



ISSN Print: 2664-844X
ISSN Online: 2664-8458
NAAS Rating (2026): 4.97
IJAFS 2026; 8(3): 304-308
www.agriculturaljournals.com
Received: 04-01-2026
Accepted: 06-02-2026

VB Thorat

M. Sc. Scholar, Horticulture
Section, Government College of
Agriculture, Dhule, MPKV,
Rahuri, Maharashtra, India

RV Patil

Officer Incharge, Onion and
Grapes Research Station,
Pimpalgaon Baswant MPKV,
Rahuri, Maharashtra, India

SD Patil

Professor of Horticulture,
Government College of
Agriculture, Dhule, MPKV,
Rahuri, Maharashtra, India

AA Patil

Subject Matter Specialist Soil
Science Krishi Vigyan Kendra,
Dhule, MPKV, Rahuri,
Maharashtra, India

DR Nandre

Senior Scientist, Krishi Vigyan
Kendra, Dhule, MPKV,
Rahuri, Maharashtra, India

DB Ahire

Assistant Professor of
Horticulture, Government
College of Agriculture,
Nandurbar, MPKV, Rahuri,
Maharashtra, India

Corresponding Author:

VB Thorat

M. Sc. Scholar, Horticulture
Section, Government College of
Agriculture, Dhule, MPKV,
Rahuri, Maharashtra, India

Effect of carbon stock on growth, yield and quality of mango, aonla and custard apple fruit crops

VB Thorat, RV Patil, SD Patil, AA Patil, DR Nandre and DB Ahire

DOI: <https://www.doi.org/10.33545/2664844X.2026.v8.i3d.1264>

Abstract

An experiment was carried out at Horticulture farm, College of Agriculture, Dhule to evaluate the “Effect of Carbon stock on Growth, Yield and Quality of Mango, Aonla and Custard Apple fruit crop” from June, 2024 to November, 2024 under Randomized Block Design (RBD) with ten treatments and four replications.

The results revealed that the growth parameters of mango, aonla and custard apple fruit crops, namely plant height, diameter at breast height, volume of tree, above ground biomass, below ground biomass and total plant biomass, were significantly influenced by carbon stock stored by these fruit crops in the following years of plantation. The highest values for these traits were recorded under T₂ [Mango plant 2], T₆ [Aonla plant 1] and T₉ [custard apple 1].

Similarly, yield attributes such as number of fruits plant⁻¹, average weight of fruit, yield kg ha⁻¹, and yield t ha⁻¹ were maximized under T₂, T₆ and T₉. For quality parameters such as total soluble solid (T.S.S.) and total sugar were found highest in order T₉ > T₂ > T₆.

Keywords: Carbon stock, growth, yield, quality, biomass

Introduction

Soil carbon stock refers to the total amount of carbon stored in various pools, including above-ground biomass, below-ground biomass, plant litter, deadwood and soil organic carbon (SOC). The key factors controlling SOC levels are climate, hydrology, parent material, soil fertility, biological activity, vegetation patterns and land use

(Jenny and Raychaudhuri, 1967) [8]. In tropical and subtropical Indian soils, high temperatures and low rainfall often lead to rapid SOC decomposition, resulting in low SOC concentrations. In contrast, humid climates with high rainfall and lush vegetation tend to maintain higher SOC levels. Notably, soil is the largest carbon pool, holding approximately 1500 Pg C, which is roughly twice the amount in the atmosphere and three times the amount in terrestrial vegetation. Land use changes can lead to significant carbon transfers from terrestrial ecosystems to the atmosphere, with 1-2 Pg C yr⁻¹ attributed to SOC decomposition. The Food and Agriculture Organization (FAO) recommends “perennialization” of agricultural lands as a strategy to mitigate climate change, enhance food security and promote ecosystem services. However, degradation of soil physical quality is a common issue in agro-systems, particularly in open field cropping systems. Notably, India is the second-largest fruit producer globally, accounting for 13% of the world's total fruit production. Despite this, perennial fruit crops occupy only about 1% of the global agricultural land area. In India, the fruit industry spans 6.82 million hectares, producing 80.96 million tons of fruit. Fruit tree ecosystems have significant potential for carbon sequestration, with the ability to remove 240-1250 g C m⁻² year⁻¹, according to Montanaro *et al.* (2010) [10]. A well-maintained fruit orchard can sequester 20-25 Mg C ha⁻¹ in above and belowground biomass over 15-20 years.

Horticulture plays a vital role in ensuring global food security, improving farmer livelihoods and mitigating climate change, making it a crucial sector for sustainable development. However, the impact of different fruit orchards on soil aggregation, aggregate-associated carbon and soil carbon stock is often overlooked, particularly in the context of soil organic carbon (SOC) dynamics. This knowledge gap is especially pronounced in fruit-based land use systems in India, where the effects of various fruit orchards on soil carbon sequestration and dynamics remain poorly understood.

Materials and Methods

The experiment carried out at Horticulture farm, College of Agriculture, Dhule on Effect of Carbon stock on Growth yield and quality of mango, Aonla and Custard Apple during the year of 2024 - 2025. Healthy trees of uniform growth and vigour was selected for the experiment. The present research programme was laid out in Randomized Block Design (RBD) consisting ten treatments replicated four times two plants were selected under each treatment. The treatment consists of (T₁) mango plant 1, (T₂) mango plant 2, (T₃) mango plant 3, (T₄) aonla plant 1, (T₅) aonla plant 2, (T₆) aonla plant 3, (T₇) custard apple plant 1, (T₈) custard apple plant 2, (T₉) custard apple plant 3 and (T₁₀) Control (land with no vegetation).

Total 75 soil samples were collected from all the various location throughout the experimental area with depth i.e. 0-30 cm, 30-60 cm and 60-90 cm. Then the samples were dried under shade to remove the moisture content and crushed with the help of wooden mortar and pestle. After that the soil was sieved through 2 mm sieve to obtain a uniform sample. Total carbon content of soils is determined by Nelson and Somner method (1982) [3]. The height and diameter at breast height (DBH) are two main biophysical measurements which measured for each tree sample. The mango, aonla and custard apple tree heights were measured by using measuring tape and bamboo stick. The tree diameter was measured at breast height (DBH) by using measuring tape (at 1.3 meters height from ground).

Growth parameters

Estimation of above and below ground biomass

The above ground biomass (AGB) has been calculated by multiplying volume of tree and wood density (Ravindranath and Ostwald, 2008). The volume was calculated based on diameter and height.

$$\text{AGB (kg)} = \text{Volume of tree (m}^3\text{)} \times \text{wood density (kg m}^{-3}\text{)}$$

The below ground biomass (BGB) has been calculated by multiplying above ground biomass taking 0.26 as the root to shoot ratio (Ravindranath and Ostwald, 1997) [2].

$$\text{BGB (kg)} = \text{AGB (kg)} \times 0.26$$

Volume of tree was estimated by using diameter at breast height (DBH) of tree and computed as per the standard formula (Ravindranath and Ostwald, 1997) [2].

$$\text{Volume of tree (V) (m}^3\text{)} = \pi \times r^2 \times H$$

$$\text{Titrateable acidity (\%)} = \frac{\text{Burette reading} \times \text{Normality of NaOH} \times \text{Volume made} \times \text{Eq.wt of acid}}{\text{Weight of sample} \times \text{aliquot of sample} \times 1000} \times 100$$

Total soluble solids (⁰BSSrix)

The Total Soluble Solids content of the pulp was measured by using Erma Hand Refractometer (0-32 ⁰Brix) and expressed in ⁰Brix (Ranganna, 1986) [1].

Total sugar (%)

The total sugars were estimated by Fehling's reagent as per the method of suggested by Ranganna (1986) [1].

The total sugar content was expressed as percentage in terms of inverts sugars according to the formula.

Where,

V = volume of tree in cubic centimetres or cubic metre

r = radius of the tree 1.3 m above ground = DBH / 2

H = height of the tree in centimetres or metres.

Total plant biomass is the sum of the above and below ground biomass (Chavan and Rasal 2011) [4].

$$\text{TPB} = \text{AGB} + \text{BGB} \text{ (All values are in kilogram)}$$

Generally, for any plant species 50% of its biomass is considered as carbon (Chavan and Rasal 2011) [4].

$$\text{Plant Carbon} = \text{total plant biomass} \times 50\% \text{ or } \text{Biomass} / 2$$

Soil organic carbon stock

Soil organic carbon stock at two depths i.e. 0-30, 30-60 and 60-90 cm were estimated by using following standard formula (Jasmine, Wagner and Abbott 2021).

$$\text{SOC Stock} = \text{TOC} \times \text{BD} \times \text{D}$$

Where,

TOC = Total organic carbon

BD = Bulk density of soil

D = Depth of soil layer

Total Organic Carbon (TOC)

Total carbon content of soils is determined by dry combustion at high temperatures in a furnace with the collection and detection of evolved CO₂ (Nelson and Sommer, 1982) [3].

Yield and quality attributing parameters

Yield kg per plant (Kg)

Yield was recorded after weighing fully mature fruits at each harvest, it was totalled and expressed in kilograms per plant.

Yield per hectare (t/ha)

The total weight of fruits was taken at each harvesting for each observational plant. The total harvesting from each plant was done to get total weight of fruit harvested during the season in kilogram per tree and it was converted to tones

Titrateable Acidity (%)

The titrateable acidity was estimated by the method suggested by Ranganna (1986) [1]. The acidity was expressed in terms of percentage.

$$\text{Total sugar (\%)} = \frac{100 \times 250 \times 0.05 \times \text{volume made}}{\text{Burette reading} \times \text{weight of sample} \times 50}$$

Reducing sugar (%)

The reducing sugars were determined by using Fehling's reagent as per the method of suggested by Ranganna (1986) [1]. Reducing sugars were worked out as per the formula given below.

$$\text{Reducing sugar (\%)} = \frac{100 \times 0.05 \times \text{volume made}}{\text{Burette reading} \times \text{weight of sample taken}}$$

Non-reducing sugars (%)

The non-reducing sugars were estimated by using following formula.

$$\text{Non-Reducing Sugar} = (\text{Total sugar} - \text{Reducing sugar}) \times 0.95$$

Results and Discussion

Growth parameters

Table 1. Shows the impact of mango, aonla and custard apple trees on total plant biomass and plant carbon.

Table 1: Effect of Carbon stock on growth of Mango, Aonla and Custard apple fruit crops.

Treatments	Tree height (cm)		Diameter at breast height (in cm.)	Volume of tree (cm ³)	Above ground biomass (kg tree ⁻¹)	Below ground biomass (kg tree ⁻¹)	Total plant biomass (kg tree ⁻¹)	Plant Carbon (kg tree ⁻¹)
Mango	T ₁	519	87.79	3139982	2135	555.1	2690.3	1345.2
	T ₂	585	88.15	3568372	2426	630.9	3057.4	1528.7
	T ₃	515	82.91	2779014	1890	491.3	2381.1	1190.5
Aonla	T ₄	562	63.88	18411905	1474	383.1	1856.6	928.3
	T ₅	575	66.78	1967428	1574	409.2	1963.2	991.6
	T ₆	616	70.9	2430764	1945	505.6	2450.2	1225.1
Custard Apple	T ₇	396	27.68	240591	120	31.3	151.6	75.8
	T ₈	404	27.82	242987	121	31.6	153.1	76.5
	T ₉	421	27.92	257622	129	33.5	162.3	81.2
SE m (±)	9.58		1.28	6.71	1.07	1.15	2.47	1.30
CD at 5%	28.74		3.84	20.13	3.21	3.45	7.41	3.91

Growth Parameters

Tree height, diameter at breast height (DBH), and volume of the tree showed significant differences among the treatments. Mango trees (T₁-T₃) exhibited higher tree heights (515-585 cm) and DBH (82.91-88.15 cm) compared to Aonla (T₄-T₆) and Custard Apple (T₇-T₉) trees. Aonla trees (T₄-T₆) had higher tree volumes (18411905-2430764 cm³) compared to Mango and Custard Apple trees.

Biomass Production

Above-ground biomass, below-ground biomass, and total plant biomass showed significant differences among the treatments. Mango trees (T₁-T₃) had higher above-ground biomass (1890-2426 kg tree⁻¹) and total plant biomass (2381.1-3057.4 kg tree⁻¹) compared to Aonla and Custard Apple trees. Aonla trees (T₄-T₆) had higher below-ground biomass (383.1-505.6 kg tree⁻¹) compared to Custard Apple trees.

Carbon Sequestration

Plant carbon content showed significant differences among the treatments. Mango trees (T₁-T₃) had higher plant carbon content (1190.5-1528.7 kg tree⁻¹) compared to Aonla and Custard Apple trees. These findings have implications for optimizing horticultural practices, such as pruning, irrigation, and fertilization, to enhance the productivity and

sustainability of these fruit tree species (Nath *et al.*, 2008) [6].

Yield contributing characters

The study evaluated the impact of different treatments on yield and fruit characteristics of Mango, Aonla, and Custard Apple trees. The results showed significant variations among the treatments, with Aonla trees (T₄-T₆) exhibiting exceptionally high yields, ranging from 9.4 to 14.0 t/ha. Treatment T₆ (Aonla) showed the highest yield (14.0 t/ha), attributed to the high number of fruits per plant (2236) and average fruit weight (35 g). Mango trees (T₁-T₃) and Custard Apple trees (T₇-T₉) also showed promising yields, ranging from 3.8 to 4.6 t/ha and 4.3 to 6.5 t/ha, respectively. Treatment T₂ (Mango) and Treatment T₉ (Custard Apple) exhibited superior performance in terms of yield and fruit characteristics. These findings highlight the potential of horticultural practices to enhance fruit production and contribute to carbon sequestration. Fruit tree-based systems can play a significant role in mitigating climate change by sequestering carbon in trees, soils, and other biomass (Lal, 2004; Kumar *et al.*, 2018) [7]. The carbon sequestration potential of these fruit tree species can be substantial, considering their biomass production and yield. As reported by Smith *et al.* (2020) [12], sustainable horticultural practices can help reduce greenhouse gas emissions and promote ecosystem services.

Table 2: Effect of carbon stock on Yield parameters of mango, aonla and custard apple fruit crops

Treatments		No. of Fruits per Plant	Average weight of fruit (g)	Yield (kg/ha)	Yield (t/ha)
Mango	T ₁	257	161	4126	4.1
	T ₂	276	166	4555	4.6
	T ₃	245	156	3817	3.8
Aonla	T ₄	1903	27	9427	9.4
	T ₅	2005	30	10922	10.9
	T ₆	2236	35	14002	14.0
Custard Apple	T ₇	239	202	4314	4.3
	T ₈	253	239	5574	5.6
	T ₉	301	241	6508	6.5
SE m (±)		21.84	0.14	2.34	0.03
CD at 5%		65.52	0.42	7.02	0.09

Quality contributing characters

The study evaluated the impact of different treatments on the physio-chemical characteristics of Mango, Aonla, and Custard Apple fruits. The results showed significant

variations among the treatments for Total Soluble Solids (TSS), Titratable Acidity, Reducing Sugar, Non-Reducing Sugar, and Total Reducing Sugar.

Total Soluble Solids (TSS)

The Total Soluble Solids (TSS) content varied significantly among the treatments, with Custard Apple fruits exhibiting the highest TSS values (21.87-23.48°Brix), followed by Mango (15.14-16.42°Brix) and Aonla (9.85-10.91°Brix). Treatment T₉ in Custard Apple showed the highest TSS value (23.48°Brix), indicating optimal sugar development. These results suggest that the treatments had a significant impact on the sugar content of the fruits, with implications for fruit quality and consumer preference.

Titrateable Acidity

The titrateable acidity content showed significant variations among the treatments, with Mango fruits exhibiting the highest acidity values (1.84-2.09%), followed by Aonla (1.14-1.33%) and Custard Apple (0.22-0.34%). Treatment T₃ in Mango showed the highest titrateable acidity value (2.09%), indicating a potential impact on fruit flavour and shelf life. These results highlight the importance of considering acidity levels in fruit production and processing.

Reducing Sugar

The reducing sugar content varied significantly among the treatments, with Custard Apple fruits exhibiting the highest reducing sugar values (16.94-18.80%), followed by Mango (4.69-5.04%) and Aonla (1.98-2.36%). Treatment T₉ in Custard Apple showed the highest reducing sugar value

(18.80%), indicating optimal sugar development. These results suggest that the treatments had a significant impact on the sugar profile of the fruits, with implications for fruit sweetness and flavor.

Non-Reducing Sugar

The non-reducing sugar content showed significant variations among the treatments, with Mango fruits exhibiting the highest non-reducing sugar values (8.80-9.42%), followed by Custard Apple (1.49-2.76%) and Aonla (1.19-1.97%). Treatment T₂ in Mango showed the highest non-reducing sugar value (9.42%), indicating optimal sugar development. These results highlight the importance of considering the sugar profile of fruits in production and processing.

Total Reducing Sugar

The total reducing sugar content varied significantly among the treatments, with Custard Apple fruits exhibiting the highest total reducing sugar values (18.45-21.60%), followed by Mango (13.55-14.50%) and Aonla (3.17-4.33%). Treatment T₉ in Custard Apple showed the highest total reducing sugar value (21.60%), indicating optimal sugar development. These results suggest that the treatments had a significant impact on the overall sugar content of the fruits, with implications for fruit quality and consumer preference.

Table 3: Effect of carbon stock on Quality parameters of mango, aonla and custard apple fruit crops

Treatments		TSS (°Brix)	Titrateable Acidity (%)	Reducing Sugar (%)	Non-Reducing Sugar (%)	Total Reducing Sugar (%)
Mango	T ₁	15.37	2.01	4.83	8.83	13.70
	T ₂	16.42	1.84	5.04	9.42	14.50
	T ₃	15.14	2.09	4.69	8.80	13.55
Aonla	T ₄	9.85	1.33	1.98	1.19	3.17
	T ₅	10.18	1.26	2.14	1.21	3.35
	T ₆	10.91	1.14	2.36	1.97	4.33
Custard Apple	T ₇	21.87	0.22	16.94	1.49	18.45
	T ₈	23.08	0.24	17.58	1.75	19.35
	T ₉	23.48	0.34	18.80	2.76	21.60
SE m (±)		0.32	0.03	0.15	0.32	0.27
CD at 5%		0.96	0.09	0.45	0.94	0.81

Soil organic carbon stock (SOC) and Total organic carbon (TOC)

Table 4. Shows the impact of mango, aonla and custard apple trees on SOC Stock and TOC.

In mango orchard treatment T₂ was observed with significantly superior SOC Stock content i.e. 33.86 Mg ha⁻¹ at depth 0-30 cm and goes on decreasing as the depth increases as 31.52 Mg ha⁻¹ (30-60 cm) and 23.11 Mg ha⁻¹ (60-90 cm) respectively as compared to treatment T₁₀ i.e. control was observed 19.46 Mg ha⁻¹ at 0-30 cm depth and 19.34 Mg ha⁻¹ and 16.25 Mg ha⁻¹ at depth 30-60 cm and 60-90 cm respectively. The SOC Stock content in treatment T₁ (32.57 Mg ha⁻¹) and T₃ (33.21 Mg ha⁻¹) was observed.

In aonla orchard treatment T₆ was observed higher for SOC Stock content i.e. 25.31 Mg ha⁻¹ at depth 0-30 cm and goes on decreasing as the depth increases as 23.76 Mg ha⁻¹ (30-60 cm) and 17.45 Mg ha⁻¹ (60-90 cm) respectively as compared to treatment T₁₀ i.e. control was observed 19.46 Mg ha⁻¹ at 0-30 cm depth and 19.34 Mg ha⁻¹ and 16.25 Mg ha⁻¹ at depth 30-60 cm and 60-90 cm respectively. The SOC Stock content in treatment T₅ (23.94 Mg ha⁻¹) and T₄ (22.57 Mg ha⁻¹) was observed.

In custard apple orchard treatment T₉ was observed significantly higher for SOC Stock content i.e. 25.81 Mg ha⁻¹ at depth 0-30 cm and goes on decreasing as the depth increases as 23.76 Mg ha⁻¹ (30-60 cm) and 21.94 Mg ha⁻¹ (60-90 cm) respectively as compared to treatment T₁₀ i.e. control was observed 19.46 Mg ha⁻¹ at 0-30 cm depth and 19.34 Mg ha⁻¹ and 16.25 Mg ha⁻¹ at depth 30-60 cm and 60-90 cm respectively. The SOC Stock content in treatment T₈ (25.13 Mg ha⁻¹) and T₇ (24.46 Mg ha⁻¹) was observed.

Surface layer soils (0-30 cm) had greater soil organic carbon (SOC) content than subsurface soil (30-60 cm) and (60-90 cm) in mango orchard soil which indicated a declining trend as depth increased due to low nutrients and biological activity in lower layer, as compared to greater organic matter at surface layer soils (Bhat *et al.* 2017) [13].

The data pertaining on soil total organic carbon (TOC) in mango, aonla and custard apple orchards soil which are presented in Table 4.

In mango orchard treatment T₂ was observed higher TOC content i.e. 1.82% at depth 0-30 cm and goes on decreasing as the depth increases as 1.07% (30-60 cm) and 0.76% (60-90 cm) respectively as compared to treatment T₁₀ i.e. control was observed 0.60% at 0-30 cm depth and 0.35% and 0.43%

at depth 30-60 cm and 60-90 cm respectively. The TOC content in treatment T₁ (1.36%) and T₃ (0.87%) was observed.

In aonla orchard treatment T₆ was observed significantly superior for TOC content i.e. 1.42% at depth 0-30 cm and goes on decreasing as the depth increases as 1.16% (30-60 cm) and 0.76% (60-90 cm) respectively as compared to treatment T₁₀ i.e. control was observed 0.60% at 0-30 cm depth and 0.35% and 0.43% at depth 30-60 cm and 60-90 cm respectively. The TOC content in treatment T₅ (1.31%) and T₄ (1.06%) was observed.

In custard apple orchard treatment T₉ was observed significantly higher for TOC content i.e. 1.39% at depth 0-30 cm and goes on decreasing as the depth increases as 1.15% (30-60 cm) and 0.68% (60-90 cm) respectively as compared to treatment T₁₀ i.e. control was observed 0.60% at 0-30 cm depth and 0.35% and 0.43% at depth 30-60 cm and 60-90 cm respectively. The TOC content in treatment T₈ (1.33%) and T₇ (1.25%) was observed.

The total organic carbon content exhibited a declining trend with soil depth, with higher concentrations in the surface soil layer attributed to the substantial addition of organic matter from tree root and leaf litter, which gradually decreased with increasing depth was observed by Ingram and Fernandes (2001) ^[14].

Table 4: Effect of SOC Stock and TOC on mango, aonla and custard apple fruit crops.

Treatments		Soil SOC STOCK (Mg/ ha)			Soil TOC (%)		
		0-30 cm	30-60 cm	60-90 cm	0-30 cm	30-60 cm	60-90 cm
Mango	T ₁	33.21	30.21	22.48	1.36	0.95	0.73
	T ₂	33.86	31.52	23.11	1.82	1.07	0.76
	T ₃	32.57	28.91	21.85	0.87	0.63	0.71
Aonla	T ₄	22.57	22.78	16.59	1.06	0.52	0.71
	T ₅	23.94	23.27	17.02	1.31	1.10	0.74
	T ₆	25.31	23.76	17.45	1.42	1.16	0.76
Custard Apple	T ₇	24.46	22.78	20.68	1.25	0.71	0.64
	T ₈	25.13	23.27	21.31	1.33	1.11	0.65
	T ₉	25.81	23.76	21.94	1.39	1.15	0.68
Control	T ₁₀	19.46	19.34	16.25	0.60	0.35	0.43
SE m(±)		1.34	0.96	0.54	0.21	0.18	0.03
CD at 5%		4.02	2.89	1.62	0.63	0.54	0.09

Conclusion

On the basis of finding of present investigation, on above basis it could be concluded that, the effect of carbon stock on growth, yield and quality of mango, aonla and custard apple fruit crops were found to be promising. The carbon stock observed in this study was found to be significantly higher in mango orchard soil because of the annual litter fall which helped in balancing the pH of soil enhancing the microbial activity and thus leading to increased nutrient content of soil. Among all the treatments taken treatment T₂ (Mango), T₆ (Aonla) and T₉ (Custard apple) has shown highest performance in terms of growth, yield and quality parameters. Thus the results of this study concludes that the carbon sequestered from the perennial fruit crops such as Mango, Aonla and Custard apple orchard is significantly higher than the control part i.e. soil without vegetation adjacent to fruit orchard in the order Mango > Aonla > Custard apple. This indicates the potential of horticultural crops both in securing rural livelihood as well as mitigating climate change.

References

1. Ranganna S. Handbook of analysis and quality control for fruit and vegetable products. Tata McGraw-Hill Education; 1986.

2. Ravindranath NH, Somashekhar BS, Gadgil M. Carbon flow in Indian forests and climate change. In: Kluwer Academic Publishers; 1997. p. 279-320.
3. Nelson DW, Sommer LE. Total carbon, organic carbon and organic matter. In: Page AL, editor. Methods of analysis: part II. Agronomy. Madison (WI): American Society Agronomy; 1982. p. 539-579.
4. Chavan BL, Rasal GB. Potentiality of carbon sequestration in six years ages young plant from university campus of Aurangabad. Glob J Res Eng. 2011;11(7):15-20.
5. Jasmine E, Black T, Wagner GD, Abbott G. Assessing lignin decomposition and soil organic carbon contents across a tropical savannah-rainforest boundary in Guyana. Front For Glob Change. 2021;4:600-629.
6. Nath AJ, Das AK. Carbon storage and sequestration in bamboo-based small holder home gardens. Curr Sci. 2008;100(2):22-27.
7. Kumar GP, Yadav SK, Thawale PR, Singh SK, Juwarkar AA. Growth of *Jatropha curcas* on heavy metal contaminated soil amended with industrial wastes and *Azotobacter* - a greenhouse study. Bioresource Technol. 2008;99(7):2078-2082.
8. Jenny H, Raychaudhuri SP. Effect of climate and cultivation on nitrogen and organic matter reserves in Indian soils. 1967. p. 15-35.
9. Food and Agriculture Organization of the United Nations. Perennial agriculture: Landscape resilience for the future [Policy brief]. 2013. Available from: <https://www.fao.org/fileadmin/templates/agphome/documents/scpi/PerennialPolicyBrief.pdf>
10. Montanaro G, Dichio B, Xiloyannis C, Celano G. Carbon budgets of Mediterranean fruit ecosystems. Acta Hort. 2010;868:41-46. DOI:10.17660/ActaHortic.2010.868.5.
11. Kumar P, Murugan P, Murkute A, Bala Singh S. A carbon sequestration strategy involving temperate fruit crops in the trans-Himalayan region. J Hortic Sci Biotechnol. 2018;85(5):405-409.
12. Smith P, Adams J, Beerling DJ, Beringer T, Calvin KV, Fuss S, et al. Land-management options for greenhouse gas removal and their impacts on ecosystem services and the sustainable development goals. Annu Rev Environ Resour. 2020;44(1):255-286.
13. Bhat ZA, Akhtar FA, Padder SA, Ganale AQ, Rehman HU, Dar NA, Gill RK. Nutrient status of grape orchard soils of Jammu and Kashmir, India. MOJ Ecol Environ Sci. 2017;2(5):12-19.
14. Ingram JSI, Fernandes ECM. Managing carbon sequestration in soils: concepts and terminology. Agric Ecosyst Environ. 2001;87(1):111-117.