjected to analysis using Analytikjena multi N/C 2100S carbon analyzer, with furnace temperature of 950°C, NDIR detector and oxygen as supportive gas for soil C_{Org} and soil total nitrogen. Soil bulk density was calculated using the Manrique and Jones (1991) equation. Carbon sequestration potential (CSP) in NPK and Farmyard manure treatment over the NPK treatment was calculated as per standard procedure (Pathak et al., 2011).

Statistical analysis

The data collected were subjected to 't' test to find out the significant difference between treatments for all villages. In addition, One-Way ANOVA was performed using SPSS 13.0 to evaluate the significant difference between districts and zones.

RESULTS AND DISCUSSION

Soil Organic Carbon

The soil organic carbon during the initial period of the experimentation did not show any statistical significant difference (P≥0.01) between the two treatments (T1 and T2) in all villages of the experimental zones (Table 2). In the course of crop growth, the soil showed a gradual increase in the mean values of SOC for both the treatments from the initial experiment stage till 60th day for both the zones. The SOC on 30th day of experimentation for T1 varied from 0.28% to 0.44 % and 0.30% to 0.49% for treatment 2 in the experimental zones. Similarly, on 60th day the soil organic carbon varied from 0.36% to 0.53% for treatment 1 and 0.40 to 0.58% for treatment 2. The increase in soil C_{Org} was due to growth of plants which sequestered atmospheric CO_2 in to plants and return of the organic carbon in to the soil. Application of chemical fertilizer also increased the soil organic carbon and addition of well decomposed farm yard manure (organic manure) significantly increased the soil C_{Org} level to a greater extent (Ghosh et al., 2006; Gong et al., 2009). The soil organic carbon was significantly ($P < 0.05$ or 0.01) higher in T2 compared with T1 throughout the trial period. Farm yard manure along with inorganic fertilizer had a significant effect ($P \leq 0.01$ or 0.05) in increasing soil organic carbon than individual inorganic fertilizer application in all the villages on 30th and 60th day. The higher amount of soil C_{Org} in T2 was due to addition of carbon through farm yard manure, increased root biomass and crop residues (Kaur et al., 2008). The increased soil C_{Org} in T2 is due to the effect of manure which decomposed slowly and resulted in more accumulation of the carbon. The high lignin content of the organic manure has contributed to the higher soil C_{Org} content (Pathak et al., 2011). The increase in soil C_{Org} content for T2 was due to application of farm yard manure which increased the soil organic matter higher than inorganic fertilizer alone (Liu et al., 2010). Gregorich et al. (2001) reported that organic manure enhances the soil C_{Org} more than inorganic fertilizers while studying the effect of changes in soil carbon under long term maize in monoculture and legume based rotation. Highly significant ($P<0.01$) differences were evident in the mean SOC values within all the villages implying that the SOC status varied with the amount of organic matter present during the initial stage of experiment till 60th day of the trial period. The maximum SOC on 60th day for both treatments was observed in V3 (0.53% and 0.58%) followed by decreasing trend in V4 (0.47% and 0.52%), V2 (0.43% and 0.48%), V1 (0.41% and 0.46%), V6 (0.40% and 0.45%), V5 (0.38% and 0.43%), V8 (0.37% and 0.41%) and V7 (0.36% and 0.40%).

Soil Carbon Sequestration Potential in Fodder Maize compared with control

The soil carbon sequestration potential in fodder maize revealed a gradual increase in sequestering carbon from 30th day to 60th day (Table 3). The CSP in fodder maize on 30th day varied from 0.43 to 1.06 t/ha and from 0.85 to 1.21 t/ha towards the 60th day of the experimentation. Cumulative CSP of fodder maize varied from 1.28 to 2.27 t/ha with the highest cumulative value for V3 (2.27 t/ha) and the least for V7 (1.28 t/ha) in both the zones.

The mean values of Soil Carbon Sequestration Potential (t/ha) in Fodder Maize compared with control in Table 3 revealed that there was a concomitant increase in carbon sequestration potential (CSP) of the soil from 30th day to 60th day with growth of plants. On 60th day the soil CSP varied from 0.85 t/ha to 1.21 t/ha with corresponding cumulative CSP varying between 1.28 t/ha to 2.27 t/ha for all the villages. The increase in CSP was due to high biomass of the roots and plant residues, higher humification rate constant and direct application of organic matter through farm yard manure (Bhattacharya et al., 2007). Moreover, the increase in soil C_{Org} from 30th day to 60th day in fodder maize plots contributed to the sequestration potential. The increase in CSP is due to improved physicochemical and biological environment suitable for fodder growth which resulted in more addition of root biomass carbon to the soil. Increased levels of long term stabilized humic material in organically amended plots and high content of soil carbohydrates in fertilized and farm yard manure treated plots has played a crucial role in building soil C_{Org} content (Kaur et al., 2008). The increase in plant growth resulted in subsequently return of more organic carbon to the soil (Ghosh et al, 2006).

Soil total nitrogen

The experimental villages did not show any significant difference in STN between two treatments in initial period of experimentation (Table 4). The STN on 30th day of experimentation for T1 varied from 181.67 to 207.33 kg/acre and 190.50 to 218.17 kg/acre for treatment 2 in the study zones. Similarly, on 60th day STN varied from 165.50 to 193.17 kg/acre for treatment 1 and 178.67 to 206.33 kg/acre for treatment 2. Gradual decrease of total nitrogen in the soil was evident in all the villages on 30th day and 60th day in both the zones. Farm yard manure along with inorganic fertilizer has significant effect on soil nitrogen values than individual application of the fertilizer. Highly significant difference in soil total nitrogen values were observed on 30th and 60th day of trial period within the villages for both treatments. STN values were significantly higher for T2 than T1 during the period of observation. Significant differences ($P<0.05$ or $P<0.01$) in soil total nitrogen were observed between the two treatments during the experimental period.

The mean values of soil total nitrogen in fodder maize for T1 and T2 on 30th and 60th were summarized in Table 4. The soil total nitrogen has shown a steady decline during the experimental period from 0th day till 60th day for both treatments. Nitrogen is vitally important plant nutrient involved in protein and enzyme synthesis. The availability of soil nitrogen and other macro and micronutrients also helped in enhancement of meristematic plant growth which resulted in higher fodder yield (Islam et al., 2010). Application of farm yard manure increased the soil physical properties, water holding capacity, organic carbon content apart from supplying good quality nutrients. On the other hand, application of farmyard manure enhances higher uptake of NPK due to greater availability of nutrients. Farmyard manure added not only acted as source of nutrients, but enhanced its availability. Cumulative effects of adequate supply of nutrients slowly throughout the growth period enhanced the crop growth. Treatment values for T2 were higher than T1 during the experimental study which clearly indicates that inorganic fertilizer added to the crop were readily utilized by the plants for enhancement of growth. But in T2, the nitrogen was liberated slowly and steadily during the course of its growth. This is in agreement with the findings of Sathyamoorthi et al. (2007).

The results concluded that use of inorganic fertilizers alone or in synergistically with organic fertilizers resulted in significant buildup of soil C_{Org} in fodder maize treated plots and achieving higher carbon sequestration potential. Also the farm yard manure helped in higher uptake of soil total nitrogen which in turn could increase the soil fertility and productivity. Thus, the present study recommended the use of farm yard manure in combination with inorganic fertilizer as a viable option for increased carbon sequestration in soil for any type of fodder crop and thus helps in carbon mitigation.

REFERENCES

Bhattacharya, R., Chandra, S, Singh, R.D, Kundu, S, Srivastava, A.K. and Gupta, H.S. (2007). Long term farmyard manure application effects on properties of a silty clay loam soil under irrigated wheat-soybean rotation. Soil Tillage Res., 94: 386-396.

Bhattacharya, R., Kundu, S, Prakash, V. and Gupta, H.S. (2008). Sustainability under combined application of mineral and organic fertilizers in a rainfed soybean-wheat system of the Indian Himalayas. Eur. J. Agron., 28: 33-46.

Ghosh, P K., Manna, M.C, Dayal, D. and Wanjari, R H. (2006). Carbon sequestration potential and sustainable yield index for groundnut and fallow based cropping systems. J. Agr. Sci., 144: 249-259.

Gong, W., Yan, X, Wang, J, Hu, T. and Gong, Y. (2009). Long-term manure and fertilizer effects on soil organic matter fractions and microbes under a wheat maize cropping system in northern China. Geoderma, 149: 318-324.

Gregorich, E.G., Drury, C.F. and Baldock, J.A. (2001). Changes in soil carbon under long term maize in monoculture and legume based rotation. Can. J. Soil Sci., 81: 21 – 31.

Islam, M.R., Rahman, S.M.E, Rahman, M.M, Oh, D.H. and Ra, C.S. (2010). The effects of biogas slurry on the production and quality of maize fodder. Turk. J. Agric. For., 34: 91-99.

Jina, B.S., Pankah, S, Bhatt, M.D. and Rawat, Y. S. (2008). Estimating carbon sequestration rates and total carbon stockpile in degraded and non-degraded sites of oak and pine forest of kumaun central Himalaya. Ecoprint, 15: 75-81.

Kaur, T., Brar, B. S. and Dhillon, N. S. (2008). Soil organic matter dynamics as affected by long term use of organic and inorganic fertilizers under maize wheat cropping system. Nutr. Cycl. Agroecosys., 81: 59-69.

Lal, R. (2002). Soil carbon dynamics in a cropland and rangeland. Environ. Pollut., 116: 353 -362.

Liu, E., Changrong, Y, Xurong, M, Wenqing, H, So, B, Linping, D, Qin, L, Liu, S. and Fan, T. (2010). Long term effect of chemical fertilizer, straw and manure on soil chemical and biological properties in north-west China. Geoderma, 158: 173-180.

Manrique, L. A. and Jones, C.A. (1991). Bulk density of soil in relation to soil physical and chemical properties. Soil Sci. Soc. Am. J., 55: 476-481.

Pan, G., Zhou, P, Li, Z, Pete, S, Li, ., Qiu, D, Zhang, X, Xu, X, Shen, S. and Chen, X. (2009). Combined inorganic/organic fertilization enhances N efficiency and increased rice productivity through organic cabon accumulation in a rice paddy from the Tai Lake region, China. Agri. Ecosys. Environ., 131: 274-280.

Pathak, H., Byjesh, K, Chakrabarti, B. and Aggarwal, P.K. (2011). Potential and cost of carbon sequestration in Indian agriculture: Estimates from long term field experiments. Field Crop Res., 120: 102-111.

Sathyamoorthi, K., Vaiyapuri, K, Alagesan, A. and Pazhanivelan, S. (2007). Influence of organic manures on the nutrient uptake and soil fertility of Cassava (*Manihotesculenta Crantz*) Intercropping systems. Int. J.Agr. Res., 2(2): 136-144.

Watson, R. T., Noble, I.R, Boblin, E, Ravindranathan, N. H. and Verardo, D. J. (2000). Land use, Land use change and Forestry. *Special report of the intergovernmental panel on climatic change. Cambridge University Press, Cambridge, UK*.

Zhao, Y., Wang, P, Li, J, Chen, Y, Ying, X. and Liu, S. (2009). The effect of two organic manures on soil properties and crop yields on a temperate calcareous soil under a wheat-maize cropping system. Eur. J. Agron., 31: 36-42.

Table – 1

Physicochemical properties of the soil at experimental sites

Zone	District	Villages	Soil Properties					
			pH	Electrical conductivity (EC)	Organic Carbon (%)	Nitrogen (kg/acre)	Phosphorus (kg/acre)	Potassium (kg/acre)
Western	Coimbatore	Kondaiyampalayam (V1)	7.1	0.57	0.28	92.34	13.5	114.7
		Idigarai (V2)	7.3	0.56	0.29	91.23	13.7	116.5
	Erode	Velankattuvalasu (V3)	7.5	0.60	0.34	94.01	14.5	120.6
		Velliyampalayam (V4)	7.4	0.58	0.32	92.18	14.1	118.9
North Eastern	Tiruvanna-malai	Vannankulam (V5)	7.0	0.58	0.25	91.72	12.8	112.1
		Kolathur (V6)	7.1	0.56	0.27	90.16	13.1	115.4
	Vellore	Saduperi (V7)	6.9	0.54	0.23	91.43	13.4	106.5
		Thirumani (V8)	6.8	0.53	0.24	89.22	13.2	109.8

Table - 2

Soil Organic Carbon (%) in Fodder Maize field in Western and North Eastern zones of Tamil Nadu

Zone	District	Villages	0th day (Percent)		t value	30th day		t value	60th day		t value
			T1	T2		T1	T2		T1	T2	
			Mean ± S.E	Mean ± S.E		Mean ± S.E	Mean ± S.E		Mean ± S.E	Mean ± S.E	
Western Zone	Coimbatore	V1	0.26 ± 0.03^{a}	0.27 ± 0.04^{ab}	0.14^{NS}	0.34 ± 0.02^{b}	0.37 ± 0.01^{b}	2.57*	0.41 ± 0.02^{bc}	0.46 ± 0.02^{c}	3.71**
		V2	0.27 ± 0.03^{ab}	0.28 ± 0.03^{ab}	0.29^{NS}	0.40 ± 0.01^{c}	0.44 ± 0.02^{c}	2.67*	0.43 ± 0.02^{c}	0.48 ± 0.01^{c}	2.55*
	Erode	V3	0.34 ± 0.01^{c}	0.32 ± 0.01^{b}	1.92^{NS}	0.44 ± 0.02^{d}	0.49 ± 0.02^{d}	2.24*	0.53 ± 0.01^{e}	0.58 ± 0.01^{e}	3.25**
		V4	0.32 ± 0.02^{bc}	0.31 ± 0.01^{b}	0.53^{NS}	0.42 ± 0.01^{cd}	0.45 ± 0.02^{c}	2.72*	0.47 ± 0.02^{d}	0.52 ± 0.02^{d}	2.28*
North Eastern zone	Tiruvannamalai	V5	0.23 ± 0.01^{a}	0.22 ± 0.01^{a}	0.46^{NS}	0.32 ± 0.01^{b}	0.34 ± 0.02^{b}	2.37*	0.38 ± 0.01^{ab}	0.43 ± 0.01^{ab}	2.53*
		V6	0.25 ± 0.01^{a}	0.24 ± 0.01^{a}	1.41^{NS}	0.33 ± 0.01^{b}	0.35 ± 0.02^{b}	2.29*	0.40 ± 0.01^{abc}	0.45 ± 0.01^{bc}	2.84*
	Vellore	V7	0.25 ± 0.01^{a}	0.26 ± 0.01^{ab}	0.22^{NS}	0.28 ± 0.01^{a}	0.30 ± 0.01^{a}	2.66*	0.36 ± 0.01^{a}	0.40 ± 0.01^{a}	3.78**
		V8	0.27 ± 0.01^{ab}	0.25 ± 0.01^{a}	2.22^{NS}	0.29 ± 0.01^{a}	0.31 ± 0.01^{a}	2.25*	0.37 ± 0.01^{a}	0.41 ± 0.01^{a}	3.80**
		F value	3.33**	3.21**		56.75**	45.87**		14.63**	32.59**	

Means bearing same superscripts within columns do not differ significantly

NS – Non Significant * - Significant ($P<0.05$) ** - Highly Significant ($P<0.01$)

Table - 3

Soil Carbon sequestration Potential (t/ha) in Fodder Maize field compared with control of Western and North Eastern zones of Tamil Nadu

Zone	District	Villages	Fodder Maize (t / ha) (compared with control)		
			30th day	60th day	Cumulative CSP
Western zone	Coimbatore	V1	0.64 [a]	1.09 [b]	1.73 [c]
		V2	0.74 [a]	1.17 [b]	1.91 [c]
	Erode	V3	1.06 [a]	1.21 [b]	2.27 [c]
		V4	0.78 [a]	1.19 [b]	1.97 [c]
North Eastern zone	Tiruvannamalai	V5	0.54 [a]	0.92 [b]	1.46 [c]
		V6	0.57 [a]	1.06 [b]	1.63 [c]
	Vellore	V7	0.43 [a]	0.85 [b]	1.28 [c]
		V8	0.50 [a]	0.89 [b]	1.39 [c]
		F value	0.33 [NS]	0.13 [NS]	0.34 [NS]

Means bearing same superscripts within columns do not differ significantly

NS – Non Significant P>0.05)

Table - 4

Soil Total Nitrogen (Kg/acre) in Fodder Maize field of Western and North Eastern zones of Tamil Nadu

Zone	District	Villages	0th day (Kg/acre)		t value	30th day (Kg/acre)		t value	60th day (Kg/acre)		t value
			T1	T2		T1	T2		T1	T2	
			Mean ± S.E	Mean ± S.E		Mean ± S.E	Mean ± S.E		Mean ± S.E	Mean ± S.E	
Western zone	Coimbatore	V1	216.67 ± 2.96^{cde}	220.17 ± 2.10^{cde}	0.96^{NS}	197.50 ± 2.72^{cde}	210.50 ± 2.94^{cd}	3.25^{**}	183.17 ± 2.91^{bc}	194.33 ± 2.26^{bc}	3.03^{*}
		V2	218.50 ± 2.80^{cde}	222.67 ± 2.99^{de}	1.02^{NS}	198.83 ± 1.28^{de}	212.83 ± 1.85^{d}	6.23^{**}	188.33 ± 1.63^{cd}	196.17 ± 3.05^{bc}	2.27^{*}
	Erode	V3	225.67 ± 4.53^{e}	228.50 ± 4.66^{e}	0.44^{NS}	202.33 ± 3.27^{e}	218.17 ± 3.89^{d}	3.11^{*}	193.17 ± 2.15^{d}	206.33 ± 4.92^{d}	2.45^{*}
		V4	221.50 ± 3.07^{de}	226.50 ± 3.13^{e}	1.14^{NS}	200.67 ± 1.52^{de}	215.83 ± 2.18^{d}	5.70^{**}	190.50 ± 1.57^{d}	200.33 ± 3.75^{cd}	2.42^{*}
North Eastern zone	Tiruvannamalai	V5	204.50 ± 3.77^{ab}	208.67 ± 3.89^{ab}	0.77^{NS}	186.82 ± 2.69^{ab}	196.50 ± 3.13^{ab}	2.34^{*}	170.17 ± 1.68^{a}	181.84 ± 2.82^{a}	3.55^{**}
		V6	211.83 ± 2.52^{bcd}	215.33 ± 2.55^{bcd}	0.98^{NS}	194.50 ± 1.95^{cd}	202.50 ± 2.60^{bc}	2.46^{*}	180.33 ± 2.04^{b}	191.50 ± 1.38^{bc}	4.52^{**}
	Vellore	V7	200.50 ± 3.60^{a}	203.83 ± 3.93^{a}	0.63^{NS}	181.67 ± 2.39^{a}	190.50 ± 2.49^{a}	2.56^{*}	165.50 ± 1.50^{a}	178.67 ± 3.12^{a}	3.80^{**}
		V8	209.67 ± 2.08^{abc}	211.83 ± 2.01^{abc}	0.75^{NS}	190.64 ± 2.52^{bc}	199.33 ± 2.86^{b}	2.27^{*}	178.50 ± 2.54^{b}	187.50 ± 2.26^{ab}	2.65^{*}
		F value	6.96^{**}	7.13^{**}		9.22^{**}	12.69^{**}		22.26^{**}	8.84^{**}	

Means bearing same superscripts within columns do not differ significantly

NS – Non Significant * - Significant (P<0.05) ** - Highly Significant (P<0.01)

Figure 1

Effect of NPK (T1) and NPK + FYM (T2) treatments on soil organic carbon (%) in Fodder Maize plots of different villages in North Eastern and Western Zone of Tamil Nadu (a) Kondaiyampalayam (b) Velankattuvalasu(c)Vannankulam (d) Saduperi

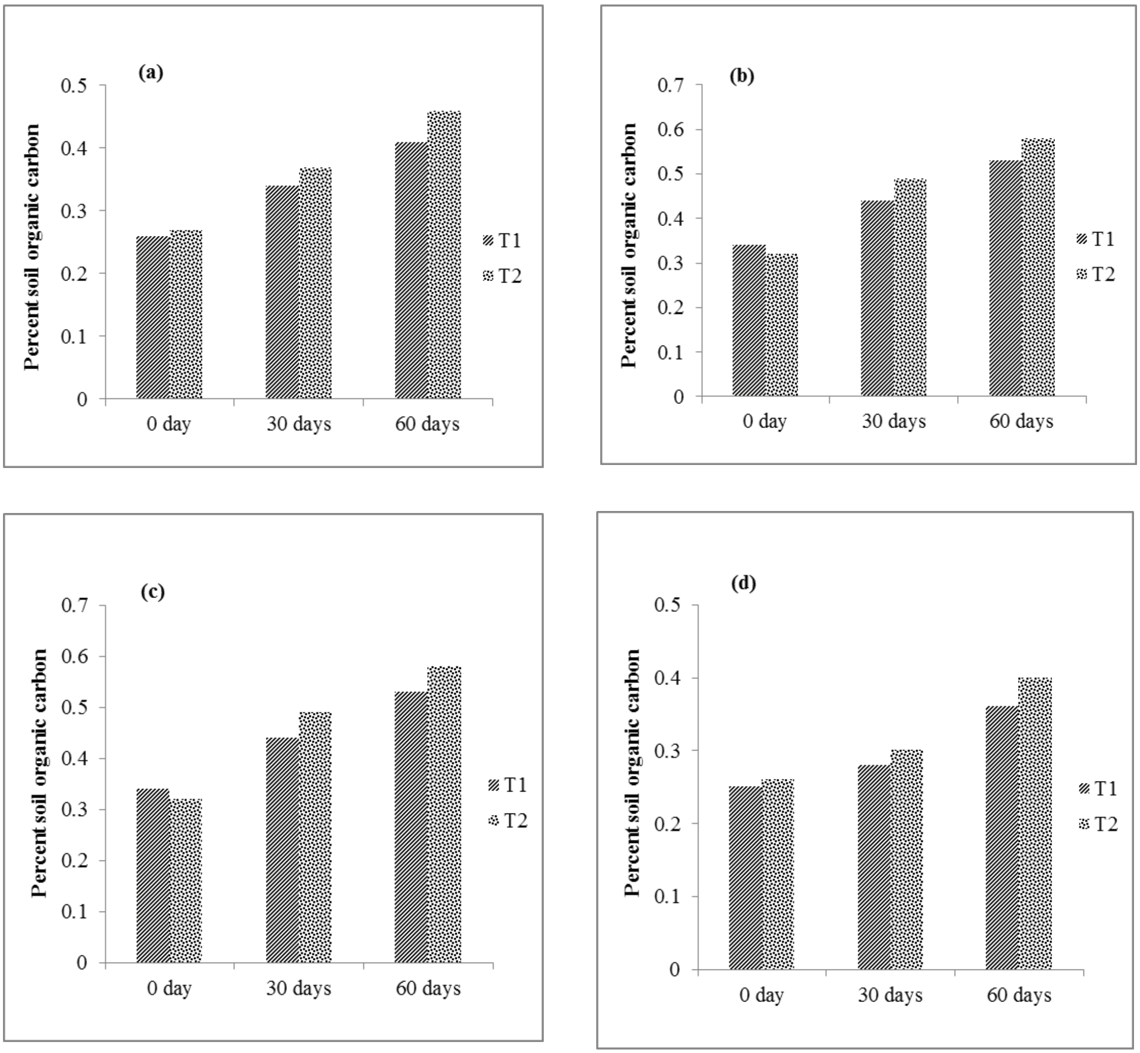

Figure 2

Effect of NPK (T1) and NPK + FYM (T2) treatments on soil total nitrogen (kg/acre) in Fodder Maize plots of different villages in North Eastern and Western Zone of Tamil Nadu (a) Kondaiyampalayam (b) Velankattuvalasu (c)Vannankulam (d) Saduperi