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Enhancing the rural livelihood and to mitigate the climate change through medicinal plant based Agroforestry

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Abstract

A large number of rural people in India have traditionally depended on products derived from plants, especially from forests, for curing human and livestock ailments. For them agroforestry is the convenient systems to provide additional income to the farmers. The highest growth parameters of the medicinal plants were recorded in agroforestry condition. The soil fertility was found to be improved under shaded condition. Among the two tree species the highest macro and micronutrient present in the soil analysis. The maximum shoot length, root length and root weight were produced from the open field, *Simarouba glauca* and *Tectona grandis*.The medicinal plants of *Withania obtusifolia* and *W. somnifera* had the suitability under two tree species. Tree outside forests play a vital role in adding to the existing pool of biological diversity and also the carbon stock. The trees and medicinal plants species in Agro - ecosystems have much more significance owing to various tangible and in tangible benefit. Thus agroforestry in the country can be an important tool for balancing biodiversity conservation and enhance the productivity to meet the demand and supply of medicinal plants and wood/timber.

Introduction

The agroforestry play a major role in land use practice in different parts of the country. With an emphasis on sustainable agriculture, different kinds of agroforestry practices have been recognized in India. India is the second largest exporter of medicinal plants next to China. However, our share is lesser than one per cent in the $62 billion market, having greater scope. At present 90-95 % of medicinal plants is being extracted from the natural forest (Ved *et al,* 1998). The continuous and over-exploitation of medicinal plants wealth from forests may diminish the supply of medicinal plants to industries and in the immediate future it will deplete the genetic stock of these plants (Nandal, 2002). Mixing up tree species and

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medicinal plants will bring potential use of land as well as help to reduce the pressure on natural forest. *Casuarina equesetifolia* and *Eucalyptus tereticornis* are important species in industrial sector, which are grown in large area, including farm lands by the farmers (Parthiban and Govinda Rao, 2008). In farm lands, farmers intercrop tree species with many agricultural crops like cotton, soyabeans, maize, ground nut etc. While agroforestry models have been developed for these agricultural crops by many researchers, no adequate research has been done to develop agroforestry system with medicinal plants. In the context of growing interests among the farmers for cultivating tree species in farm lands, in particular of tree species and existing potential market for medicinal plants, the present study is proposed to develop suitable agroforestry systems with medicinal plants.

Tree outside forests play a vital role in adding to the existing pool of biological diversity and also the carbon stock. In this regard, the trees in agroforestry-ecosystems have much more significance owing to the various tangible and in tangible benefits. Agroforestry has been the traditional practice of several indigenous communities and therefore has tremendous socio-economic bearing. Thus agroforestry and farm forestry in the country can be an important tool for balancing biodiversity conservation with climate reliance (Arunachala and Arunachalam 2010).

Materials and Methods

Species selected for the study

The following tree species and medicinal plants were selected for raising agroforestry trial with the medicinal plants.

Table 1: Selected species for study

S. No.	Tree species selected		S. No.	Medicinal plants studied	
	Species	**Spacing**		**Species**	**Spacing**
1.	*S. glauca*	5 x 5m	1.	*W. obtusifolia*	60cm x 60cm
2.	*T. grandis*	3 x 2m	2.	*W. Somnifera*	60 cm x 60cm

Experimental design:

The proposed agroforestry model with two tree species and two medicinal plants were established in a Randomized Block Design (RBD). Three replications were maintained. Tree species of *S. glauca* and *T. grandis* planted in an appropriate spacing along with medicinal plants in the field. The experiments were carried out in the Forest College and Research Institute (FC&RI) at Mettupalayam in Coimbatore district of Tamil Nadu. The field experiment was conducted to investigate the combatability of *W. obtusifolia* and *W. somnifera* under open, *Simarouba glauca* and *Tectona grandis*. Existing 5 year old *S. glauca* spacing of (5 x 5 m) and *T. grandis* (3 x 2 m) plantations were choosen (0.8 acre) and the intercrops of *Withania* were planted in plots of 2 x 2 m. The seedlings were planted at a spacing of 60 cm x 60 cm in three replications. The plants were taken to record the observation on 180th day.

Plant growth characters registered under open, *S. glauca* and *T.grandis* in *W. somnifera* significantly differed. The highest values were recorded in T_{17} with tallest shoot length (100.56 cm), the highest fresh shoot weight (552.60 g), maximum shoot dry weight (279.67 g) the highest collar diameter (1.11 cm), the longest root length (45.34 cm), the largest fresh root weight (74.36 g) and root dry weight (19.90 g) at 180 DAP which was highly significant and superior than all the other treatments. In *W. obtusifolia* the maximum shoot length (74.40 cm), the greater shoot fresh weight (523.22 g), maximum shoot dry weight (254.39g), maximum collar diameter (0.90 cm), higher root length (47.36 cm) the greatest root fresh weight (64.34 g) and dry root weight (18.55 g) were recorded at 180 DAP as in the case *W. somnifera*.

Table 2: Effect of INM treatments on shoot length (cm) of *W. obtusifolia* and *W. somnifera* under open field, *S. glauca* and *T. grandis*:

Treatments	*W. obtusifolia*			*W. somnifera*		
	under open	*S. glauca*	*T. grandis*	Under open	*S. glauca*	*T. grandis*
T_1	52.16	55.86	37.13	73.66	65.76	61.77
T_2	56.60	58.65	41.20	75.07	66.71	66.23
T_3	66.31	66.81	50.85	98.61	82.68	68.53
T_4	66.22	65.80	46.66	92.75	81.76	66.61

T_5	57.11	60.27	41.14	76.79	68.13	67.27
T_6	59.36	60.85	41.61	77.79	71.68	69.31
T_7	77.76	77.26	60.33	119.63	95.63	79.10
T_8	61.60	62.25	44.26	85.81	76.25	66.97
T_9	74.81	74.80	56.77	114.12	91.12	73.43
T_{10}	61.21	61.63	42.11	82.27	75.36	66.49
T_{11}	72.16	71.36	53.31	112.71	87.68	73.24
T_{12}	76.67	76.37	57.16	116.81	92.32	76.69
T_{13}	67.20	67.87	51.65	110.82	85.81	70.59
T_{14}	66.37	66.86	47.46	98.11	35.67	70.95
T_{15}	62.31	62.81	46.15	91.06	77.98	69.12
T_{16}	71.16	70.91	55.39	112.12	82.75	72.33
T_{17}	81.25	79.90	62.05	121.66	97.34	82.69
T_{18}	61.66	64.22	44.86	87.26	76.83	67.03
T_{19}	68.81	70.91	32.10	111.82	86.14	66.84
Mean	66.35	67.12	48.01	97.84	78.82	70.27

Fig 1: Open Field

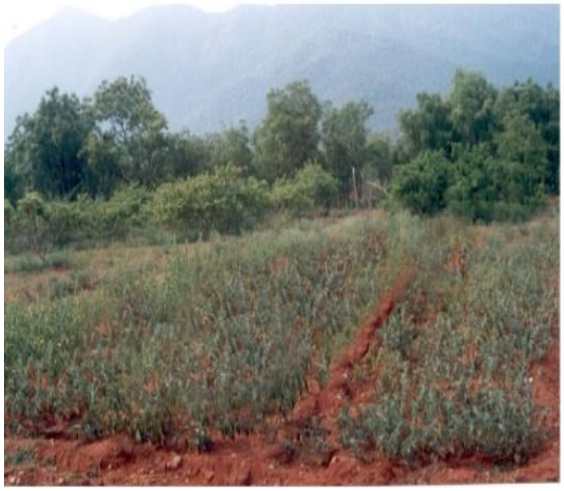
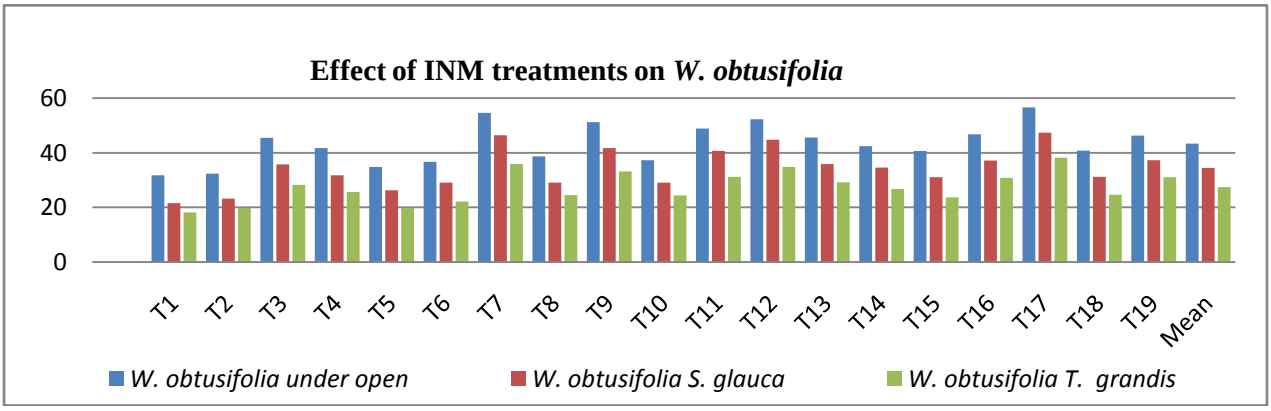


Fig 2: Intercrop under Paradise tree *(S. glauca)*

Fig 3: Inter crop under Teak *(T. grandis)*

W. obtusifolia *W. somnifera*

Fig 4: Effect of INM treatments on root legnth (cm) of *W. obtusifolia* and *W. somnifera* under open field, *S. glauca* and *T. grandis*:



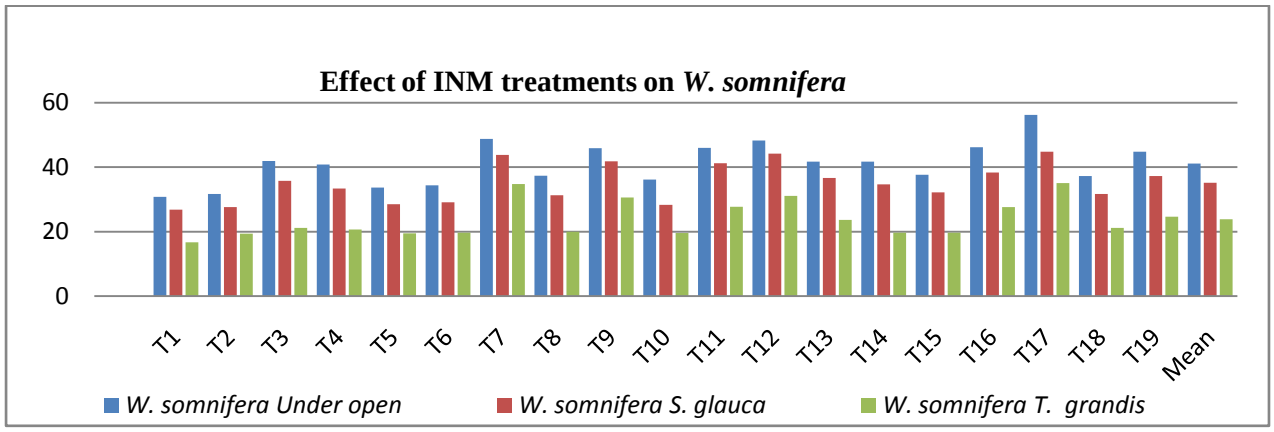
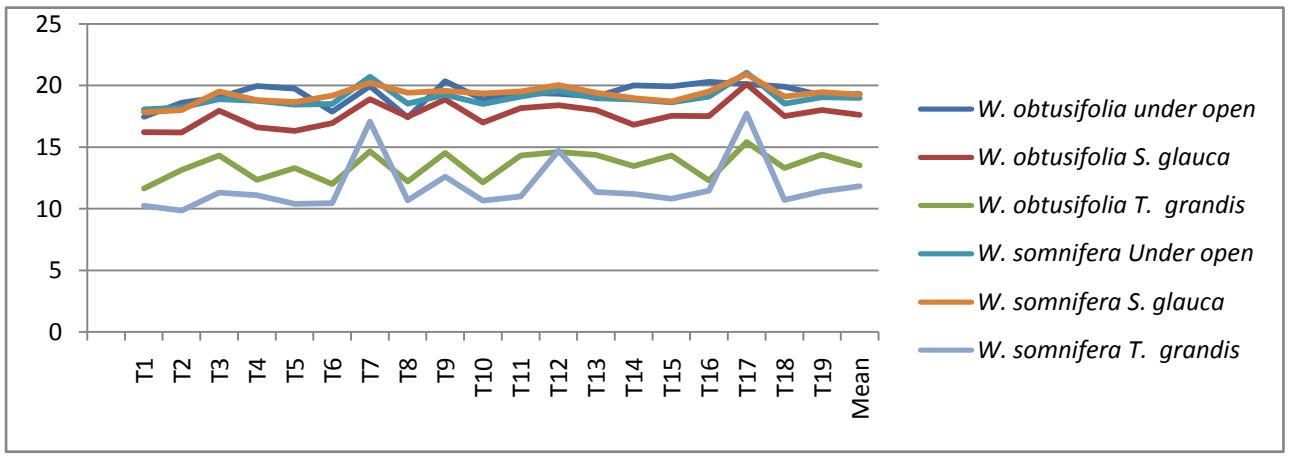


Fig 5: Effect of INM treatments on root weight (g) of *W. obtusifolia* and *W. somnifera* under open field, *S. glauca* and *T. grandis* :



Discussion

The *S. glauca* and *T. grandis* plantations was selected and planted with *W. obtusifolia* and *W. somnifera* at Metupalayam. Comparatively *W. somnifera* attain the maximum shoot length, root length and root weight under *S.glauca* based agroforestry ecosystem. The similar findings reported by Sarvanan *et al.,* (2006) conducted studies in various agroforestry system (*viz.* Teak, Amla and Subabul based agroforestry systems) with *Withania somnifera* as intercrop and assessed the yield under different agroforestry systems. Amla based agroforestry model registered maximum tuber yield of 64 kg/acre compared to other tree species. Jessykutty *et al.,* (2005) studied the feasibility of *ex-situ* conservation and sustainable production of *Asparagus recemosus,* as a part of an oil palm based cropping system. Root yield per plant was higher under the oil palm shade compared to open condition and the highest yield was noticed under young oil palm canopy. Introduction and integration of *Asparagus racemosus* in the oil palm based cropping system can become a potential agroforestry

system which could be effectively utilized for the conservation and sustainable production of this valuable herb. Panneer Selvam *et al,.* (2007) reported that an INM study was conducted results showed that the combined application of organic manures, biofertilizers and chemical fertilizers brought about an increase in growth parameters. Soil fertility was found to be improved under shaded condition and maximum available soil nitrogen was observed under *T. grandis*. Higher phosphorus was found under open condition. NPK uptake of plant was highest under open as compared to *S. glauca* and *T. grandis.* Between the two tree species better growth attributes were registered under *S. glauca* than in *T. grandis.* Many tropical countries are well adapted to partial shading, moist soil, high relative humidity and mild temperatures (Vyas and Nein 1999), allowing them to be intercropped with timber and fuel wood plantations, fruit trees and plantation crops. Some well known medicinal plants that have been successfully intercropped with fuel wood trees (e.g., *Acacia auriculiformis*, *Albizia lebbeck*, *Eucalyptus tereticornis*, *Gmelina arborea*, and *Leucaeana leucocephala*) in India, include *Safed musli* (*Chlorophytum borivilianum*), Rauvolfia (*Rauvolfia serpentina*), Turmeric (*Curcuma longa*), wild Turmeric (*C. aromatica*), *Curculigo orchioides*, and Ginger (*Zingiber officinale*). The study was carried out to explore the medicinal and aromatic plant - *Ammi majus* Linn.in Poplar based Agroforestry. Experimental trail conducted under 2 to 6 year old poplar block plantations and tree-less plots revealed significant differences in growth and yield attributes of the medicinal plants. The studied attributes viz., plant height, seed yield, straw yield, seed weight and No. of shoots per plant showed significance difference in the values. The mature seed and without seed were significantly higher in tree-less fields and young plantations compared to old aged plantations of 6 years (Dhiman and Gandhi 2011).

According to Karthikumar (2001) *Withania somnifera* produced maximum root yield, shoot length, fruit yield and also total alkaloid content more in open condition compared to the shade condition. The medicinal plants namely *Gymnema sylvestre, Mentha arvensis, Coriandrum sativum* and *Coleus forskholii* were tried under Kapok and open field application with graded dose of nitrogen fertilizer (Karikalan, 2001). Among the medicinal plants *Gymnema sylvestre* recorded maximum plant height, number of leaves, leaf area, root length, shoot length, fresh weight and dry weight in open field than in shaded field. Available soil NPK was higher in kapok tree with *Gymnema sylvestre* intercropping system. Plant NPK uptake in open field eity *Coleus forskholii* was higher than other treatments. Madheswaran (2002) screened the shade tolerant medicinal plants under teak based agroforestry system. Seven medicinal plants were chosen as intercrops in teak plantation namely *Adatoda vasica* Mill, *Withania somnifera* Dunal, *Aloe vera* L., *Ocimum tenuiflorum, Gymnema sylvestre* R. Br., *Solanum trilobatum* L. and *Ocimum basilicum* L. He concluded that *Gymnema sylvestre* R. Br was more shade tolerant than other species.

Agroforestry can improve the lives of resource – poor rural population by proving increased income, diversification and sustainability of agriculture and food security. It can also reduce pressure on natural forests and has a potential to bridge the gap in demand and supply of forest products, including pulp and paper (Handa *et al., 2017*). The medicinal plants like *Decalepis hamiltonii, Gloriosa superba* and *Hemidesmus indicus* had the suitability under all the three (*Eucalyptus camandulensis, Casuarina equisetifolia* and *Casuarina junghuhniana*) tree species (Panneer Selvam *et al.,* 2017). Similarly Singh *et. al* (2018) discussed that *Melia composite* and *Emblica officinalis* in combination with medicinal plants *Rauvolfia serpentina* and *Withania somnifera* was conducted in degraded lands. Initially growth of *E. officinalis* and *M. composita* performed better in respect of height. The fresh yields of *R. serpentina* under Aonla and *W. somnifera* under *Melia* are also performed maximum on medicinal agroforestry and proved successful to the agro-climatic conditions as well as degraded lands.

Conclusion

Agroforestry systems can play an important role through which we can cultivate tree crops as well as medicinal plants on same piece of land and it's a additional income to farmers. The highest growth of medicinal plants was recorded under *S. glauca*. The soil fertility was found to be improved under agroforestry plantations condition. Among the two tree species the highest macro and micronutrient was observed in the soil analysis of *S. glauca* plantation followed by *T. grandis.* The highest shoot length, root length and root weight of *W. obtusifolia* and *W. somnifera* were produced from the open field compared to *S. glauca and T. grandis*. The medicinal plants of *W. obtusifolia* and *W. somnifera* had the suitability under all the tree species. The above mentioned medicinal plants based agroforestry ecosystem may help to increase the soil fertility and the perennial medicinal plants may recover from the endangered one, so such a research programme are needed to conserve the valuable medicinal plants. These two medicinal plants had the better suitability under the tree species. The practice of agroforestry will also reduce the pressure on the natural forest ecosystem and domestication helps to conserve the medicinal plants in the wild and alleviate the rural poverty and to overcome the climate disruption.

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