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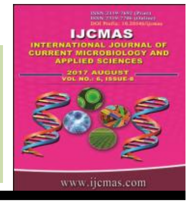

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Carbon Sequestration Potential in a Ten Year Old Oil Palm under Irrigated Conditions

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ABSTRACT

Keywords

Carbon sequestration, Oil palm, Irrigated conditions.

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Terrestrial ecosystems play a vital role in regulating greenhouse gas balance of crop production given the need to minimize the emissions associated with global warming and climate change. Such emissions can be minimized by growing perennial crops such as oil palm to enhance the buildup of terrestrial carbon pool. Carbon sequestration in a ten year old mature oil palm plantation was taken up for the study by destructive analysis. Among different plant parts, trunk biomass contributed to 50.9 $T.ha^{-1}$, while leaves and roots accumulated 19.3 and 2.20 $T.ha^{-1}$ respectively. The carbon sequestered by the adult oil palm was 29.7 $T.ha^{-1}$. This present investigation would be useful for developing a comprehensive and accurate database regarding the carbon storage in a ten year old oil palm under irrigated conditions and also quantify the carbon sequestration potential by oil palm plantations and explore its potential in mitigating global climate change.

Introduction

Oil palm is the fastest growing component of Indian vegetable oil sector giving 4-6 tonnes of oil/ha. Recognizing the scope of this crop in India under irrigated conditions, potential areas at present oil palm is grown in India to an extent of 2.62 lakh ha with productivity levels reaching as high as 30-35 t FFB/ha/year. Out of 15 states of oil palm grown areas, Andhra Pradesh leads the forefront in terms of area and productivity. It is a humid tropical crop which requires rainfall of 2000-3000 mm per annum with monthly minimum and maximum temperature range of 22-24˚C and 29-33˚C. The higher concentration of green house gases (GHG) in the atmosphere, particularly CO_2, which is responsible for 50% of the overall GHG effect (Bergonzini, 2004) and its average concentration increased from 290 to 380 ppm from 19th to 20th century. Capturing of atmospheric carbon (C) and storing it in the terrestrial biosphere is one of the options, for mitigation of GHG reduction. The input of carbon into the plant is first determined by the rate of photosynthesis and the metabolic reactions that convert carbohydrates to plant biomass and maintain the standing biomass. Oil palm has major potential for atmospheric CO_2 sequestration and is used for judging the environmental impacts of this perennial crop (Lamade and Bouillet, 2005). It not only helps in reduction of CO_2 from atmosphere but also increases its sequestration, which enhances quality of soil, air and wildlife habitat. Based on the eddy covariance technique by Henson (1989), the annual uptake of CO_2 by mature oil palm on coastal soil in Malaysia was 46.4 T ha^{-1} yr^{-1} with a net fixation of about 11.0 T ha^{-1}.

Clean development mechanism was also created as a part of the Kyoto protocol in 1997 to lower cost involved in reducing GHG emissions released to the atmosphere and to support sustainable development initiatives with-in the developing countries like India. Terrestrial carbon sequestration is the carbon-storage approach which can be attained by planting perennial crops like oil palm to mitigate climate change and achieve enhanced terrestrial carbon pool. Enhanced biological storage of carbon has the potential to reduce atmospheric CO_2 considerably (Winjum *et al.*, 1992; Mutuo *et al.*, 2005). The carbon capture and storage technologies provide a potentially valuable set of tools for achieving the magnitude of emissions reduction required for CO_2 stabilization. Lenton and Huntingford (2003) reported that the biosphere may soon become a net source rather than a net sink of atmospheric carbon due to changes in climate. Unsustainable practices like deforestation, causing damage to wild life, unprecedented use of fertilizers and pesticides cause environmental damage in terms of increased carbon emission and therby global warming, disturbance to biodiversity with a severe impact on planet earth. The direct method for measurement of carbon stocks accumulated by a plant is by weighing plant samples for annual or perennial plants by measuring specific parameters like diameter, height, wood density etc. This paper examines the changes in total biomass and carbon storage content among different plant parts of oil palm by destructive sampling.

Materials and Methods

The study was conducted at Directorate of Oil Palm Research, Pedavegi and is situated in West Godavari district, Andhra Pradesh, India which was located at 16°8’ N, 81°11’ E, with a mean sea level of 13.4 m. The palms were planted with 9 m triangular spacing and standard agronomic practices were followed (Berthaud *et al.*, 2000). Two palm trees grown under uniform management conditions (Fig. 1) were uprooted and plant parts were separated. Fresh weights of trunk, leaflets, rachis, spears and roots were taken and their representative samples were dried in hot air oven at 65˚C to attain constant weight and dry weights were taken. The samples are ground by 0.2 mm sieve for analyzing the total carbon (Syahrinudin, 2005). The estimation of carbon contents in the different samples were done on the basis of dry combustion, with the help of CHNS analyzer (Vario EL III, Elementar, Germany). The total carbon of the systems was calculated based on the carbon component and mass of each component of the system.

Results and Discussion

Among different plant parts, trunk biomass contributed to 50.9 $T.ha^{-1}$, while leaves and roots accumulated 19.3 and 2.20 $T.ha^{-1}$ respectively (Table 1).

Table.1 Above and below ground biomass (T ha^{-1}) and carbon sequestered (T $C.ha^{-1}$) by different plant parts in a ten year palm grown under irrigated conditions (Mean ±SD)

Plant part	Biomass (kg $palm^{-1}$)	Biomass ($T.ha^{-1}$)	Carbon sequestered (kg $palm^{-1}$)	Carbon sequestered (T $C.ha^{-1}$)
Leaf	135.5 ± 36.1	19.3 ± 5.2	50.1 ± 13.4	7.1 ± 1.9
Trunk	356.5 ± 68.6	50.9 ± 9.8	153.5 ± 29.1	21.9 ± 4.2
Roots	15.42 ± 2.2	2.20 ± 0.3	7.52 ± 0.6	1.07 ± 0.1
Total	507.12 ± 34.6	72.5 ± 5.0	208.3 ± 16.3	29.7 ± 2.3

Fig.1 Ten year old oil palm selected for destructive analysis under irrigation conditions

Fig.2 Oil palm showing root biomass around the palm base

Oil palm produces large quantities of dry matter mainly due to larger surface area, complete ground cover by the whole year resulting in higher light interception and total dry matter production (Rees, 1962) compared to annual crops. The standing biomass in a adult indicated higher biomass content in trunk followed by leaf and roots under both irrigated rainfed conditions (Suresh and Kiran, 2011). Dufrene (1989) observed that the above ground biomass accumulation in trunk was about 40 T dry matter ha^{-1} or more in palms older than 20 years and found a total root biomass of 31.5 T ha^{-1} for 10 year old palms in Ivory coast, where as Lamade and Setiyo (1996) found only 14.1 T ha^{-1} and 9.7 T ha^{-1} of two families in Indonesia. Root biomass is more difficult to estimate and its measurement requires destructive sampling (Fahmuddin *et al.*, 2009). Differences in root biomass in different areas were obtained according to different soil types. 89% of carbon losses from atmosphere are mainly because of loss of living biomass of total carbon stored in both vegetation and soil (Houghton, 2005). The results conform to the findings of Hartley (1988) that most of the roots are concentrated around the palm base and within 0.5 m from the ground (Fig. 2).

Among different plant parts, trunk sequestered 21.9 T $C.ha^{-1}$, while leaves and roots sequestered 7.16 and 1.07 T $C.ha^{-1}$ respectively. The total carbon sequestered by a ten year adult oil palm was 29.7 $T.ha^{-1}$ (Table 1). The amount of C sequestered was more in trunk followed by leaves and roots and confirm to the findings of Suresh *et al.*, (2008) who reported carbon sequestration of 17.98 - 35.44 T $C.ha^{-1}$. The carbon contents were found to be low in younger leaves and higher in older leaves. Syahrinudin (2005) reported that biomass C of oil palm system in Indonesia increased persistently with plantation age and ranged from 16.6 to 84.6 $Mg.ha^{-1}$ (3-30 years old) plantations respectively. Carbon storage in the biomass elaborates each year primarily with the age and secondarily on agro-ecological conditions. Loss of standing biomass may be offset by long-term carbon storage, either as harvested material or carbon sequestered in soil organic matter. The total amount and proportion of C storage varies depending on soil fertility, climate, and land use types (Fahmuddin *et al.,* 2009).

To conclude, standing perennial crops like oil palm serve as net accumulators of carbon, thereby offsetting carbon emissions, arising from the consumption of fossil fuels and also help in financial gains through carbon trading under the Kyoto Protocol. The expansion of oil palm plantations may represent a carbon debit if practice is to replace the tropical forest by this crop (Fargione *et al.*, 2008). It also seems to be a prime candidate for storing carbon in which oil palm is grown and is eligible for the clean development mechanism. The present investigation would be useful for developing a comprehensive and accurate database regarding the carbon storage in oil palm plantation under irrigated conditions and also quantify the carbon sequestration potential by oil palm plantations and explore its potential in mitigating global climate change.

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