



Appraisal of Carbon Capture, Storage, and Utilization Through Fruit Crops

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OPEN ACCESS

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Specialty section:

This article was submitted to
Interdisciplinary Climate Studies,
a section of the journal
Frontiers in Environmental Science

Received: 26 April 2021

Accepted: 25 June 2021

Published: 29 July 2021

Citation:

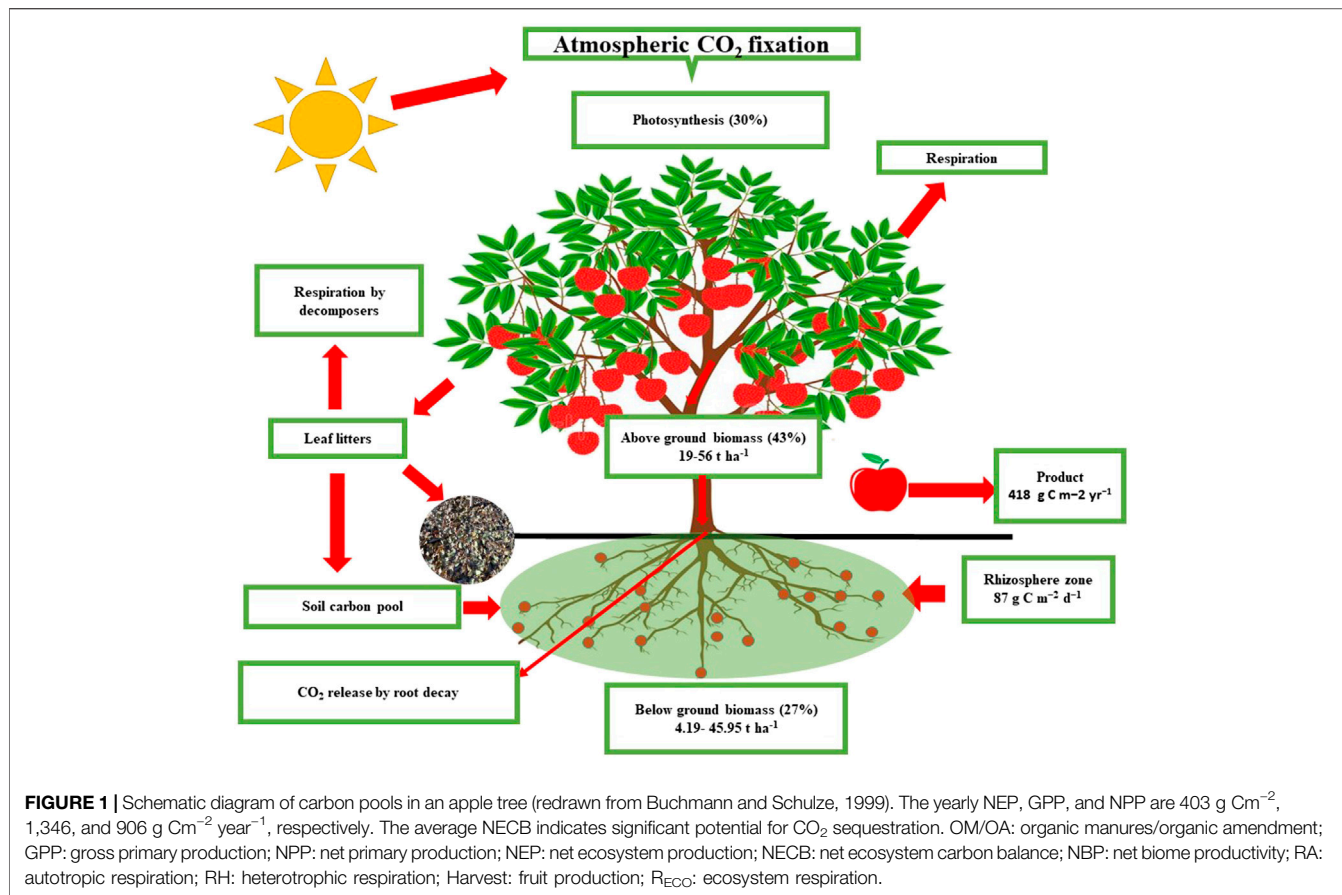
Sharma S, Rana VS, Prasad H, Lakra J
and Sharma U (2021) Appraisal of
Carbon Capture, Storage, and
Utilization Through Fruit Crops.
Front. Environ. Sci. 9:700768.
doi: 10.3389/fenvs.2021.700768

Nowadays, rapid increases in anthropogenic activities have resulted in increased greenhouse gases (GHGs; CO₂, CH₄, N₂O) release in the atmosphere, resulting in increased global mean temperature, aberrant precipitation patterns, and several other climate changes that affect ecological and human lives on this planet. This article reviews the adaptation and mitigation of climate change by assessing carbon capture, storage, and utilization by fruit crops. Perennial plants in forests, fruit orchards, and grasslands are efficient sinks of atmospheric carbon, whereas field crops are a great source of GHG due to soil disturbance, emission of CH₄ and/or N₂O from burning straw, and field management involving direct (fuel) or indirect (chemicals) emissions from fossil fuels. Thus, there is a need to establish sustainable agricultural systems that can minimize emissions and are capable of sequestering carbon within the atmosphere. Fruit orchards and vineyards have great structural characteristics, such as long life cycle; permanent organs such as trunk, branches, and roots; null soil tillage (preserving soil organic matter); high quality and yield, which allow them to accumulate a significant amount of carbon. Hence, the fruit plants have significant potential to sequester carbon in the atmosphere. However, the efficiency of carbon sequestration by different fruit crops and their management systems may vary due to their growth and development patterns, physiological behavior, biomass accumulation, and environmental factors.

Keywords: carbon emission, climate changes, fruit trees, production, storage

INTRODUCTION

The worldwide population is expected to be around 9.1 billion by 2050, which would be 34% higher than the existing population (UN, 2019). This will enhance the food demand to match the needs of the rising population. Horticultural commodities, in general, and fruits, in particular, have been designated as the sources of nutraceuticals (Sharma et al., 2021). The global mean surface temperature increment of pre-industrial values has reached up to 0.87 ± 0.10°C during the 2006–2015 decade (Hoegh-Guldberg et al., 2018). According to the Fifth Assessment Report (AR₅) of the Intergovernmental Panel on Climate Change (IPCC), 2013–2014, the mean global temperature of the land and the ocean showed a warming of 0.85°C, i.e., range b/w 0.65–1.06°C during 1880–2012 (Wolf et al., 2017). The main reason behind this increase is anthropogenic interference (Hartmann et al., 2013; Stocker et al., 2013). An IPCC Special Report has confirmed that the rise in the mean temperature globally affected peoples, different ecosystems, and livelihoods worldwide. Moreover, climate change might obstruct progress toward a world without hunger for all people. A robust change in global pattern is noticeable in the effects of the inclination of temperature



on sustainable crop production. Due to climate change, the steadiness of food systems might be at risk because of the short-term variability in the supply chain (Wheeler and Von Braun, 2013). However, the prospective consequences are less clear at provincial scales, but climate change will directly impact food security in areas that are susceptible to hunger and malnutrition (IPCC, 2018). Similarly, it indirectly influences the household and individual earning and causes loss of access to drinking water and damage to health. The emissions of greenhouse gas (GHG) is inclining globally day by day, but many practices are available to maintain the emission of these gases, the most prevalent one being the cultivation and conservation of trees like fruit orchards or agroforestry (Boonen, 2015; Kumar and Sharma, 2015; Kumar et al., 2020; Sarkar et al., 2021; Thakur et al., 2021). This practice might be a vital solution to reduce the emission of harmful gases and has many positive effects on the environment, also known as “climate-smart cultivation” (Brown et al., 1995; Canadell and Raupach, 2008; Nair et al., 2010; Shaffer, 2010; Zanotelli et al., 2013; Chakrabarti, 2017). Fruit cultivation is considered a potential tool of good agricultural practices that might be reduced by the impact of climate change (Rana and Rana, 2003; Jhalegar et al., 2012). Hence, the combination of trees, usually in different systems, increases productivity, improves the nutrient cycle, and helps maintain the ecological balance because of the “biological carbon sequestration potential” (Ospina, 2017;

Rana et al. 2020; Kumar et al. 2021; Rai et al., 2021; Sheikh et al., 2021; Tamang et al., 2021). Given the above-mentioned fact, this review article showed the complete effect of fruit crops on carbon sequestration, that is, the process by which carbon source is taken from the atmosphere and stored in another place. The present article mainly focuses on assessing the above-ground biomass (AGB) and below-ground biomass (BGB) of fruit orchards and their corresponding carbon stocks so that net contributors of GHG to the atmosphere could be estimated. Besides, mitigation measures are also suggested to reduce the C-stock and GHG emissions from fruit orchards in the future under CO_2 enrichment and global warming.

RELATIONSHIP BETWEEN FRUITS TREE AND CARBON SEQUESTRATION

Carbon sequestration in terrestrial ecosystems is the process of net exclusion of carbon sources like CO_2 from the environment or reducing its emissions from terrestrial ecosystems and storing them into another form in a productive manner (IPCC, 2018). The process of removal of carbon through photosynthesis process in green plant (vegetation) in which inclined CO_2 uptake from atmosphere takes place and CO_2 is stored in different photosynthetic or non-photosynthetic parts such as trunks, branches, leaves, and roots of the plants (IPCC, 2018). Carbon

sequestration of soil induction of the possible amount of organic carbon (OC) into the soil also reduced the amount of atmospheric C (De Moraes Sá and Lal, 2009). CO₂ gas is a chief source of the atmospheric greenhouse effect depiction (**Figure 1**). From 1951, the rapid changes in the level of CO₂ took place, hence influencing global climate changes. According to NASA, the concentration of CO₂ globally was 416.14 ppm up to March 2021 (NOAA, 2021). However, many other gases such as methane (CH₄), water vapor (H₂O), ozone (O₃), and nitrous oxide (N₂O) also play a vital role in climate change because of their higher global warming potential compared to the CO₂ (Barbera et al., 2018). Land management practices are one of the important factors affecting carbon sequestration (Lal, 2018). The alteration in the global carbon balance occurs through anthropogenic activities such as burning of fuel, production of cement (67%), and agriculture and land use changes (33%) (Friedlingstein et al., 2020). Perennial crops, such as citrus, apple (orchards), kiwifruit, and grapes (vineyards), are significantly important for converting more atmospheric carbon compared to annual crops like flowers and field crops (Robertson et al., 2000; Xiao et al., 2003; Kalcsits et al., 2020).

In general, crops have some structural characteristics that allow them to capture more carbon sources because of their life cycle and large photosynthetic activity (Bationo et al., 2007; Xu et al., 2019). In addition, fruit growers not only depend on the quantity they produce but also on quality to enhance income (grape berry color and shape). Some fruit crops show less potential in terms of yield because of less distribution of carbon to the fruits than that of high-yielding crops (Kumari et al., 2020). Hence, the net primary production (NPP) is prevalent in the accumulation C cycle or distributed into the permanent structures of the tree. NPP is the distinction between total photosynthesis and respiration in flora and fauna and is assessed through estimating the quantity of the new organic matter (OM) formed, i.e., in living plants under a specific time given time (Clark et al., 2001; Levesque et al., 2019). There is limited literature available on the potential of fruit crops to sequestering carbon and environmental service. However, fruit orchards greatly influence sustainable development under changing climate scenarios (FAO, 2010). However, the benefit to the fruit growers is restricted or limited as compared to forest and plantation crops (Xiao et al., 2003; Liu et al., 2018), but with the emergence of Kyoto protocol fruit, orchardists can derive their remuneration via carbon trading and gaining creditability (Page et al., 2011).

Fruits farming is a sustainable system of production where solar energy can be utilized at different levels, soil resources can be used efficiently and cropping intensity can also be altered (Nimbolkar et al., 2016). The system consists of three main components: main crop, filler crop, and intercrops, which occupy three different tiers in the production system (Nimbolkar et al., 2016). Orchards are recognized for carbon storage because they can capture a large quantity of C in their vegetative organs for a longer period of time (Nardino et al., 2013). Like orchards, soil is the primary terrestrial carbon sink globally (Hammad et al., 2020). However, its sequestering potential depends on several factors, such as climate, type of

soil, crop and vegetation, and management practices (Meena et al., 2020). The carbon stored in soil organic matter (SOM) is affected by the addition of dead plant materials and loss of carbon through respiration, the microbial status process, and soil disturbance (natural and human disturbance) (Koné and Yao, 2021). The carbon capture process can be done by different plant organs: trunks, branches, leaves, flowers, fruits, and roots (Henry et al., 2020). There are various fruit trees, namely, avocado, banana, citrus, mangosteen, and mango, which significantly increase the rate of photosynthesis, thereby increasing the tree biomass. By applying CO₂ at 800 ppm for one year, Schaffer (2009) has ameliorated the photosynthesis rate by 40–60% compared to ambient CO₂ concentration in mangosteen. The heavy bearing ability of fruit trees has a great tendency to increase carbon capturing from the atmosphere and store it in the form of cellulose (Patil and Kumar, 2017; Zade et al., 2020). Fruit orchards can significantly contribute to sustainable fruit production under changing climate scenarios in tropical and sub-tropical areas (FAO, 2010; Nath et al., 2019).

CARBON SEQUESTERING IN TREES AND SOILS

Fruit orchards might play an important role in climate change via the sequestration of carbon, biological growth (increasing biomass), and deforestation (increasing carbon emissions) (Hammad et al., 2020; Khan et al., 2021). The process of photosynthesis is that a tree can capture the little amount of carbon stored in the form of carbohydrates and return some of the amount to the atmosphere through the respiration (**Figure 1**) process (Nunes et al., 2020). Carbon is stored not only in tree biomass but also in soils (Sedjo and Sohngen, 2012). Therefore, carbon present in the plant tissue is either consumed by humans (fruits) or added to the soil in the form of litter when the plant dies and decomposes (Patil and Kumar, 2017). Carbon is stored in the soil in the form of soil organic matter (SOM) (Cotrufo et al., 2019). It is a combination of carbon compounds formed after the decomposition of plant and animal tissues (Khattoon et al., 2017). These materials can be developed with the help of soil biotas such as protozoa, nematodes, fungi, and bacteria and then are associated with soil minerals (Zhang et al., 2021). Thereafter, carbon can remain stored in soils for a long time or can rapidly return back to the atmosphere *via* the respiration process by soil microbes (Sharma et al., 2018; Zhang et al., 2021). Various factors like climatic conditions, natural vegetation, soil physicochemical properties, drainage, and human land use affect the amount of carbon and the length of time carbon is stored in soil (Wiesmeier et al., 2019).

FACTOR AFFECTING CARBON SEQUESTRATION IN FRUIT CROPS

Numerous factors influence the carbon sequestration in fruit crops. Out of these factors, latitude, water availability, plant age and species, nutrients, temperature, and atmospheric gases highly influence the carbon sequestration rate.

Solar Radiation

Solar radiation is one of the important factors by which the photosynthesis process is directed (Pawar and Rana, 2019). The photosynthesis process depends on light duration intensity and the duration (Hüve et al., 2019) and further regulates the metabolic process of carbon in fruit trees. The rapid increase in carbon sequestration rate was found to increase significantly with incoming solar radiation (Gough et al., 2012; Rao et al., 2021). Moreover, the intensity of light increases or decreases the pattern of the carbon storage (Shaver et al., 1992).

Water Availability

Like light, water availability to the plants is also part of the photosynthesis process (Pawar and Rana, 2019). The availability of water affects NPP because the moisture content helps increase leaf area index (LAI) (Li et al., 2020). The density of foliage is directly proportional to the productivity of the tree because of the more capturing tendency for carbohydrates molecules (DeMattos et al., 2020). However, water scarcity will cause wilting of plants due to reduced photosynthetic activity, falling C uptake, and less carbon capture (Gower, 2001).

Nutrients Requirement

Nutrients are a vital component for several internal biological processes because crops species cannot complete their life cycle events in the absence of this element (Jones, 1997). There are 17 essential nutrient elements required for the tree species and the role of each nutrient element is specific to a specific plant species (Das and Avasthe, 2018). The tree foliage consist of variable numbers and amounts of nutrients (Gough et al., 2012). Trees species are able to proliferate themselves with an optimum supply of nutrients; therefore, a greater amount of carbon is sequestered (Pawar and Rana, 2019; Sharma et al., 2021).

Temperature

Temperature is an important ecophysiological factor that affects the ratio of plant growth and development (Restrepo-Díaz et al., 2010). The metabolic activities are also influenced by the rate of temperature. If the rate of temperature increases, then metabolic activities (photosynthesis and respiration) also increase significantly up to optimum temperature and then decline rapidly (Pawar and Rana, 2019). For this reason, temperate fruit crops capture the least amount of carbon in the winter because the canopy is leafless (winter dormancy). In contrast, more carbon is captured in the summer when the temperature is increased and carbon is gained via the photosynthesis process (Gough et al., 2012).

Atmospheric Gases

The concentration of atmospheric gases (particularly CO₂ and O₃) affects the rate of carbon sequestration. The rate of atmospheric CO₂ levels affects carbon availability to the plants. Karberg et al. (2005) have revealed an increase in NPP (20%) with an increase in the rate of CO₂. Unfortunately, some harmful compositions like ground-level ozone might be increased with the increment of carbon values in the atmosphere; therefore, NPP rate has decreased (Pregitzer et al., 2008).

CARBON CAPTURE OF LONG RESIDENCE WOODY, LEAF, FRUIT, AND ROOTS

The atmospheric CO₂ is absorbed during the photosynthesis process; the carbohydrates and their accumulation follow anabolic pathways (Farquhar and Sharkey, 1982; Kumar et al., 2017). Similarly, the loss occurs through green and non-green organs *via* the process of respiration (Haslam and Treagust, 1987; Yu et al., 2018; Chen and Chen, 2019). The accumulated portion is conglomerated with organic compounds; later on, it is distributed into different plant parts, leading to the formation of new biomass, represented as the net primary production (NPP) (Clark et al., 2001). Gross primary product (GPP) and NPP are the prime phases of the carbon cycle under ecosystems where GPP is the aggregate CO₂ level adjusted by photosynthesis, i.e., signifying the ability of crops to collect carbon and energy (Badawy, 2011). C losses occur at the ecosystem level because of the respiration of heterotrophic organisms under the soil (Rh) (Wang et al., 2019). The main difference between NPP and Rh is denoted as net ecosystem production (NEP). NEP is a vital ecological factor that signals out of the photosynthesis or respiration, which is a dominant factor used in assessing the ecosystem potential (Rodda et al., 2021). Moreover, net ecosystem carbon balance (NECB), particularly in agricultural systems, increases or decreases the carbon level by cultivation over a passage of time (Antar et al., 2021), as depicted in **Figure 2**. It is also dependent on the value of carbon that comes in *via* organic amendments and moves out *via* end-products like fruits or timber (Oviedo-Ocaña et al., 2021).

Literature available on carbon fluxes under fruit crop and NPP and GPP for horticultural crops, especially fruit crops (Ceschia et al., 2010; Marín et al., 2016; Shi et al., 2017; Khalsa et al., 2020), is summarized in **Table 1**. Fruit trees (woody, leaf, fruit, and roots) represent a valuable portion of land use in various areas and have an important role in capturing net carbon dioxide sink and storing carbon compounds in the permanent woody parts of the fruit tree (Scandellari et al., 2016; Chamizo et al., 2017; Tezza et al., 2019). Moreover, the prospect of using organic manures or soil amenders may ameliorate the capability of fruit orchards systems as CO₂ sink. In horticultural systems, in terms of the addition or removal of carbon over time, for example, during cultivation (NECB), the volume of carbon entry depends on the amount of manure applied to the crop, and produce like fruits is an example of carbon removal. Furthermore, planting orchards is a valuable land use form worldwide.

Scandellari et al. (2016) have analyzed the biomass, NPP and NECB, and net carbon balance by either direct or eddy covariance methodology. They showed that above-ground NPP ranged between 10 and 20 t ha⁻¹ with direct methodology, whereas the below-ground NPP was reduced by 20 percent from the total NPP. The carbon removal through the fruit system ranged between 2 and 3 t ha⁻¹. Fruit orchard ecosystems had shown significant results on the net ecosystem productivity, ranging from 4.30 to 7.5 t C ha⁻¹ yr⁻¹ in Apple-2 and Grape-1, respectively. Moreover, NECB, ranging 0.6–5.9 t C ha⁻¹ year⁻¹, indicates potential carbon capturing through long residence woody, leaf, fruit, and roots and storage of the carbon

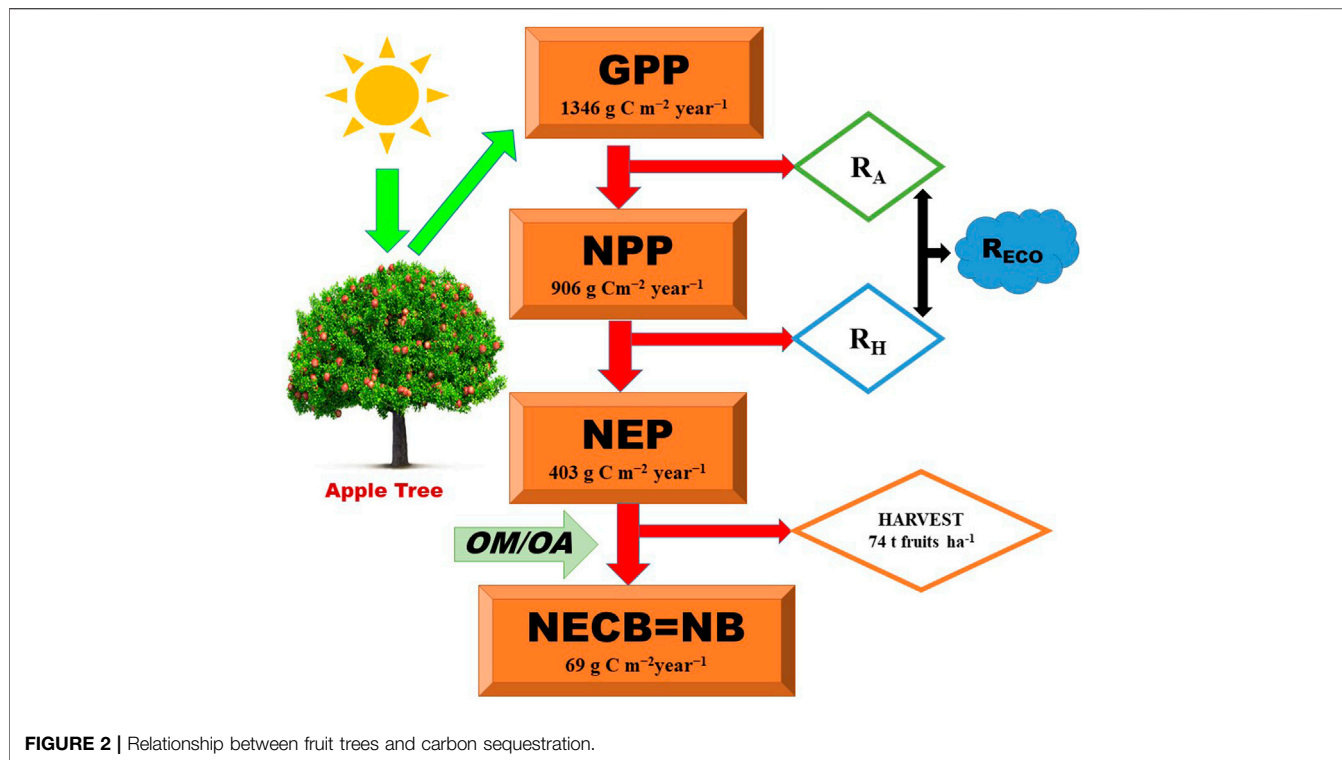


FIGURE 2 | Relationship between fruit trees and carbon sequestration.

TABLE 1 | Carbon fixation (NPP, NEP, and NECB) by different fruit tree orchards.

Tree/vine/tree ecosystem	NPP (g C ha ⁻¹ yr ⁻¹)	NEP	NECB	References
Agroforestry system and citrus	17.7			Marín et al. (2016)
Tropical palm plantation	16.1			Navarro et al. (2008)
Tropical forests	12.5			Grace 2004
Citrus trees	11.4			Quiñones et al., 2013
Kiwi fruits	8.0			Facini et al., 2007
Apple	5.2–13.3			Wu et al. (2012)
Apple "Gala"	11.81	4.30 to 7.5 t C ha ⁻¹ y ⁻¹	0.6 to 5.9 t C ha ⁻¹ y ⁻¹	Scandellari et al. (2016)
Apple "Fuji"	17.44			
Peach "Supercrimson"	9.94			
Citrus "Tarocco"	11.88			
Grape	9.96			
Cocoa	18.8			Morel et al. (2019)
Peach		11.7–17.5 t C ha ⁻¹ year ⁻¹ 3 ¹	90 g C m ⁻² yr ⁻¹ –730 g C m ⁻² yr ⁻¹	Montanaro et al. (2021)
Oil palm plantation	121.7			Melenya et al. (2015)

(Scandellari et al., 2016). Bhatnagar et al. (2016) have reported that carbon accumulation values in fruits ranged 32–41%, whereas the other structural organs like twigs, branches, and stems stored ~25% of the total carbon. Hence, Nagpur mandarin is regarded as another vital sink for carbon partitioning of around 6 kg C⁻¹ tree⁻¹yr⁻¹ (2.5 Mg C⁻¹ha⁻¹yr⁻¹). Khalsa et al. (2020) have shown that the application of nitrogen (N) supplement an orchard enhanced the capturing of more C, thus lowering the net global warming potential (GWP) in a California almond

orchard. In this intensive system, 309 kg N ha⁻¹ yr⁻¹ fertilizer N rates also increased the net primary productivity (Mg C ha⁻¹), N productivity (kg N ha⁻¹), and net nitrogen mineralization (mg N kg⁻¹ soil d⁻¹). Wu et al. (2012) have analyzed the carbon sequestration capability in apple orchards and stated that the capability of trees for carbon sequestration is enhanced when they reach 18 years of age and declines with age. The net carbon sink and C storage (biomass) in Chinese apple orchards are between 14 and 32 Tg C and 230 and 475 Tg C, respectively, from 1990 to

TABLE 2 | Effect of different fruit tree species on biomass and carbon sequestration with special reference to age and spacing.

Crop	Botanical name	Biomass kg/tree or vine	Age Year old	Spacing	Country	Carbon sequestration	References
Apple	<i>Malus domestica</i> <i>Borkh.</i>	224.08	18	3 × 5 m	China	6,871.8 C ⁻¹ m ² yr ⁻¹	Wu et al. (2012)
Litchi	<i>Litchi chinensis</i>	8.42	7	10 × 10 m	India	30.81 Mg ha ⁻¹	Kanime et al., 2013
Mango	<i>Mangifera indica</i>	27.02	15	10 × 10 m		98.90 Mg ha ⁻¹	
Chinese plum	<i>Prunus saliciana</i>	8.05	5	5 × 5 m		29.40 Mg ha ⁻¹	
Apple	<i>Malus domestica</i> <i>Borkh.</i>				India	0.01–35.00 MT ha ⁻¹	Attar et al. (2016)
Apricot	<i>Prunus americana</i>					0.04–61.22 MT ha ⁻¹	
Walnut	<i>Juglans regi</i>					0.35–62.50 MT ha ⁻¹	
Citrus	<i>Citrus reticulata</i>				India	217 g C ⁻¹ m ² yr ⁻¹	Bhatnagar et al. (2016)
Nagpur	<i>C. reticulata</i>	5.94	6		India	1.65 t ha ⁻¹	Mehta et al. (2016)
Mandarin							
Mango	<i>Mangifera indica</i>	733.025			India	73.59 t ha ⁻¹	Ganeshamurthy et al. (2019a)
Mango	<i>Mangifera indica</i>	269.07			Konkan, India	26.91 t ha ⁻¹	Ganeshamurthy et al. (2019b)
Hazelnut	<i>Corylus avellana</i>		17	5 × 5 m	Italy	58.8 Mg ha ⁻¹ year ⁻¹	Granata et al. (2020)

2010. The calculated net carbon sequestration in the apple from 1990 to 2010 was approx. 4.5% of the total net carbon sink in the terrestrial ecosystems in China. Therefore, apple production systems can be considered an important carbon sink in fruit culture (Wu et al., 2012). Similarly, many reports on carbon emission in various crops have been confirmed by other researchers globally (Piao et al., 2009; Bhatnagar et al., 2016; Marín et al., 2016; Shi et al., 2017; Khalsa et al., 2020).

Kumar et al. (2019) have used various models for estimating biomass of plants, i.e., 225 mg ha⁻¹ with biomass accumulation and carbon storage reduced by roots followed by twigs and leaves and branches. Mehta et al. (2016) have reported a similar result in fruit orchards, i.e., fixation by the fruit crop is higher than that of annual and herbaceous crops. The mean AGB and BGB was 13.21 kg tree⁻¹, where the above-ground contribution maximum share was 76% and the below-ground contribution was 24%. The maximum carbon was stored by the fruit biomass (2.10 Kg tree⁻¹), followed by roots and branches in a six-year-old citrus plant in a plantation orchard. Many reports have studied the potential of carbon sequestration in many fruit orchards, mainly perennials species, which is the key point in mitigating climate change scenario (Marín et al., 2016). Navarro et al. (2008) have assessed carbon accumulation in vegetative organs of palm trees, which was approximately 16.1 Mg C⁻¹ ha⁻¹ yr⁻¹. Likewise, Janiola and Marin (2016) have suggested that tropical fruit trees, like mango, are more capable of accumulating more carbon in fifteen-year-old orchards, i.e., 45 Mg C⁻¹ ha⁻¹ yr⁻¹. Similarly, the carbon (1750 g C⁻¹ m² yr⁻¹) accumulation rates were found in citrus Pernice et al. (2006). Further, Rossi et al. (2007) have assayed the carbon storage (1,160 g C m⁻²) in kiwifruit cv. Hayward within seven months. Various researchers have confirmed that orchards like citrus, wine grape, apple, olive, peach, hazelnut, and orange could be a substantial sink for atmospheric carbon (Liguori et al., 2009; Granata et al., 2020). Similarly, any agricultural practices, like the use of organic manures or AM fungi, may act as carbon sinks (Shi et al., 2017; Sharma et al., 2018; Verbruggen et al., 2021). Several studies have shown that the

application of organic manures improves the physicochemical properties of soil (Evanylo et al., 2008; Bravo et al., 2012; Sharma et al., 2018; Sharma et al., 2021) and ameliorates root development (Baldi et al., 2010; Sarita et al., 2019). Granata et al. (2020) have quantified the CO₂ sequestered by *Corylus avellana* L. (hazelnut) orchards. They have reported that the total amount of CO₂ accumulated by hazelnut was 58.8 ± 9.1 Mg ha⁻¹ year⁻¹, where the highest value of carbon capturing is in May (12.4 ± 2.0 Mg CO₂ ha⁻¹ month⁻¹). Hence, not only is the cultivation of hazelnut is important from the nut production point of view, but it also has a greater role as a carbon sink. Ganeshamurthy et al. (2019a) have estimated the AGB and BGB carbon in the mango orchards in different states, ranging from 776.9 to 1,574 kg tree⁻¹ (Table 2). The above reports have suggested that fruit orchards may act as a great means for carbon accumulation in biomass. Hence, this pool of carbon fixation might help reduce atmospheric CO₂. Thus, fruit culture could play an efficient role in mitigating climate change scenarios.

CONCLUSION AND THE WAY FORWARD

After careful deliberations, it can be concluded that climate change due to different anthropogenic activities could potentially disturb improvement toward a world without hunger. A robust and coherent global pattern is discernible of the impacts of climate change on crop productivity that could have consequences for food availability. Various fruit crops like apple mango, citrus, and grapes have shown their potential roles in sequestering carbon, thus enhancing biological yield. The carbon sources also improve the NPP, NEP, and NECB of various fruits compared to those of annual crops. The calculation of C biomass gives an idea about the quantity and quality of carbon available in the area and how it behaves in tree species compared to the annual crops, where the carbon is eventually degraded to GHGs to the environment causing global warming and climate change. The recommendation of suitable mitigation measures is also given in order to reduce GHG emissions. Hence, crop-fixing

carbon might help reduce atmospheric CO₂ and has a great capability of CO₂ capture, storage, and utilization of carbon sources.

Various crops have a tremendous potential toward sequestering the carbon; however, the potential of many fruit trees is still unexploited. Hence, there is an urgent need to know the carbon sequestration potential in fruit crop species. A smart approach is required to develop and identify suitable propagation methods, systems, and appropriate tree species to ameliorate carbon storage and enhance fruit production.

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AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication. SS, VR: (Writing - original draft preparation); SS and HP, (Figures and Tables); VR and SS (Conceptualization and supervision); US and HP (Helped in data compilation and arrangement); SS, VR and HP (Reviewed the write up and Helped in finalizing the draft); SS and HP (Revised the Manuscript).

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