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An account of soil organic carbon reserve under long-term fertilizer experiment in mulberry [*Morus alba* L.]

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ABSTRACT

A long-term fertilizer experiment (LTFE) in mulberry [Morus alba L.] variety S_{1635} has completed 20 crop cycles on a sandy clay loam soil at the Institute farm at Berhampore, West Bengal comprising nutrient-input treatments of varying origin. Soil organic carbon stock (SOCS) under different treatments has been computed by exercising analytical organic carbon content with bulk density (BD) and depth of soil. It is creditable to note that SOCS has been improved due to application of organic as well as inorganic combination of nutrients resources and also organic, inorganic as well as biological combination of nutrients resources over sole chemical fertilizers as well as treatment without any nutrient input. Subsequent impact of SOCS on soil fertility and growth as well as yield attributes of mulberry has also been studied and found mostly positive.

Key words: Bulk density, mulberry, soil organic carbon stock

Soil is the largest terrestrial pool of organic carbon (Batjes, 1992). Stock of the latter is nothing but the resultant of two reverse processes, namely, carbon bio-sequestration through vegetation and carbon reversion due to management practices exerted upon the vegetation. Mulberry is an important perennial plant of India, occupying an area of 1.85 lakh hectares and nutrition management of the same is already standardized in terms of different combinations of nutrient inputs (Kar *et al.*, 1997; Setua, 2006). But, information on the changes of organic carbon reserve in soil due to intervention of different sources of nutrient inputs is lacking. The present study aims at investigating the extent of soil organic reserve under a LTFE in mulberry (*Morus alba* L.). Attempt has also been made to examine the subsequent effect of SOCS on soil fertility as well as growth and yield attributes of mulberry.

MATERIALS AND METHODS

A long term fertilized experiment in mulberry (*Morus alba* L.) variety S_{1635} has completed 20 crop cycles (5 cycles year^{-1}) on a sandy clay loam soil at the Institute farm with the following treatments: T_1 = No nutrient, T_2 = NPK @ 336, 180 and 112 kg ha^{-1} year^{-1}, T_3 = T_2 + FYM @ 20 mt ha^{-1} year^{-1}, T_4 = NPK @ 168, 180 and 112 kg ha^{-1} year^{-1} + FYM @ 20 mt ha^{-1} year^{-1} + N-biofertilizer @ 20 kg ha^{-1} year^{-1}, T_5 = NPK @ 168, 90 and 112 kg ha^{-1} year^{-1} + FYM @ 20 mt ha^{-1} year^{-1} + N-biofertilizer @ 20 kg ha^{-1} year^{-1} + P-biofertilizer @ 75 kg ha^{-1} once in four years and T_6 = T_2 + vermicompost @ 10 mt ha^{-1} year^{-1}. The treatments were applied on the mulberry planted at two different spacing of 60 x 60 cm and 90 x 90 cm constituting a factorial RBD design with three replications and recommended package of practices for irrigated condition was employed for the maintenance of plantation.

For quantification of SOCS, soil samples collected down the depth of 30 cm under each treatment were analyzed for estimation of bulk density (BD) and organic carbon (OC) content. While BD was determined by employing the 'core-cutter' method (Blake and Hartage, 1986), OC was estimated following the method of rapid chromic acid oxidation (Black, 1965). The analytical value of OC was converted to total soil OC by standard factor (Batjes, 1996) and the latter was subsequently exercised with BD as well as soil depth to compute SOCS with the help of following equation:

$$S = \rho .\ C.\ d \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where S is the SOCS (Mg ha^{-1}), ρ is the BD (Mg ha-m^{-1}), C is the total soil OC (kg Mg^{-1}) and d is the depth (m) of soil.

Growth attributes as well as leaf and shoot yields of mulberry were recorded crop wise and were pooled on annual basis. Available N, P and K contents of soil samples were analyzed following the standard procedures. Regression analysis was further done relating SOCS with soil fertility as well as growth and yield attributes of mulberry to ascertain impact of the former on the latter.

RESULTS AND DISCUSSION

SOCS under mulberry nutrient management system

Variation of BD and SOCS of mulberry growing soil under different combinations of nutrient inputs has been furnished in table- 1. Improvement in BD due to application of FYM and vermicompost is

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quite conspicuous in both the spacing, but spacing itself has not imparted any significant effect. Due to application of organics, BD of the soil under experimentation has been approaching towards the optimum with special reference to mulberry cultivation (Bongale and Siddalingaswamy, 1996; Kar *et al.*, 2008). Humic acids derived from the organic manures due to their different functional groups might have imparted coagulation in association with soil particles through ionic interaction (Sanyal and Majumdar, 2009; Ghosh *et al.*, 2009) and the same, in turn, has facilitated formation and stabilization of soil aggregates to improve BD.

Further, it is creditable to note that SOCS has been enhanced due to application of organic as well as inorganic combination of nutrients resources and also organic, inorganic as well as biological combinations of nutrients resources over sole chemical fertilizers as well as treatment without any nutrient input. However, effect of spacing on SOCS is similar to that of BD. Such improvement in SOCS may be explained in terms of source-sink relation. Besides, leaf fall from the mulberry plant (Anon., 2009) is also likely to affect SOCS and the same is substantiated by the regression equation relating total soil OC (y) with leaf fall% (x) as $y = 5.952 + 0.104x$ ($r = 0.620$*).

Table 1: BD, analytical SOC and SOCS under mulberry nutrient management system

Treatment	BD (mg m^{-3})		Analytical SOC (g kg^{-1})		SOCS (mg ha^{-1})	
	Spacing (cm)					
	60 x 60	90 x 90	60 x 60	90 x 90	60 x 60	90 x 90
T_1	1.47	1.45	5.53	5.23	32.42	30.29
T_2	1.41	1.38	5.80	5.90	32.86	32.50
T_3	1.31	1.31	7.67	8.43	40.22	44.27
T_4	1.35	1.31	7.73	6.43	41.61	33.61
T_5	1.39	1.36	6.87	6.70	38.05	36.28
T_6	1.34	1.33	7.53	6.93	40.23	36.73
LSD (0.05) nutrient	**0.06**		**0.86**		**5.42**	
LSD (0.05) spacing	**NS**		**NS**		**NS**	

Table 2: Regression equations relating SOCS with soil fertility, mulberry growth and yield attributes

Regression analysis	Regression equation	Correlation coefficient (r)
Soil available-N (y) and SOCS (x)	$y = 160.141 + 1.653x$	0.448**
Soil available-P (y) and SOCS (x)	$y = -20.160 + 1.402x$	0.605**
Soil available-K (y) and SOCS (x)	$y = 153.736 + 4.740x$	0.654**
Plant height (y) and SOCS (x)	$y = 54.128 + 1.022x$	0.351*
Number of leaves plant^{-1} (y) and SOCS (x)	$y = 146.010 + 1.692x$	NS
Leaf area (y) and SOCS (x)	$y = 0.493 + 0.010x$	0.381*
Leaf yield (y) and SOCS (x)	$y = -4.556 + 0.753x$	0.525**
Shoot yield (y) and SOCS (x)	$y = -4.408 + 0.541x$	0.493**

Impact of SOCS on soil fertility and mulberry productivity

The effect of SOCS on soil fertility as well as growth and yield attributes of mulberry has been furnished in table-2 in terms of regression equations. Except number of mulberry leave plant^{-1}, all other attributes are significantly and positively correlated with SOCS. The treatments comprising combinations of organic, inorganic as well as biological sources of nutrient inputs have not only improved BD and enhanced SOCS but also, in turn, improved soil fertility and promoted the performance of mulberry in terms of growth as well as yield attributes.

The supplementary and complementary use of organic manures, inorganic fertilizers and bio-fertilizers has augmented the efficiency of the applied substances to maintain high level of soil fertility under organic ambience (Thakuria *et al.*, 1991), which in turn, may have ensured better nutrients mobilization into mulberry plant resulting improvement of mulberry growth and productivity. Similar reports are also quite available in agricultural crops (Hati *et al.*, 2008; Swarup and Singh, 2009) relating SOCS and productivity of crops.

Thus, it can be concluded from the present study that LTFE in mulberry (*M. alba* L.) variety S_{1635} comprising of different combinations of nutrients' resources is capable of sustaining SOCS and the same, in turn, can exert positive influence on soil fertility as well as mulberry growth and productivity.

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