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Research article

INFLUENCE OF LONG TERM FERTILIZATION ON LABILE CARBON AND N MINERALIZATION OF SOIL IN SORGHUM-WHEAT CROPPING SYSTEM

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ABSTRACT: The experiment was under taken during the year 2007-08 to study the effect of long term fertilization and manuring on labile carbon and N mineralization. The dynamics of C and N was studied in the ongoing long term fertilizer experiment initiated since *kharif* 1988 at Akola, Maharashtra. The experiment comprised of twelve treatments including NPK levels with and without FYM, sulphur and zinc replicated four times in randomised block design. The manure and fertilizers were given to sorghum crop every year and only fertilizers were applied to wheat crop. The soil samples from all the treatments were collected from 0-20 cm depth. The highest and significant increase in the, labile carbon, and NO_3 - N and NH_3 - N were recorded in the treatment of 10 t FYM ha^{-1} + 100% NPK (100:50:40 kg NPK for sorghum and 120:60:60 kg NPK for wheat) by 40.1, 18.5 and 29.0 per cent respectively over 100% recommended NPK.

Key words: Long term fertilization, labile carbon and N mineralization

INTRODUCTION

Long term manuring and fertilizer experiments conducted in India showed declining trend in productivity even with the application of NPK fertilizers under modern intensive farming. Neither organic source alone nor inorganic fertilizers can achieve sustainability in crop production under intensive agriculture, where nutrient turnover in soil-plant system is much higher. However, their combined use appeared promising in enhanced crop productivity besides improving soil fertility. The mineralization of carbon and nitrogen plays significant role in availability of nutrients. However, the role of mineralization determines the flux of nutrient flow. When fertilizer nitrogen is added to the soil, the portion of it is immobilized, but the mineralization rate of recently immobilized fertilizer is greater than indigenous organic nitrogen. The rate of carbon and nitrogen mineralization is different for various cropping systems and hence, it is necessary to study mineralization. N-mineralization potential increases with increasing nitrogen rate in dryland and irrigation conditions. In order to investigate the long term influence of fertilization on soil labile carbon and N mineralization, the present study was undertaken in sorghum-wheat cropping sequence on Vertisol.

MATERIALS AND METHODS

The long term fertilizer experiment was initiated during *kharif* 1988 on the Research Farm of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola in Maharashtra ($22^0$42' N and $77^0$02' E, 307.42 m above mean sea level). The soil is Vertisol with alkaline pH (8.1), high cation exchange capacity (48 c mol (p^+) kg^{-1}), medium soil organic carbon (4.6 g kg^{-1}), total nitrogen (0.044 %), low available phosphorus (8.4 kg ha^{-1}) and high available potassium (358 kg ha^{-1}). The present investigation was undertaken during 2007-08 after 19^{th} cropping cycle of this long term experiment. The experiment consisted of twelve treatments *viz*., T_1- 50 % NPK, T_2- 100 % NPK, T_3- 150 % NPK , T_4- 100 % NPK(S free), T_5- 100 % NPK + 2.5 kg Zn ha^{-1}, T_6-100 NP, T_7- 100 % N, T_8- 100 % NPK+ FYM @10 t ha^{-1}, T_9-100 % NPK (S free) + 37.5 kg S ha^{-1}, T_{10}- FYM @ 10 t ha^{-1}, T_{11}- 75 % NPK and T_{12}-Control. The experiment is laid out in randomized block design and replicated four times. The experiment is being conducted on same site and same randomization. The nutrients were applied through the fertilizers like urea, single super phosphate, muariate of potash, diammonium phosphate (T_4 and T_9).

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Sulphur is applied through gypsum (T_9 only) for sorghum crop and zinc is applied through zinc sulphate once in two years for wheat crop only (T_5 only). The farmyard manure was applied every year one month before sowing of sorghum crop. The recommended fertilizer doses were applied as 100:50:40 and 120:60:60 kg N, P_2O_5 and K_2O ha^{-1} to sorghum and wheat crops, respectively. During the year of study, sorghum (CSH-9) was sown during first week of July and harvested in second week of November and wheat (AKW-1071) was sown during second fortnight of November and harvested in first week of April. The grain and straw yields of each crop were recorded and plot wise soil samples (0-20 cm) collected after harvest of wheat which was analyzed for organic carbon, labile carbon and N-mineralization. Organic carbon was estimated by Walkley and Black's method as described by Piper (1966). Labile carbon was estimated by Potassium permanganate oxidation technique suggested by Reddy (2007) and N-mineralization was estimated by 2 mol KCl using flow injection analyzer (FIA) (Bremner, 1965).

RESULTS AND DISCUSSION

Labile carbon (POSC)

Soil organic carbon as being composed of two major pools: a labile and a stabilized fraction. The labile fraction consists of material in transition between fresh plant residues and stabilized organic matter. Pools of organic matter that have been identified as part of the labile fraction include particulate organic matter, microbial biomass carbon, soluble carbon, potentially mineralizable carbon and that extractable with various reagents. In this present study permanganate oxidizable soil carbon (POSC) was taken as labile carbon and results are presented in Table 1.

Table 1: Long term effect of various treatments on soil labile C and OC under sorghum- wheat cropping sequence

Treatments	Labile C (mg kg^{-1})	OC (g kg^{-1})
T_1 - 50%NPK	218	4.32
T_2 - 100%NPK	234	5.11
T_3 - 150%NPK	279	5.93
T_4 - 100%NPK S free	223	5.10
T_5 - 100%NPK + 2.5 kg Zn ha^{-1}	239	5.15
T_6 - 100%NP	231	4.90
T_7 - 100%N	214	4.29
T_8 - 100%NPK +10 t FYM ha^{-1}	328	6.77
T_9 - 100%NPK + 37.5 kg S ha^{-1}	273	5.21
T_{10} - FYM only 10 t ha^{-1}	306	6.01
T_{11} - 75% NPK	228	4.64
T_{12} - Control	206	2.81
SE(m)±	0.93	0.13
CD at 5%	2.59	0.38

Significantly highest labile carbon (328 mg kg^{-1}) was observed with the application of 100% NPK in combination with 10 t FYM ha^{-1} (T_8) and this treatment was significantly superior over all other treatments. Similar findings were reported by Bhattacharyya *et al.* (2004). Application of 100% NPK + S (T_9) (273 mg kg^{-1}) was found to be superior over 100% NPK (S free) (223 mg kg^{-1}) treatment and the increase was to the extent of 22.4 per cent. The treatments of inorganic fertilizer application also showed significant increase in labile carbon over control. This could be attributed to the increase in root biomass in the soil due to availability of nutrients (Bhardwaj *et al.*, 1994). FYM @ 10 t ha^{-1} to the sorghum only showed increase in labile carbon over inorganic fertilizer application alone (White bread et al., 1996).

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Organic carbon

The result obtained in respect of organic carbon content in soil after 19th cropping cycle of sorghum-wheat sequence is reported in Table 1 which showed increasing trend due to increasing levels of NPK. Significantly highest organic carbon content (6.771 g kg^{-1}) was observed with the application of 100% NPK in combination with 10 t FYM ha^{-1} (T_8) and this treatment was significantly superior to all other treatments. Similar findings were reported by Gupta et al. (1992) and Sharma *et al*. (2000).

Application of 100% NPK + S (5.208 g kg^{-1}) was found to be superior over 100% NPK (S free) (5.104 g kg^{-1}) treatment, the increase was to the extent of 2.04 per cent. The treatments of inorganic fertilizer application also showed significant increase in organic carbon over initial content (4.6 g kg^{-1}). This could be attributed to the increase in root biomass in the soil due to easy availability of nutrients (Bhardwaj et al., 1994)

The lowest organic carbon content was recorded in control treatment. Application of 100% NPK + 2.5 kg $ZnSO_4$ ha^{-1} was found to be superior over 100% NPK alone (Bhattacharyya *et al*, 2004). FYM @ 10 t ha^{-1} to the sorghum only showed increase in organic carbon over inorganic fertilizer application alone. Increase in organic carbon might be ascribed due to direct application of FYM every year.

Table 2: Long term effect of various treatments on N-mineralization of soil in sorghum-wheat cropping sequence

Treatments	N-mineralization	
	NO_3 -N (mg $100g^{-1}$)	NH_4 -N (mg $100g^{-1}$)
T_1 - 50%NPK	3.32	3.07
T_2 - 100%NPK	4.76	4.48
T_3 - 150%NPK	5.11	4.96
T_4 - 100%NPK S free	4.69	4.42
T_5 - 100%NPK + 2.5 kg Zn ha^{-1}	4.85	4.67
T_6 - 100%NP	4.45	4.21
T_7 - 100%N	3.96	3.72
T_8 - 100%NPK +10 t FYM	5.64	5.78
T_9 - 100%NPK + 37.5 kg S ha^{-1}	4.89	4.73
T_{10} - FYM only 10 t ha^{-1}	3.97	3.76
T_{11} - 75% NPK	4.08	3.84
T_{12} - Control	3.22	2.94
SE(m)±	0.23	0.20
CD at 5%	0.66	0.56

N-mineralization

In tropical and sub tropical conditions available nitrogen is rarely adequate for plant growth unless it is replenished by organic N-mineralization. In the present study presence of NO_3 - N and NH_4 - N in soil is taken as N-mineralization. NO_3 - N was (Table 6) noticed significantly superior over all the treatments in T_8 (100% RDF + 10 t FYM ha^{-1}) (5.64 mg 100 g^{-1}) but this treatment was found at par with 150% NPK (T_3) (5.11 mg 100 g^{-1}) (Bhardwaj *et al.*, 1994). Increasing dose of inorganic fertilizers showed enhanced NO_3 - N in the soil. Further, it was seen that imbalanced application of nutrients reduced NO_3 - N content. By and large similar trend was observed in NH_4 - N content.

Close scrutiny of the data indicated that, the FYM @ 10 t ha^{-1} application recorded lower NO_3 - N and NH_4 - N as compared to T_8. This could be attributed to the low rate of N-mineralization which leads to reduced nutrient supply to sorghum and wheat crops (Bhardwaj et al., 1994). Furthermore, it could be observed that, the NO_3 - N was found to be higher than NH_4 - N in all the treatments indicating more availability of nitrogen in the nitrate form to the crop. There was 23 per cent and 85.4 per cent more N-mineralization in 100% NPK + FYM treatment over 100% NPK and control treatments respectively. T_2 treatment (100% NPK) found to be superior over control in N-mineralization. Continuous addition of fertilizer N along with organic manures is known for stimulating mineralization and reduced immobilization (Ravankar et al., 2004). Apparently similar results were recorded by Constantinides and Fownes (1994).

Application of FYM 10 t ha^{-1} significantly increased the N-mineralization over control. The buildup of N in soil is attributed to the regular application of fertilizer NPK, addition of higher biomass and organic manures as compare to control and sub optimal levels of fertilization (Ravankar et al., 2004).

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