Progressive Research 9 (1) : 91-94 (2014) *Society for Sci. Dev. in Agric. and Tech.*

CARBON SEQUESTRATION POTENTIAL AND SEED YIELD OF BIO FUEL SPECIES IN NORTH EASTERN DRY ZONE OF KARNATAKA

Raju L. Chavan[1], Shivanna Honnurappa[2], K.N. Kattimani[3] and Ashok[4]

[1]*Silviculture and Agroforestry, College of Forestry, Sirsi,*

[2]*Forest Biology and Tree Improvement, College of Forestry, Sirsi,*

[3]*Koppal, UHS Bagalkot, Koppal,* [4]*College of Horticulture, Sirsi,*

ABSTRACT

Carbon sequestration rate has been measured for 7 years old of *Simarouba glauca, Pongamia pinnata, Azodirchta indica* and *Jatropha curcas* and total biomass carbon has been analyzed by CHN analyzer. Plant adoptability (Survival 81 % to 99.25 %) and major role in sequestering carbon that addresses the mitigation of climate change as stated among different tree born oil seed species was highly significant. The average total tree biomass obtained was 151.01 ton/ha among bio fuel species. Taking about 48 % of a biomass as carbon, the carbon sequestration rate (mean) from the ambient air during winter season as obtained by *Azadirachta indica* (83.22 ton/ha) was higher followed by *Simarouba glauca* (77.64 ton/ha) than *Pongamia pinnata* (65.65 ton/ha) and Jatropha curcas. While, it is not difficult to project over a longer period in to the future, the average Carbon dioxide sinks was 276.85 ton/ha and also significantly higher in *Azadirachta indica* (305.13 ton/ha) among bio fuel species. Biomass and carbon accumulation were relatively higher in both *Azadirachta indica* and *Simarouba glauca* and can play an important role as carbon sinks and contribute significantly to the removal of CO_2 from the atmosphere. Silvicultural parameters viz., tree height, clear bole height, diameter at breast height and crown spread were higher in *Simarouba glauca* fallowed by *Azadirachta indica*. Suggested that both species were found most promising to be fast growing and suitably for reforesting cleared areas. However, *Simarouba glauca* (2.2 ton/ha) followed by *Azadirachta indica* (1.8 ton/ha) were exhibited higher seed yield productivity for bio diesel oil seed purpose among species.

Key words : *TBO's species, biomass, carbon dioxide sinks, seed yield, annual increment*

The Planning Commission, Govt. of India, has initiated an ambitious program of growing bio fuel species on wastelands for Biodiesel production to initiate the potentiality of species for biodiesel. The entire cost economics is dependent on the quality and performance of the raw material of bio fuel species. The most important source of supply of non-edible oils are the seeds known as Tree Borne Oilseeds and the species belong to this category are known as non-edible oil seed crops. Tree Borne Oilseeds namely *Jatropha curcas, Pongamia pinnata, Azadirachta indica* and *Simarouba gluaca* etc. have potential to grow and establish in varied agro climatic conditions and in the wasteland of the country. Now days, meeting on species in commercial forest tree plantation' found that is a fundamental tenet of the conservation ethic and that bio fuel species is an important consideration when managing biofuel stands, ecosystem and landscapes (1). Bio fuel species are used for afforestation, especially in watersheds, in drier parts of the country and also in social forestry plantations. Species needs to be assessed in long-term genetic resource collections, in breeding populations, in seedling seed orchards or planting materials producing populations and in production populations (2).

There is a growing interest in the role of different types of land use systems in stabilizing the atmospheric CO_2 concentration and reducing the CO_2 emissions or on increasing the carbon sink of forestry and bio fuel systems. Forestry has been recognized as a means to reduce CO_2 emissions as well as enhancing carbon sinks. The role of forests (or bio fuel trees) in carbon cycles is well recognized and forests are a large sink of carbon. Carbon is a fundamental building block of all life. Carbon dioxide is essential for photosynthesis in green plants and other photo-auto tropes for producing plant products including food and it is also a prominent green house gas. Carbon dioxide

forms approximately 0.04 per cent of earth's atmosphere. As on November 2007, Carbon dioxide concentration in earth atmosphere was 384 ppm (parts per million by volume), which increased to 387 ppm in March 2009. This shows that there is an increase of 3 ppm within a period of 15 months, which accounts to 0.2 ppm of carbon addition per month and 0.0066 ppm of carbon addition per day in the earth atmosphere. In the present situation, India ranked top position in carbon emission from consumption and flaring of fossil fuels along with other developed countries like North America, Japan and other European countries

As different bio fuel trees have variable capacity to sequester carbon, therefore in order to study the potentiality of carbon sequestration and productivity of different bio fuel species in established seedling seed orchard, the study was undertaken to estimate amount of carbon sequestered and seed yield productivity in bio fuel species of Northern Dry Zone of Karnataka.

MATERIALS AND METHODS

The field experiment was laid out in Randomized Block Design with four replications from 2005-06 to 2011-12, having four oil yielding tree species viz., *Azadirachta indica, Jatropha curcas, Pongamia pinnata* and *Simarouba gluaca* planted in each pit (1.5 cu. ft) with a spacing of 4 m x 5 m. The study area is located between 16° 15' N and 77° 21' E longitude with an altitude of 389 meters above the mean sea level and an average rainfall of 660 mm with 39 rainy days. The soils of the experimental site were analyzed for various physico-chemical properties. The soil is shallow red having pH of 6.6, EC 2.4 m.mol/cc and 173, 18.8, 178 kg/ha of N; P_2O_5; K_2O, respectively and also these soils were low in nitrogen and phosphorus and medium in available potassium. In each replication the treatment was represented by 10 trees of each species among them only the middle 5 trees were used for recording observations on various silvicultural parameters, viz., tree height (m), clear bole height (m), diameter at breast height (DBH) (cm), crown spread (m^2) and number of branches/tree the observation during 2009-10 and 2010-11 were recorded by using standard techniques at the end of 5th and 6th year of plantation. The total height of the tree was measured from the base of the tree upto the top of the main stem by using marked pole and expressed in meters. The clear bole height was measured from ground level upto the point where stem is free from branches by using marked pole and expressed in meters. The diameter measured by marking plant at 1.37 m from ground level with white paint (accept for *Jatropha curcas* (0.5 m) and measurement were made by using tree calipers and expressed in centimeter. The collar diameter at base was avoided because of swelling caused by wind pressure on plants in field condition. Total volume was determined by using following formula (3) and expressed in m^3 (Volume = Total height x Basal area x Form factor). The crown spread of seedlings in North-South and East-West directions was measured and expressed in square meter. The above ground biomass of standing trees was estimated to work out the amount of carbon sequestration by reducing the total biomass yield to its 50% (4) or converting biomass by multiplying 0.5. The data recorded on various characters during the course of investigation were subjected to Fisher's method of analysis of variance and interpretation of data was made as per the procedure given by (5).

RESULTS AND DISCUSSION

The data on tree height (m) and clear bole height (m) of the last two years viz., 2010-11 and 2011-12 (6th and 7th year of plantation) of different oil yielding tree species are presented in Table-1. *Simarouba glauca* and *Pongamia pinnata* species were showed superior performance in both the years for total tree height among the oil yielding tree species. Whereas, the *Azadirachta indica* shown highest rate of growth with an annual increment of (0.71 m) compared to the other tree species, which was closely followed by *Simarouba glauca* (0.66 m). The clear bole height among the different oil yielding tree species, the species like the *Pongamia pinnata, Simarouba glauca* and *Azadirachta indica* were showed superior performance in both the years but the annual increment of the clear bole height was not significant. The results with respect to height clear bole height and dbh at 5 and 6 years were similar with the findings of (6) in *Pongamia pinnata, Simarouba glauca* and *Azadirachta indica* at the age of 5 years.

Table-1 : Total tree height and clear bole height of Bio fuel species under dry land condition.

Bio fuel species	Tree height (m)	Clear bole height (m)				
	2010-11	2011-12	Annual Increment	2010-11	2011-12	Annual Increment
Azadirachta indica	4.99	5.7	0.71	2.14	2.25	0.11
Simarouba gluaca	4.59	5.3	0.66	1.95	2.05	0.10
Pongamia pinnata	4.55	5.2	0.65	1.52	1.60	0.08
Jatropha curcas	3.50	4.0	0.50	0.22	0.23	0.01
Mean	4.41	5.04	0.63	1.46	1.53	0.08
SEm ±	0.08	0.10	0.01	0.13	0.14	0.007
CD (0.05)	0.26	0.30	0.04	0.40	0.42	0.021
CV (%)	4.25	4.25	4.25	19.93	15.93	14.933

Table-2 : Diameter at breast height (DBH) and Qualitative traits of Bio fuel species under dry land condition.

Bio fuel species	Diameter at breast height (cm)			Qualitative traits		
	2010-11	2011-12	Annual Increment	Survival (%)	Number of branches/ tree	Crown spread (m^2)
Azadirachta indica	31.77	32.83	1.06	99.25	21.60	13.55
Simarouba glauca	31.32	32.42	1.10	98.75	21.40	24.40
Pongamia pinnata	32.27	33.30	1.03	98.25	15.00	23.55
Jatropha curcas	35.74	36.88	1.14	81.00	22.20	16.95
Mean	32.77	33.86	1.08	94.31	20.05	19.61
SEm ±	0.68	0.69	0.02	1.83	1.63	1.44
CD (0.05)	2.08	2.14	0.07	5.63	5.01	4.42
CV (%)	4.61	4.58	4.37	4.33	12.13	16.36

Table-3 : Total wood biomass, carbon dioxide storage and carbon sequestered in Bio fuel species.

Bio fuel species	Tree height (m)	DBH (cm)	Volume m^3/ha	Above ground biomass ton/ha	Below ground biomass ton/ha	Total biomass ton/ha	Carbon storage ton/ha	Carbon dioxide sinks ton/ha
A. indica	5.7	32.83	192.97	133.15	33.29	166.43	83.22	305.13
S. gluaca	5.3	32.42	174.97	124.23	31.06	155.29	77.64	284.69
P. pinnata	5.2	33.30	181.12	105.05	26.26	131.31	65.65	240.73

The data on diameter at breast height (cm) of last two years viz., 2010-11 and 2011-12 (6th and 7th year of plantation), number of branches/tree and crown spread of different oil yielding tree species are presented in Table-2. The diameters at breast height among the different species the *Simarouba gluaca* and *Azadirachta indica* species were shown superior performance in both the years and also the annual increment of diameter at breast height higher in the *Simarouba glauca* as compared to other tree species. The rate of crown spreading of the tree species among the four tree species the *Pongamia pinnata* and *Simarouba glauca* were shown the good results and annual increment of crown spreading was also more in these two species of oil seed trees. Intensity of height and diameter growth of any tree species over the years is outcome of interaction between genome and micro-site environment as well as integrated and organized energy conversion system. This means that the better growth potential of some species even at the harsh sites can be ascribed to the prevailing growing condition. The number of branches/ tree differed significantly among the species of oil seed trees and was higher in *Jatropha curcas* and lower in *Pongamia pinnata.* Similarly *Simarouba gluaca* and *Azadirachta indica* species were shown on par with each other for number of branches/tree. Table-2 shows data on survival, number of branches/tree and canopy spread for different species at the age of six year. Survival ranged from 81.0% (*Jatropha curcas*) to 99.25% (*Azadirachta indica*). The higher survival percentage of 99.25% was recorded in *Azadirachta indica* followed by *Simarouba gluaca* (98.75%) and

Pongamia pinnata (98.25%). Assessment of survival in bio fuel species plantation showed that *Azadirachta indica* has significantly superior survival rates. A minimum survival was recorded in *Jatropha curcas,* which may be due to lack of moisture content, shallow root system and as suitable soil. Environmental condition, such as soil, rainfall and climates are very much influential to the growth of species (6). Considering all these parameters, it may be inferred that the tree borne oilseed tree species viz., *Simarouba glauca* and *Azadirachta indica* were the most promising to fast growing nature which may be utilized for the dry land areas of the Karnataka for oilseed purpose. However, *Simarouba glauca* (2.2 ton/ha) followed by *Azadirachta indica* (1.8 ton/ha) were exhibited higher seed yield productivity for bio diesel oil seed purpose among species. Similar results on the better performance of bio fuel species under dry land region was also observed by (7) and suggests that *Simarouba glauca* and *Azadirachta indica* were superior growth in dry land.

In the present study volume, biomass and carbon sequestration showed significant difference among different tree species. The average total tree biomass obtained was 151.01 ton/ha among bio fuel species. Taking about 48% of a biomass as carbon, the carbon sequestration rate (mean) from the ambient air during winter season as obtained by *Azadirachta indica* (83.22 ton/ha) was higher followed by Simarouba glauca (77.64 ton/ha) than *Pongamia pinnata* (65.65 ton/ha) and *Jatropha curcas* (Table-3). Similar results have been reported by earlier worker (8). While, it is not difficult to project over a longer period in to the future, the average Carbon dioxide sinks was 276.85 ton/ha and also significantly higher in *Azadirachta indica* (305.13 ton/ha) among bio fuel species. Biomass and carbon accumulation were relatively higher in both *Azadirachta indica* and *Simarouba glauca* and can play an important role as carbon sinks and contribute significantly to the removal of CO_2 from the atmosphere. These results are in line with the findings of (9) who reported carbon sequestration, at the growth intervals of 8, 16 and 24th month in *Pongamia pinnata.*

It is concluded that the present study paved the way for selecting fast growing bio fuel species among different species planted in seedling seed orchard under Northern dry zone of Karnataka, *Pongamia pinnata* and *Azadirachta indica* showed superior performance. These species can be best utilized for bio fuel plantation in farmer's field in larger areas so that thus reduces the carbon concentration in the atmosphere, then minimizing reduces the consequences of global warming.

REFERENCES

1. Anonymous (2010). 5th Research and Development report on tree borne oilseeds 2009-10. *NOVOD Board,* Gurgaon (Haryana). pp. 1-3.
2. Thakur, K.; Chauhan, K.C. and Singh, C. (2009). Evaluation and genetic improvement through progeny trials in different provenance of Bauhinio variegata -suitable forfoothills of the Himalayas. *Ind. J. Soil Cons., 37(3):* 185-192.
3. Chaturvedi, and Khanna, (1984) Forest Mensuration *International Book Distributors,* Dehradun.
4. Khajuria, H. N. and Chauhan, S. K. (2003). Marketing direct and indirect carbon fixation. *National Symposium on Agroforestry in 21st century,* 2003, Pp: 11 – 14.
5. Gomez, K.A. and Gomez, A.A. (1984). Statistical procedure for agricultural research. *John Willey and Sons*. New York.pp. 680.
6. Patil, S.B.; Mulla, S.R. and Jambagi, M.B. (2010). Evaluation of tree borne oilseeds for dryland areas of Karnataka. *Advance Research Journal of Crop Improvement, 1 (2):* 111-113.
7. Nandeshwar, D.L.; Vijayaraghavan, A. and Meshram, M. (2006). Performance of different multipurpose tree species in degraded land of Saptapur Region of Madhya Pradesh. *Indian Forester, 129 (1):* 205-209.
8. Devaranavadgi, S.B.; Patil, S.B. and Ashvathama, V.H. (2005). Cultivation of oil yielding tree species (Kannada). Tree borne oilseeds, pp. 1-15.
9. Rai, P.; Solanki, K. R. and Singh, U. P. (2000). Growth and biomass production of multipurpose trees species in natural Grassland under semi-arid conditions. *Indian Journal of Agro-forestry, 2 :* 101-103.
10. Shivanna, H.; Parashurama Janagiri, H. C. Balachandra, and Sanjeev, Kyatappanavar, (2006). Potential of Pongamia pinnata in carbon sequestration- an important Bio-diesel yielding plant. *My For., 42(1) :* 5-11.