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Comparative performance of teak in agroforestry system and sole plantation

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Abstract

Growth parameters of 24 years old teak grown under agroforestry system and without agroforestry system *i.e.*, sole plantation of teak was compared. Tree height, girth at breast height, crown spread in north-south direction and east-west direction of teak was increased under teak based agroforestry system. Similarly, increment in girth at breast height, crown spread in North-south direction and crown spread in East-west direction from commencement of intercropping to the final harvest of intercrop was recorded significantly maximum in pooled analysis with different treatments combinations under teak based agroforestry system as compare to sole teak plantation.

Keywords: Teak, agroforestry system, growth parameters

Introduction

Tectona grandis Linn. (Family - Lamiaceae) is one of the most well-known woods in the world, renowned for its dimensional stability, extreme durability, and hardness, as well as its resistance to decay even when unprotected by paints and preservatives. This tree is commonly called as teak and locally known as Sagon, sagwan etc. It is one of the most important heartwood of the world over. Timber value of teak has been well known from decades (Keiding *et al.*, 1986 and Kjaer *et al.*, 1995) [3, 5]. In India, the localities where most important teak forests are found are Madhya Pradesh, Maharashtra, Tamil Nadu, Karnataka and Kerala besides Uttar Pradesh, Gujarat, Orissa and Rajasthan (Troup, 1921) [10]. The total area of natural teak forests in India has been estimated to be 9.77 M ha, which is about 13% of the total forest area of the country (Keswani, 2001) [4]. Large scale plantations of teak have been raised, both within and outside its range of natural distribution due to ever increasing demand of its timber. Agroforestry is the only option because it has a tremendous potential to simultaneously offer both economically and ecologically viable option to farmers and rural people community for large-scale diversification in agriculture to get supplement fuel, fodder, fruits and fibers on one hand and stabilizing the ecosystems (increase the tree cover, production of timber and other wood products thus reduces the pressure on the forests) on the other hand (Bijalwan, 2013) [1]. Present study was attempted to analyse the growth performance of teak tree under agroforestry system and sole plantation.

Material and Methods

The present investigation was carried out in 24 years old teak plantation in year 2021 and 2022 at College Farm (Plot No-21), N. M. College of Agriculture, Navsari Agricultural University, Navsari, Gujarat, India

In agroforestry system cluster bean was grown with teak in summer season in year 2021 and 2022. Micronutrient foliar application was given to cluster bean crop. Eight treatment combinations of cluster bean variety with foliar application of iron sulphate and zinc sulphate under teak based agroforestry system and sole teak plantation was used for the study to determine their effect on growth of teak. Statistically Randomized Block Design (RBD) was used with 4 replications. Teak trees were measured for their height, girth at breast height (GBH) and crown spread (E-W) and (N – S) during both year of study, further increment in growth parameters was also recorded at commencement (in month of February of both years) and final harvest of intercrop (in month of May of both years). Tree height was measured with the help of a clinometer. The girth at breast height (1.37 m above the ground level) was measured with the help of measuring tape.

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Crown spread was measured through cross sectional crown diameter with the help of a measuring tape. Two variety of cluster bean viz., V₁- Pusa Navbahar Variety and V₂- Local Variety; two foliar applications of micro nutrients (Iron and Zinc) i.e., F₀- No foliar application of FeSO₄, F₁- Foliar application of 0.5% FeSO₄, Z₀- No foliar application of ZnSO₄ and Z₁- Foliar application of 0.5% ZnSO₄ and their combinations were given to intercrop under teak based agroforestry system with the nearby plantation of teak in which no intercrop was grown.

Result and Discussion

The growth attributes viz., tree height (m), girth at breast height (GBH; cm) and crown spread in East – West (E-W) and North – South (N-S) (m) direction of teak at commencement of intercropping and after cluster bean harvest for both the years were recorded. Further increment in growth attributes of teak was also recorded. The data of respective parameters were given in Table 1, 2, 3, 4, 5 and 6. The height, girth at breast height, crown spread in North –

South direction and crown spread in East – West direction of *T. grandis* tree at commencement of intercropping and final cluster bean harvest was not varied significantly in different treatment combinations under teak based agroforestry system and sole teak during both years of investigation. However, during both the years, maximum height of teak was recorded in treatment combinations V₂F₁Z₁ under teak based agroforestry system (Table 1). Whereas, minimum tree height was recorded in V₁F₀Z₁. The maximum Girth at Breast Height of *T. grandis* tree was recorded with treatment combination V₁F₁Z₁ under teak based agroforestry system and lower girth was recorded in V₁F₁Z₀ in consecutive years (Table 2). The increased crown spread in North – South direction of teak was observed with treatment V₁F₀Z₀ among different combinations under teak based agroforestry system during both the years of study (Table 3). Higher crown spread in East – West direction was recorded with treatment combination V₁F₀Z₁ under teak based agroforestry system. Whereas, minimum was registered in treatment combination V₂F₁Z₀ (Table 4).

Table 1: Comparison of teak (*T. grandis*) tree height (m) under teak-based agroforestry system and sole teak planation

Treatment	Tree height (m)			
	Year 2021		Year 2022	
	At commencement of intercropping	At harvest of Intercrop	At commencement of intercropping	At harvest of Intercrop
V ₁ F ₀ Z ₀	20.84	20.91	21.35	21.42
V ₁ F ₀ Z ₁	18.46	18.54	18.67	18.75
V ₁ F ₁ Z ₀	19.36	19.44	19.58	19.65
V ₁ F ₁ Z ₁	20.55	20.62	20.79	20.87
V ₂ F ₀ Z ₀	20.81	20.87	21.06	21.12
V ₂ F ₀ Z ₁	19.27	19.34	19.57	19.64
V ₂ F ₁ Z ₀	21.16	21.24	21.42	21.50
V ₂ F ₁ Z ₁	21.30	21.38	21.57	21.66
Sole Teak	18.68	18.74	18.90	18.96
S.Em. (±)	1.16	1.14	1.15	1.13
CD @ 5%	NS	NS	NS	NS
CV (%)	11.54	11.37	11.31	11.10

Table 2: Comparison of teak (*T. grandis*) girth at breast height (cm) under teak-based agroforestry system and sole teak planation

Treatment	Girth at breast height (cm)			
	Year 2021		Year 2022	
	At commencement of intercropping	At harvest of Intercrop	At commencement of intercropping	At harvest of Intercrop
V ₁ F ₀ Z ₀	66.04	66.59	67.25	67.74
V ₁ F ₀ Z ₁	63.40	64.00	64.64	65.16
V ₁ F ₁ Z ₀	58.34	58.84	59.43	59.91
V ₁ F ₁ Z ₁	71.30	71.85	72.57	73.10
V ₂ F ₀ Z ₀	63.48	64.04	64.68	65.18
V ₂ F ₀ Z ₁	65.88	66.43	67.10	67.64
V ₂ F ₁ Z ₀	67.17	67.67	68.34	68.84
V ₂ F ₁ Z ₁	70.06	70.58	71.29	71.81
Sole Teak	62.59	63.01	63.64	64.07
S.Em. (±)	3.10	3.08	3.18	3.16
CD @ 5%	NS	NS	NS	NS
CV (%)	9.48	9.36	9.55	9.44

Table 3: Comparison of teak (*T. grandis*) crown spread (m) in North – South direction under teak-based agroforestry system and sole teak plantation

Treatment	Crown Spread (North – South) (m)			
	Year 2021		Year 2022	
	At commencement of intercropping	At harvest of Intercrop	At commencement of intercropping	At harvest of Intercrop
V ₁ F ₀ Z ₀	4.63	4.76	4.89	5.00
V ₁ F ₀ Z ₁	4.51	4.62	4.72	4.82
V ₁ F ₁ Z ₀	4.27	4.38	4.49	4.60
V ₁ F ₁ Z ₁	3.85	3.97	4.09	4.20
V ₂ F ₀ Z ₀	4.14	4.25	4.37	4.49
V ₂ F ₀ Z ₁	4.36	4.49	4.63	4.75
V ₂ F ₁ Z ₀	3.64	3.75	3.87	3.98
V ₂ F ₁ Z ₁	3.69	3.82	3.95	4.06
Sole Teak	4.47	4.57	4.67	4.77
S.Em (±)	0.27	0.27	0.24	0.24
CD @ 5%	NS	NS	NS	NS
CV (%)	12.95	12.52	11.07	10.81

Table 4: Comparison of teak (*T. grandis*) crown spread (m) in East – West direction under teak-based agroforestry system and sole teak plantation

Treatment	Crown Spread (East – West) (m)			
	Year 2021		Year 2022	
	At commencement of intercropping	At harvest of Intercrop	At commencement of intercropping	At harvest of Intercrop
V ₁ F ₀ Z ₀	2.91	2.99	3.12	3.21
V ₁ F ₀ Z ₁	3.62	3.69	3.81	3.88
V ₁ F ₁ Z ₀	3.20	3.28	3.41	3.49
V ₁ F ₁ Z ₁	2.81	2.89	3.00	3.07
V ₂ F ₀ Z ₀	3.16	3.24	3.36	3.44
V ₂ F ₀ Z ₁	3.32	3.41	3.55	3.65
V ₂ F ₁ Z ₀	2.73	2.82	2.96	3.04
V ₂ F ₁ Z ₁	3.53	3.62	3.74	3.83
Sole Teak	3.36	3.43	3.54	3.61
S.Em (±)	0.21	0.21	0.22	0.22
CD @ 5%	NS	NS	NS	NS
CV (%)	13.37	13.14	12.83	12.56

The increment in height of teak (from commencement of intercropping to final harvest of intercrops) was not significantly affected by various treatment combinations under teak and sole teak plantation during year 2021, 2022 and pooled analysis (Table 5). Maximum increment in height of teak was reported with different treatment combination under teak based agroforestry system as compare to sole teak. Maximum increment in height of teak (8.72 cm) was observed with treatment combination V₁F₁Z₀ in the year 2021. However, in the year 2022 and pooled analysis higher increment was recorded under V₂F₁Z₁ (8.98 and 8.13 cm, respectively). The lower increment in height was found in sole teak plantation for both the years of study and pooled

analysis (5.82, 5.86 and 5.84 cm, respectively).

Increment in Girth at Breast Height (GBH) was found non-significant in both the years of investigation but significant in pooled analysis (Table 5). Sole teak plantation without intercrops had lower increment in GBH as compared to different treatment combination under teak based agroforestry system during both the years and pooled analysis. The highest increment in GBH was registered in V₁F₀Z₁ during year 2021 (0.60 cm) and pooled analysis (0.56 cm) under teak based agroforestry system. In the year 2022, it was maximum in V₂F₀Z₁ (0.54 cm). However, lowest increment was obtained with sole teak plantation in consecutive years and pooled analysis (0.42, 0.43 and 0.43 cm, respectively).

Table 5: Comparison of Tree height increment and girth increment (cm) under teak-based agroforestry system and sole teak plantation

Treatment	Tree height increment (cm)			Tree girth increment (cm)		
	Year 2021	Year 2022	Pooled	Year 2021	Year 2022	Pooled
V ₁ F ₀ Z ₀	7.19	6.96	7.07	0.54	0.49	0.51
V ₁ F ₀ Z ₁	8.16	7.73	7.94	0.60	0.52	0.56
V ₁ F ₁ Z ₀	8.72	7.39	8.06	0.51	0.47	0.49
V ₁ F ₁ Z ₁	7.47	7.30	7.39	0.55	0.53	0.54
V ₂ F ₀ Z ₀	6.07	5.95	6.01	0.56	0.50	0.53
V ₂ F ₀ Z ₁	7.47	7.39	7.43	0.55	0.54	0.55
V ₂ F ₁ Z ₀	7.75	8.03	7.89	0.49	0.50	0.50
V ₂ F ₁ Z ₁	7.27	8.98	8.13	0.52	0.52	0.52
Sole Teak	5.82	5.86	5.84	0.42	0.43	0.43
S.Em.±	0.89	0.80	0.60	0.04	0.04	0.03
C.D. at 5%	NS	NS	NS	NS	NS	0.08
C.V. (%)	24.34	21.87	23.14	16.02	14.38	15.27

Y						
S.Em.±			0.28			0.01
C.D.at 5%			NS			NS
Y X T						
S.Em.±			0.85			0.04
C.D.at 5%			NS			NS

The increment in crown spread in North-South (N- S) direction of teak was significant during the year 2021 and pooled analysis but non-significant in the year 2022 (Table 6). The increment in crown spread in N-S direction of teak was increased in different treatment combinations under teak based agroforestry system as compared to sole teak. The highest increment in crown spread in N-S direction (13.00 cm) of teak was obtained with V₂F₀Z₁ in pooled analysis. However, lowest was obtained with sole teak plot for both the years and pooled analysis.

The increment in crown spread in East-West direction did not show any significant variation in consecutive years but showed significant variation in pooled analysis (Table 6). Increased crown spread in E-W direction was observed with growing of intercrop (variety and foliar zinc, iron combinations) under teak-based agroforestry system in comparison to sole teak. The combination of V₂F₀Z₁ recorded maximum increment (9.28, 9.44 and 9.36 cm, respectively) over sole teak plantation (6.95, 6.91 and 6.93 cm, respectively) for first, second year and pooled analysis.

Table 6: Comparison of crown spread increment in North-South (N-S) direction and East-West (E-W) direction under teak-based agroforestry system and sole teak plantation

Treatment	Crown spread increment (N-S) (cm)			Crown spread increment (E-W) (cm)		
	Year 2021	Year 2022	Pooled	Year 2021	Year 2022	Pooled
V ₁ F ₀ Z ₀	12.93	10.87	11.90	8.32	9.40	8.86
V ₁ F ₀ Z ₁	10.41	9.95	10.18	7.63	7.37	7.50
V ₁ F ₁ Z ₀	10.52	10.84	10.68	8.53	7.73	8.13
V ₁ F ₁ Z ₁	11.60	10.77	11.19	7.41	7.57	7.49
V ₂ F ₀ Z ₀	11.10	12.29	11.70	7.83	8.73	8.28
V ₂ F ₀ Z ₁	13.19	12.80	13.00	9.28	9.44	9.36
V ₂ F ₁ Z ₀	11.04	11.53	11.29	9.05	8.73	8.89
V ₂ F ₁ Z ₁	12.72	10.75	11.73	8.46	9.06	8.76
Sole Tree	9.94	9.84	9.89	6.95	6.91	6.93
S.Em.±	0.76	0.65	0.50	0.54	0.66	0.43
C.D. at 5%	2.22	NS	1.42	NS	NS	1.22
C.V. (%)	13.20	11.75	12.53	13.32	15.83	14.66
Y						
S.Em.±			0.24			0.20
C.D.at 5%			NS			NS
Y X T						
S.Em.±			0.71			0.60
C.D.at 5%			NS			NS

Increment in terms of growth of teak in agroforestry system than sole teak plantation without any intercrop might be attributed to benefit of crop management practices like field preparation, interculture operations viz., application of recommended dose of FYM and fertilizers as well as irrigation. The growth parameters of teak viz., tree height, DBH, crown length, crown width and number of branches showed significantly ($p < 0.05$) higher values indicating better teak growth in wheat-based agroforestry system as compared to its sole plantation (Sharma *et al.* 2011)^[8]. The leguminous crops (cluster beans and vegetable cowpea) might have increased the fertility status of soil which in turn influenced the growth of Ailanthus. Percent increase in tree height due to intercropping with cluster beans was 17.41% more than Ailanthus alone (Rajalingam *et al.*, 2016)^[6]. The performance of poplar trees in agroforestry plantations was significantly more than in the pure plantation (Rani *et al.*, 2011)^[7]. Teak growth was comparatively higher in agroforestry system as compare to block plantation (Shukla and Viswanath, 2014)^[9]. Further, these findings are analogues with earlier result by Desai *et al.* (2018)^[2].

Conclusion

This study shows that in comparison of sole teak plantation

and teak-based agroforestry system. Growth performance of teak was found better with intercrop (cluster bean) under teak based agroforestry system.

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