The Pharma Innovation Journal 2022; 11(4): 1145-1148

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(4): 1145-1148

www.thepharmajournal.com
Received: 09-01-2022
Accepted: 22-03-2022

MP Divya
Professor and Head, Department of Forest Products and Wildlife, Forest College and Research Institute, TNAU, Mettupalayam, Tamil Nadu, India

K Baranidharan
Associate Professor, Department of Forest Products and Wildlife, Forest College and Research Institute, TNAU, Mettupalayam, Tamil Nadu, India

P Hemalatha
Assistant Professor, (Horticulture), Department of Agroforestry, Forest College and Research Institute Mettupalayam, Tamil Nadu, India

S Manivasakan
Assistant Professor, Department of Forest Products and Wildlife, Forest College and Research Institute, TNAU, Mettupalayam, Tamil Nadu, India

S Selvanayaki
Associate Professor (ARM), Department of Agroforestry, Forest College and Research Institute Mettupalayam

M Packialakshmi
Research Scholar, Department of Forest Products and Wildlife, Forest College and Research Institute, TNAU, Mettupalayam, Tamil Nadu, India

Corresponding Author:
MP Divya
Professor and Head, Department of Forest Products and Wildlife, Forest College and Research Institute, TNAU, Mettupalayam, Tamil Nadu, India

Screening of shade tolerant medicinal plants for teak (*Tectona grandis* Linn.) based agroforestry system

MP Divya, K Baranidharan, P Hemalatha, S Manivasakan, S Selvanayaki and M Packialakshmi

Abstract
In this experiment, seven medicinal plants were taken as intercrops under the shade of teak trees, as well as pure crop in the open field conditions. The growth parameters like plant height, shoot/root ratio, number of branches and yield were recorded to find out the production potential of selected medicinal plants under teak (*Tectona grandis* Linn.) based agroforestry system. All these recorded parameters were reduced under shade, except *Gymnema*. From this study, it was found that the relative crop yield (RCY) of *Gymnema* (174.72 per cent) was best under teak. The next best treatment was *Ocimum sanctum* (86.95 per cent) followed by other treatments in the rank *viz*., *Withania* (81.66 per cent), *Adathoda* (77.68 per cent), *Ocimum basilicum* (76.48 per cent), *Solanum trilobatum* (76.57 per cent) and *Aloe vera* (72.73 per cent).

Keywords: Medicinal plants, relative crop yield, agroforestry and shade tolerance

Introduction
Agroforestry is a low-input system which combines trees with crops in various combinations or sequences. It is an alternative to intensive cropping systems (Upadhaya *et al.*, 2021) [11]. Medicinal plants have a promising future because there are about half million plants around the world, and most of them their medical activities have not investigate yet, and their medical activities could be decisive in the treatment of present or future studies (Hassan *et al.*, 2012) [5]. Heavy pressure on natural forests not only leads to deforestation but also lead to large-scale destruction of medicinal plants either knowingly or unknowingly by the local people. These apart many plants of medicinal value are also being lost gradually without knowing their medicinal value. Hence, the conservation of these native medicinal plants, which are becoming extinct, has to be viewed seriously owing to their high medicinal value and demand. Most of the medicinal plants thrive well under shade in plains and higher altitudes. This facilitates them to be easily adopted as intercrops in farmer's land in agro forestry system. This will not only increase the monetary benefits but also increase the quantum of raw materials for extracting drugs.
Teak is grown in combination with many agricultural crops at least in the initial few years of establishment. It is very popular in Tamil Nadu (Saravanan and Berry, 2021) [9].
It was planted on field bunds 2x2 m apart in two to five rows depending up on the width of the bunds. Wide interspace having no shade is utilized as strips of agriculture crops. Most common crops *are O. tenuiflorum, O. gratissimum and O. basilicum*, *Zea mays*, *Cymbopogon flexuosus* (Kumar *et al.*, 2015) [7]. Keeping these in view, the present study was designed to findout shade tolerant medicinal plants under teak based agroforestry system.

Materials and Methods
A field trial to screen the shade tolerant medicinal plants under teak based Agro forestry system was laid out at Forest College & Research Institute, Mettupalayam. Which is situated on the foothills of the Kothagiri hills of the Western Ghats sprawling in an area of 200 ha. The geographical position of the institute is 11.19ºN and 76.56'E at 300 m above MSL. The climate is semi-arid tropical type with dry hot summers and cold winters. The dry season starts from early February to mid July and a wet season from mid August to early November. The average annual rainfall is 900 mm of which the north east monsoon contributes 80% of the rain fall and balance 20 per cent of the rain fall is from south west monsoon season and the summer showers.

The average temperate range in this place is between 37 ºC maximum and 25 ºC minimum.

An existing plantation of 0.6 acre was chosen and subsequently thinning was carried out, cleaned and then plots of 4 x 2 m were designed with irrigation channels. The field has eight-year-old trees on red gravelly soil at 4x2m spacing. In this experiment, there are seven medicinal plants were taken as intercrops under the shade of teak trees as well in open as pure crops. The crops *viz*., Adathoda (*Adathoda vasica* (Tourn.) Mill.) 1m x 1m, Withania (*Withania somnifera* Dunal.) 50 cm x 50 cm, Chottukathalai (*Aloe vera* (Tourn. ex Linn.) 60 cm x 45 cm, Thulasi (*Ocimum sanctum* Linn.) 50 cm x 50 cm, Gymnema (*Gymnema sylvestre* R.Br.) 1m x 1m, Tuduvalai (*Solanum trilobatum* Linn.) 50 cm x 50 cm and Thiruneertrupachalai (*Ocimum basilicum* Linn.) 50 cm x 50 cm were grown in the open field with out shade as a control. In this experiment both treatment and control was replicated thrice and Factorial RBD was taken for analysis part to compare shade and unshaded conditions.

For the biometric observations, five sample plants in each plot were taken in random manner for destructive sampling studies at 30, 60, 90, 120 and 180 days and at harvest, except Gymnema. In which only one plant was taken due poor population. For all seven medicinal plants the following attributes were recorded from 30 days after planting. The growth parameters like plant height, shoot/ root ratio, number of branches, number of leaves, crop growth rate and relative crop yield were recorded. The results were subjected to an analysis of variance and tested for significant difference according to Panse and Sukhatme (1967) [8].

Results and Discussion

Total Plant height

Plant height is an indicator of growth, which is influenced by genetic, environmental, and management factors. Among the intercrops, *Gymnema* (T_5) shows the total plant height of 163.40 cm under shade in 180 DAS (Table 1). The other treatments *viz*., T_1 (*Adathoda)* and T_2 (*Withania)* recorded the highest total plant height of 92.30 and 90.20 cm receptively under shade conditions in 180 DAS. The per cent decreases over unshaded for T_1 (*Adathoda)* and T_2 (*Withania)* was recorded 29.65 and 26.25 respectively. The lowest plant height of 11.30 cm was registered by (T_7) *O. basilicum* in 180 DAS. This shows that Plant height is reduced considerably under shade of Teak. The same trend was observed by (kumar *et al.,* 2016) [6] in palmarosa (160.5 cm) fallowed by patchouli (66.0 cm) and lemongrass (60.0 cm) teak-based agroforestry model. The similar result was reported by Divya *et al.* (2006) [13] in *Jatropha curcas.*

Table 1: Effect of shade on total plant height (cm plant^{-1}) of seven medicinal plants under teak based agroforestry system

Treatments	30 DAS		60 DAS		90 DAS		120 DAS		150 DAS		180 DAS	
	Shade	Open	Shade	Open	Shade	Open	Shade	Open	Shade	Open	Shade	Open
T_1	30.20	36.20	40.50	54.50	54.20	79.30	68.50	102.30	81.30	118.30	92.30	131.40
T_2	31.30	36.20	41.50	53.20	54.20	71.30	70.30	92.30	80.20	107.50	90.20	119.30
T_3	15.20	18.20	21.50	27.10	30.30	38.10	36.50	50.20	43.20	57.41	46.50	64.30
T_4	24.30	27.40	33.20	38.20	43.20	46.50	50.20	54.40	55.20	61.30	59.30	66.30
T_5	71.30	63.40	89.60	79.30	108.50	98.20	130.50	118.20	150.30	135.20	163.40	146.40
T_6	11.30	13.50	15.70	20.50	21.30	28.30	28.20	36.20	32.40	42.20	36.50	45.50
T_7	6.50	7.30	9.40	10.50	13.40	14.20	17.40	17.30	19.40	20.40	11.30	21.30
Mean	27.10	28.90	35.90	40.50	46.40	53.70	57.40	67.30	66.00	77.50	72.90	84.90
	C	T	C X T									
S.Ed	0.051	0.047	0.072									
CD (P= 0.05)	0.100	0.093	0.142									

Results of the present study are supported by Ashalatha (2011) [1] observed under *Melia dubia* based agroforestry system, among the different intercrops tried, maximum height increment in tree component was recorded under black gram (3.03 m) and the lowest was found under sesame (2 m).

Shoot/Root ratio

The different treatment showed a significant effect on shoot/root ratio. Among the treatments, *Gymnema* (T_5) was registered the highest shoot/root ratio of 5.73 and followed by *Adathoda* (T_1 – 3.45), *Withania* (T_2 – 3.04) in 180 DAS under shade condition. The same was reported by Sarita *et al. (*1999) [10]. The lowest shoot/root ratio (1.24) was recorded by *O. basilicum* (T_7) and *Ocimum sanctum* (T_4) under shade condition (Table 2).

Table 2: Effect of shade on shoot/root ratio of seven medicinal plants under teak based agroforestry system

Treatments	30 DAS		60 DAS		90 DAS		120 DAS		150 DAS		180 DAS	
	Shade	Open	Shade	Open	Shade	Open	Shade	Open	Shade	Open	Shade	Open
T_1	2.73	2.76	0.59	0.59	3.72	3.75	3.78	3.81	3.62	3.65	3.45	2.31
T_2	2.18	2.13	0.51	2.05	2.06	1.98	2.81	2.16	3.09	2.13	3.04	2.22
T_3	1.82	1.40	0.24	1.16	1.64	1.18	1.53	1.24	1.57	1.18	1.68	1.43
T_4	1.53	1.45	0.35	1.45	1.46	1.54	1.35	1.33	1.25	1.32	1.24	1.25
T_5	6.51	7.75	1.33	7.32	6.03	6.26	5.52	5.45	5.67	5.28	5.73	5.42
T_6	1.46	1.15	0.16	1.13	1.45	1.07	1.46	1.07	1.45	1.05	1.42	1.05
T_7	1.35	1.28	0.25	1.45	1.46	1.52	1.36	1.53	1.35	1.44	1.24	1.49
Mean	2.51	2.57	0.49	2.16	2.55	2.47	2.54	2.37	2.57	2.29	2.54	2.17
	C	T	C x T									
S.Ed	0.033	0.018	0.047									
CD (P= 0.05)	0.060	0.034	0.092									

The maximum shoot/root ratio of 2.55 was recorded at 90 DAP and started to decline with growth stages and attained minimum of 2.54 at 180 DAP under shade. The Same trend of result was obtained for unshaded. The maximum shoot / root ratio of 2.57 at 30 DAP and minimum was 2.17 registered at 180 DAP. The present findings were in consonance with the findings noticed in *Lagestromia parviflora* and *Writia tinctoria* (Sarita *et al.,* 1999) [10].

Number of branches

The various treatments found to be reduced the number of branches in intercrops except *Gymnema* (T_5 - 4.5) over the unshaded. Gill (2006) [4] reported that in case of cowpea, the numbers of branches per plant were higher in association with mango as compared to control. The next best treatment *O. sanctum* (T_4) found to possess number of branches (9.7) lesser than unshaded.

The magnitude of decrease was 21.14 per cent over unshaded. Regarding the stages, the number of branches increased significantly from 30 DAP (2.1, 2.4) to 180 DAP (9.0, 11.4) respectively under shade and open conditions. Considering the interaction, maximum numbers of branches (15.0 and 19.0) were observed in the treatment (T_4) *O. sanctum* at 180 DAP both in shade and open conditions (Table 3). The results of the present study were supported by Ravi *et al* (2011) in *Ailanthus excelsa* and Subbulakshmi *et al.* (2019) [17] in *Jatropha curcas* based agroforestry systems in Tamil Nadu.

Table 3: Effect of shade on number of branch plant^{-1} of seven medicinal plants under teak based Agroforestry system

Treatments	30 DAS		60 DAS		90 DAS		120 DAS		150 DAS		180 DAS	
	Shade	Open	Shade	Open	Shade	Open	Shade	Open	Shade	Open	Shade	Open
T_1	2.0	3.0	3.0	5.0	4.0	6.0	5.3	7.0	6.0	9.0	9.0	11.0
T_2	2.0	4.0	3.0	5.0	5.0	7.0	6.0	9.0	7.0	12.0	9.0	13.0
T_3	-	-	-	-	-	-	-	-	-	-	-	-
T_4	3.0	3.0	5.0	7.0	9.0	13.0	12.0	15.0	14.0	17.0	15.0	19.0
T_5	1.0	3.0	2.3	5.0	3.0	7.0	4.0	8.0	4.0	10.0	5.0	12.0
T_6	3.0	3.0	5.0	6.0	7.0	9.0	8.0	12.0	10.0	13.0	12.0	15.0
T_7	3.0	3.0	4.0	5.0	7.0	11.0	8.0	13.0	10.0	15.0	11.0	17.0
Mean	2.1	2.4	3.3	4.3	5.1	7.0	6.3	8.6	7.6	10.0	9.0	11.4
	C	T	C x T									
S.Ed	0.033	0.017	0.047									
CD (P= 0.05)	0.065	0.035	0.092									

Similar results were reported by Balasubramanian *et al.* (2017) [2] reported that, the number of branches in all five tree species *viz., Tectona grandis, Gmelina arborea, Dalbergia sissoo, Bambusa vulgaris* var. *vulgaris* and *Swietenia macrophylla.* The number of branches was observed in *Dalbergia sissoo* of an average about 14 branches per plant at 32 months from date of planting and in *Bambusa vulgaris* var. *vulgaris* also the number of culms per plant was more than 13. The other three species *viz., Tectona grandis, Gmelina arborea* and *Swietenia macrophylla* hardly produced 3 branches per plant and showed their poor performance at the study site.

Number of leaves: *O. sanctum* (T_4) recorded highest (241.0) number of leaves under shade which is 79.7 per cent over unshaded at 180 DAS (Table 4). All other treatments found to be reduced the number of leaves in intercrops. The next best treatment, *Withania somnifera* (T_2) found to possess a greater number of leaves (225.67) than that of unshaded (362.33) at 180 DAS. The magnitude of increase was 62.28 per cent over unshaded. The number of leaves increased significantly from 18.67, 20.71(30 DAP) to 128.33, 162.95 (180 DAP) respectively under shade and open conditions (Table 4). The interaction revealed that maximum numbers of leaves were observed in the treatment (T_4) *O. sanctum* at 180 DAP. These results are in parity with the findings of (Righi *et al.,* 2007) in Rubber + coffee-based agroforestry model.

Table 4: Effect of shade on leaf number plant^{-1} of seven medicinal plants under teak based Agroforestry system

Treatments	30 DAS		60 DAS		90 DAS		120 DAS		150 DAS		180 DAS	
	Shade	Open	Shade	Open	Shade	Open	Shade	Open	Shade	Open	Shade	Open
T_1	18.00	27.00	43.00	56.00	68.00	82.00	103.00	128.00	144.33	164.33	182.67	230.33
T_2	12.33	19.00	39.00	46.33	69.00	97.00	123.33	172.33	172.67	262.00	225.67	362.33
T_3	5.67	6.67	7.33	8.00	8.33	9.00	8.67	10.33	10.00	12.33	9.67	14.33
T_4	33.33	38.67	60.00	69.00	130.67	135.33	154.67	185.00	186.00	295.00	241.00	302.33
T_5	32.00	16.67	44.67	31.00	57.33	41.00	67.33	48.67	87.33	63.33	127.33	92.67
T_6	4.33	5.00	8.33	12.67	17.00	20.67	22.00	28.00	25.33	34.67	28.00	44.00
T_7	25.00	31.67	36.00	40.67	56.67	67.67	66.67	78.67	74.00	89.67	84.00	94.67
Mean	18.67	20.71	34.05	37.67	58.24	64.77	78.00	93.00	99.95	131.57	128.33	162.95
	C	T	C x T									
S.Ed	0.600	0.321	0.849									
CD (P= 0.05)	1.185	0.633	1.675									

Crop growth rate: The CGR of intercrops significantly varied among the treatments studied as well as stages of observations and varied from 12.10, 14.96 g m^{-2} day^{-1} at 30 DAP to 27.13 and 7.98 g m^{-2} day^{-1} at 180 DAP under shade and open conditions respectively (Table 5). Among the treatments *O. basilicum* (T_7) recorded the highest CGR of 30.35 g m^{-2} day^{-1}, followed by *S. trilobatum* (T_6) 20.17 g m^{-2} day^{-1} at 180 DAS. The lowest CGR 7.12, 7.33 g m^{-2} day^{-1}

were observed in the treatment (T_1) *Adathoda vasica.* The results are parity with (Das, 2015) [3] who recorded maximum Crop Growth rate during 90- 110 days, significantly higher CGR (42.4 g m-2 day-1) was under 100 cm pruning height in Jatropha than other pruning treatments. The similar result was reported by Rajalingam *et al.* (2015) [14] in *Ailanthus excels*a; Ashalatha, *et al.* (2015) [12] *Melia dubia* and Rajalingam *et al.* (2017) [15] in A*nthocephalus cadamba* based agroforestry systems in Tamil Nadu.

Table 5: Effect of shade on crop growth rate (g $m^{-2}day^{-1}$) of seven medicinal plants under teak based Agroforestry system

Treatments	30 - 60 DAS		60- 90 DAS		90 -120 DAS		120 -150 DAS		150- 180 DAS	
	Shade	Open	Shade	Open	Shade	Open	Shade	Open	Shade	Open
T_1	9.48	13.77	19.47	29.14	29.14	15.08	9.39	6.33	7.12	7.33
T_2	15.18	7.94	9.22	5.03	5.09	14.23	9.33	10.96	7.20	5.86
T_3	10.28	27.28	12.08	10.46	10.46	19.37	11.87	8.21	7.92	5.18
T_4	10.45	10.97	17.25	14.81	14.78	8.74	13.46	7.70	8.88	7.45
T_5	10.35	19.40	7.30	7.33	7.43	13.55	15.29	16.45	8.31	14.30
T_6	17.50	15.20	13.46	14.21	14.17	9.40	24.43	10.24	20.17	14.41
T_7	11.49	10.19	14.30	10.52	10.51	10.59	7.33	23.47	30.35	1.35
Mean	12.10	14.96	13.30	13.07	13.08	12.99	13.01	11.91	27.13	7.98

	C	T	C x T
S.Ed	0.037	0.020	0.052
CD (P= 0.05)	0.0735	0.039	0.104

These findings were in confirmation with the findings of Cock *et al.* (1984) who reported that the yield of cassava CGR in the range of 90-130 to 80-120 g m^{-2} $weak^{-1}$ under *Leucaena.*

Relative crop yield (RCY)

It was known that the RCY performance of *Gymnema* was best under teak. Among the treatments, the highest RCY was registered by (T_5) *Gymnema* (174.72 per cent). The next best treatments were *O. sanctum* (T_4-86.95 per cent) and *Withania* (T_2-81.66 per cent) (Table 6). The low values were registered by *Adathoda* (T_3- 72.73 per cent). Among the stages, the highest value of RCY was observed at 180 DAP (96.11) and low values recorded at 90 DAP (88.89) under both shade and open conditions. The result of the current study is in consistent with the findings of Karikalan *et al.* (2020) [16] in medicinal plants under kapok based agroforestry system.

Table 6: Effect of shade on relative crop yield (%) of seven medicinal plants under teak based agroforestry system

Treatments	30 DAS	60 DAS	90 DAS	120 DAS	150 DAS	180 DAS	Mean
T_1	79.46	74.36	70.16	78.34	81.52	82.27	77.68
T_2	87.38	74.32	77.19	80.52	87.29	83.26	81.66
T_3	56.39	60.36	62.36	82.44	86.48	88.34	72.73
T_4	86.18	84.38	86.23	86.24	88.50	90.16	86.95
T_5	183.35	180.22	176.49	169.41	169.30	169.55	174.72
T_6	73.19	79.24	75.29	75.39	78.62	77.70	76.57
T_7	72.63	73.42	74.52	77.49	79.35	81.49	76.48
Mean	91.22	89.47	88.89	92.83	95.86	96.11	92.40

	S.Ed	CD (P= 0.05)
C	0.073	0.145
S	0.067	0.134
C x S	0.178	0.355

Conclusion

Shade influences the leaf and root production of medicinal plants under Teak. From the study it was found that *Gymnema* is a shade-loving crop. All other crops are shade tolerant, but its yield was reduced considerably under shade than open. Aloe vera, Tulasi, and Adathoda can also give good yield under optimally pruned conditions.

References

1. Ashalatha A. Development of suitable Melia dubia based agroforestry system for higher productivity and carbon sequestration. (M.Sc. Thesis), Tamil Nadu Agricultural University, Coimbatore, 2011.
2. Balasubramanian A, Prasath CN, Radhakrishnan S. Carbon Sequestration Potential of Native Vegetation in Sivagangai District of Southern Tamil Nadu, India. Int. J Curr. Microbiol. App. Sci. 2017;6(5):1880-1885.
3. Das N. Comparative growth analysis and yield performance of Glycine max under Jatropha curcas based Agrisilviculture system of agroforestry in the northern part of Bangladesh. Journal of Forests. 2015;2(2):14-23.
4. Gill AS. Inter cropping of oats in mango (Mangifera indica Linn.). Indian Journal of Agricultural Research. 2006;40(2):119-122.
5. Hassan BA. Medicinal plants (importance and uses). Pharmaceut Anal Acta. 2012;3(10):2153-2435.
6. Kumar D, Bijalwan A, Kalra A, Dobriyal MJ. Effect of shade and organic manure on growth and yield of patchouli [*Pogostemon cablin* (Blanco) Benth.] under teak (Tectona grandis lf) based agroforestry system. Indian For. 2016;142(11):1121-1129.
7. Kumar M, Thakur NS, Hegde HT. Growth, herb yield and financial flows from Ocimum spp. intercropped under teak (Tectona grandis L f)-Ocimum spp. based silvi-medicinal system in Gujarat, India. International Journal of Innovative Horticulture. 2015;4(2):113-118.

8. Panse VC, Sukhatme PV. Statistical methods for agricultural workers. 2nd edition, ICAR, New Delhi, 1967,328p.
9. Saravanan S, Berry N. Agroforestry practices in Tamil Nadu, India–a boon for farmers for livelihood security. Current Science. 2021;120(4):644-653.
10. Sarita GB. Heterotrophic Bacteria Associated with Healthy and Moribund Larvae of Penaeus monodon H. Milne Edwards, 1999.
11. Upadhyaya K, Ram A, Dev I, Kumar N, Upadhyaya S, Gautam K, *et al*. Above-and below-ground interactions in teak-barley agroforestry system in the Bundelkhand region of Central India. Indian Journal of Agroforestry, 2021, 23(1).
12. Ashalatha A, MP Divya and V Ajayghosh. "Development of Suitable *Melia dubia* based Agroforestry Models for Higher Productivity." Madras Agricultural Journal, 2015, 102.
13. Divya MP, R Santhi and KR Ramesh. Evaluation of Suitable Intercrops for *Jatropha curcas* based Agroforestry Systems. Indian Journal of Agroforestry. 2006;8(2):1-4.
14. Rajalingam GV, KT Parthiban, MP Divya and A Nandagopalan. "Evaluation of leafy vegetable crops under Ailanthus excelsa based silvihorticulture system in North Eastern Zone of Tamil Nadu." Indian Journal of Agroforestry. 2015;17(1): 91-95.
15. Rajalingam GV, KT Parthiban, K Sivakumar and MP Divya. "Growth and productivity of vegetables under Anthocephalus cadamba based silvihorticultural system." Indian Journal of Agroforestry. 2017;19(1):79-82.
16. Karikalan TV, Maged M Yassin, MP Divya, D Gopi. "Effect of intercropping and nitrogen management on growth and yield of medicinal plants under kapok. 2020.
17. Subbulakshmi V, K Srinivasan, MP Divya, S Mani. "Effect of spacing and intercropping on the growth of Jatropha curcas and availability of light under Agroforestry System in Tamil Nadu, India." 2019.