



Performance of different bamboo species and *Indigofera tinctoria* in agroforestry situation in the tropical humid region of Karnataka

Pramod¹, Ramakrishna Hegde^{1*}, Maheswarappa V.², Clara Manasa, P.A. and R.N. Kencharaddi⁴

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ABSTRACT: Bamboos are commercially important woody perennial grasses that have been recognized as a substitute for timber. In the recent years, owing to its diversified uses and mass cultivation all over the world, it is being incorporated in the agroforestry systems to enhance productivity. In this context a study at Iruvakkki, Shivamogga, assessed the growth performance of six bamboo species; *Dendrocalamus brandisii*, *Bambusa tulda*, *Bambusa nutans*, *Bambusa balcooa*, *Thyrsostachys oliveri* and *Dendrocalamus latiflorus* in three-year-old plantations. Tissue-cultured bamboo plantlets were planted in a randomized complete block design with a 4 m × 4 m spacing. *D. latiflorus* exhibited superior attributes with a height of 9.47 m and a total number of 20.9 culms. *B. nutans* excelled in clump girth with 3.55 m. *B. tulda* demonstrated the highest culm diameter (3.4 cm, 2.5 cm, and 1.5 cm for first, second, and third-year culms, respectively). *D. latiflorus* surpassed in internodal length for all age categories (41.54 cm, 33.4 cm, and 27.02 cm). The interrow spaces accommodated *Indigofera tinctoria* as an intercrop. *D. latiflorus* showed superior internodal length for all culm ages, with values of 41.54 cm, 33.4 cm, and 27.02 cm. Intercropping with *I. tinctoria* produced 3.43 Mg ha⁻¹ in sole cultivation, while agroforestry systems, such as Indigo + *B. balcooa* (3.21 Mg ha⁻¹) and Indigo + *B. tulda* (3.02 Mg ha⁻¹), yielded comparable results. This study provides valuable insights into bamboo growth and its potential in agroforestry, highlighting species-specific performance and intercropping dynamics.

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1. INTRODUCTION

Bamboos belong to a specific category of plants called Bambusoideae, which is part of the larger grass family (Poaceae). Often bamboos are referred to as 'the grass of hope,' bamboo is a remarkable plant with over 1500 documented applications (Ranjan, 2001). The ecological services provided by bamboo are extensive and far-reaching. It acts as an effective carbon sink, sequestering substantial amounts of atmospheric carbon dioxide and contributing to climate change mitigation efforts. Additionally, bamboo's extensive root system helps prevent soil erosion, stabilize slopes, and improve water retention in the soil. These properties make it an excellent choice for reforestation and land restoration projects. Furthermore, bamboo forests serve as habitats for various flora and fauna, promoting biodiversity conservation. From an economic perspective, bamboo offers numerous opportunities for rural communities, ranging from construction materials and handicrafts to food products and bioenergy sources,

thus providing a sustainable means of income generation and poverty alleviation. Thus, this 'green gold,' also known as "poor man's timber" (Ram *et al.*, 2010), presents itself as a valuable and abundant resource capable of meeting various livelihood needs while providing numerous ecological services to rural communities. Additionally, bamboo is a robust, rapidly growing, and highly versatile material, having been utilized structurally for millennia across many regions of the world. Globally, bamboo is extensively cultivated in plantations due to its short gestation period and its wide array of socio-economic and environmental benefits. Due to their inherent resilience, bamboos enhance farmers' resilience against climate change, safeguard livelihood options, and offer opportunities for the sustainable utilization of these resources (Lobovikov *et al.*, 2012).

Bamboos can thrive outside forests as agroforestry systems on agricultural lands and farms in rural landscapes, as well as along roads and human settlements in and around urban areas. While contributing to environmental sustainability, they also provide income and a variety of goods and ecosystem services for rural households (Solomon *et al.*, 2021). As agroforestry represents a dynamic,

✉ Ramakrishna Hegde
ramakrishnahegde@uahs.edu.in

¹ College of Forestry, Ponnampet, Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga

eco-friendly natural resource management system, the integration of bamboo into agricultural fields can diversify and sustain production, thereby enhancing economic benefits for land users at all levels. Bamboo's versatility and ecological significance extend far beyond its traditional uses. Bamboo-based agroforestry systems represent a promising approach for sustainable land management, yielding enhanced productivity, sustainability, and resource preservation. These systems, akin to other agroforestry practices, are poised to diversify agro ecosystems, generating fresh income streams. This diversification encompasses the cultivation of short duration crops harmoniously integrated with bamboo, provisioning livestock fodder, and the marketing of processed bamboo culms for various applications (Clara Manasa, *et al.* 2024).

In the realm of economic development, bamboo offers numerous opportunities for rural communities and emerging economies. Its potential in the construction industry is particularly noteworthy, with bamboo-based materials increasingly being used as sustainable alternatives to traditional building materials. The textile industry has also embraced bamboo fibers for their softness, durability, and antimicrobial properties. Furthermore, bamboo's role in food security cannot be overlooked, as bamboo shoots are a nutritious food source in many cultures. The plant's versatility extends to bioenergy production, with bamboo biomass being used to generate electricity and produce biofuels. As research and innovation in bamboo utilization continue to advance, this remarkable plant is poised to play an even more significant role in addressing global challenges related to sustainability, climate change, and economic development.

The significance of various bamboo species is increasingly recognized in the current context, where they offer numerous advantages over traditional tree species. These advantages include a relatively short maturation period from planting to harvest, a versatility of use that surpasses most tree species, and the capacity to provide building materials. Bamboo-based agroforestry holds substantial potential for generating additional income for farmers, enhancing soil fertility, contributing to the national forest cover target of 33%, and supplying raw materials for industrial and

domestic use within rural communities. Therefore, it is essential to understand the performance and interactions of different bamboo species with intercrops in agroforestry systems. This experiment aims to fulfill this objective by quantifying the growth of various bamboo species and assessing their impact on intercrops cultivated under humid climatic conditions.

2. MATERIALS AND METHODS

The experiment was conducted in an established three-year-old plantation of different bamboo species which were planted during 2019-20 in Randomized Complete Block Design (RCBD) with four replications at Iruvacki campus, Shivamogga. The study area has a tropical humid climate with mean annual rainfall of 1500 mm with mean annual 95 rainy days. The mean annual maximum and minimum temperature during the period ranged from 36.24°C and 19.7°C, respectively. The soil belongs to lateritic and clay loam types with soil pH 6.5. In each replication, ten individuals were planted in two rows (five plants in each row) with an espacement of 4 m × 4 m such that the size of the each treatment plot in each replication was 20 m X 4 m (Plate 1).

	REPLICATION I					REPLICATION II					REPLICATION III				
1	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
3	6	6	6	6	6	5	5	5	5	5	6	6	6	6	6
4	6	6	6	6	6	5	5	5	5	5	6	6	6	6	6
5	2	2	2	2	2	5	1	1	1	1	5	5	5	5	5
6	2	2	2	2	2	5	1	1	1	1	5	5	5	5	5
7	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2
8	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2
9	3	3	3	3	3	2	3	3	3	3	1	1	1	1	1
10	3	3	3	3	3	2	3	3	3	3	1	1	1	1	1
11	5	5	5	5	5	3	6	6	6	6	4	4	4	4	4
12	5	5	5	5	5	3	6	6	6	6	4	4	4	4	4
13	Indigofera sole crop					Indigofera sole crop					Indigofera sole crop				
14															

1. *Dendrocalamus brandisii*
2. *Bambusa tulda*
3. *Bambusa nutans*
4. *Bambusa balcooa*
5. *Thyrsostachys oliveri*
6. *Dendrocalamus latiflorus*

Plate 1. Layout of the bamboo and Indigofera experimental trial

prior to recording observations, the bamboo clumps were demarcated using standard colour code (Table 1) as different culm age categories to have a better understanding about the growth behavior of bamboos. After recording the bamboo growth attributes, the intercrop *Indigofera tinctoria* was cultivated for four months from December 2022 to March 2023 between the interspaces of the bamboo rows. For the statistical analysis, different bamboo species were treated as treatments along with the sole intercrop.

Observations recorded on bamboo

The growth observations were measured at the start of the experiment which include Clump height (m) measured with the help of measuring pole, Culm diameter (cm) measured with digital calliper, Total number of culms per clump and Internodal length (cm). The remaining observations include Canopy density (%) and Light intensity (lux) which were measured with the help of densiometer and lux meter respectively. To determine the light interception, available for the intercrop, measurements on Light intensity were recorded at monthly basis throughout the cultivation period.

Intercrop growth and yield parameters

To determine the Indigo's growth performance, the observations were recorded as growth and yield parameters. The growth parameters include plant height and number of branches which were assessed at the time of intercrop harvest by laying out a sample plot of 1 m × 1 m at the center of each replication. The yield parameters include Herbage yield (kg/ha) and Biomass (kg/ha) which were calculated by laying out a sample plot of 1 m × 1 m at the center of each replication, extrapolated to per hectare basis

Harvest Index

The Harvest index was calculated by adopting the following formula (Sharma and Mittra, 1988). The economic yield was calculated by adding total leaf weight with the shoot weight whereas biological yield includes total biomass of the plants.

$$\text{Harvest index (\%)} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

Land Equivalent Ratio (LER)

LER was calculated using the below mentioned formula as per Dev *et al.*, (2020)

$$\text{LER} = \frac{\text{Yield of intercrops in agroforestry}}{\text{Yield in sole cropping}}$$

Data Analysis

The data were subjected to analysis of variance (ANOVA) on Randomized Complete Block Design (RCBD) using Genstat 5 and Origin (Pro), 2022b after

angular transformation of per cent values and square root transformation of count.

3. RESULTS AND DISCUSSION

Growth performance of different bamboo species under humid climatic conditions

Various bamboo species exhibit distinct performance characteristics in a given environment due to their unique genetic makeup and adaptability. Evaluating their performance enables the assessment of a species suitability for a specific site. The evaluation process typically involves monitoring and collecting data on key growth parameters *viz.*, clump height, clump girth, number of culms, culm diameter, internodal length and canopy density. This data helps in comparing different species and their responses to site-specific conditions. In the present study, the growth performance of three-year-old six different bamboo species was studied and analyzed. Results revealed the existence of a significant difference among all the bamboo species for all the growth parameters (Table 2).

The culm height and number of culms directly affect the overall productivity of the bamboo clump. A healthy bamboo clump with a sufficient number of culms is more likely to maintain its vitality and provide a sustainable resource over time. A higher number of culms influences the total economic value and biomass accumulation of the bamboo stand (Alemayehu *et al.*, 2015), whereas the height of the bamboo culms is very important as it is one of the main characteristics in fetching a higher market value with respect to individual culms. Superior values for both clump height (9.47 m) and number of culms (21) were recorded in *D. latiflorus* followed by *B. tulda*. The higher vegetative growth of both species may be attributed to genetic characteristics and adaptability of the species which gave them higher ability to grow under humid climatic conditions. Yen *et al.* (2023) also reported similar results that, in the third year, *D. latiflorus* attained a maximum clump height of 10 m under humid conditions. Similarly, Singh *et al.* (2018) reported that in the sixth year, *D. strictus* had the maximum value for clump height (9 m) and the total

Table 1: Colour code used for bamboo age demarcation

Sl. No.	Culm age	Colour Code	Identification characters
1	0-1 year	Red	Younger culms usually have green surfaces, more intact culm sheaths and more light-coloured bristles on the sheath ring around nodes (Mei <i>et al.</i> , 2020)
2	1-2 year	Yellow	Relatively the culms will have lower culm girth and culm sheath will be present in the upper region
3	2-3 year	Blue	Older culms will be in the center of the clump, reduced persistence of the sheaths and will have white spots on the outer wall

number of culms per clump (39) followed by *B. tulda* (8.7 m and 27, respectively). Further, *B. nutans* had attained maximum clump girth (3.55 m) whereas the species, *B. balcooa* has the lowest values for the clump girth (1.64 m) and total number of culms per clump (10). The lower performance of *B. balcooa* could be linked to its ability to adapt to the local climate, especially considering its vulnerability to browsing, which occurred during the initial planting years. Similar findings have been reported by Gaikwad *et al.* (2021) that, the lowest clump girth (4.78 m) and number of culms per clump (5.67) were obtained in the *B. balcooa* among the seven different bamboo species in the second year of plantation.

Among the bamboo species maximum canopy density was scored by *D. latiflorus* (93.91 %) followed by *B. nutans* (92.53 %) and the least was recorded by *B. balcooa* (66.80 %). In contrary maximum light interception was in *B. balcooa* (24084 lux) and the least was in *D. latiflorus* (9312 lux). The higher light intensity under the species *B. balcooa* is due to the lower vegetative growth in the form of branches and crown expansion compared to the other bamboo species of the study. Higher canopy density in *D. latiflorus* may be due to its potential to grow vigorously under humid climatic conditions. The factors contributing to canopy density can vary depending on the bamboo species, environmental conditions, and the soil nutrient status of the area. However, the combination of rapid growth, adaptive capacity and competitive advantages generally makes the bamboo conducive to high canopy density (Shi *et al.*, 2014).

The morphological characteristics such as the culm height, number of internodes per culm, and internodal length, are considered important factors in determining the strength and suitability of bamboo for

various applications (Selvan and Tripathi, 2017). In the present study, the other growth parameters, culm diameter and internodal length were studied based on the age of the culms (Table 3). The close perusal of the data presented reveals that among the species, the maximum culm diameter and internodal length were attained by *B. tulda* and *D. latiflorus*, respectively for all culm age categories (first, second and third-year culms). Internodal length is directly correlated with the culm height *i.e.*, the higher the internodal length and culm diameter, the higher will be the applicability of bamboo for end uses like furniture, basket making, building poles and scaffolding (Rane *et al.*, 2016). The higher growth of the former species may be attributed to its vigorous growth and the significant genetic differences that lead to the variation in growth among the species (Adhikari and Shrestha, 2008). Similarly, Amlani *et al.* (2017) reported that the maximum culm diameter and internodal length were recorded in *D. strictus* (4.42 cm and 30.91 cm respectively) and *B. tulda* (3.97 cm and 45.19 cm respectively). Lower internodal length was recorded in second- and third-year culms for all the species. The species with smaller internodal length will have more number of internodes which has a different set of applicability as Chaowana *et al.* (2023) reported that the culm specimens with higher nodes showed higher shear strength and density.

There is a significant difference existed in between the different aged culms, which was in the order: third-year culms < second-year culms < first-year culms, for both culm diameter and internodal length. In line with the work, Dessalegn *et al.* (2022) reported that, one-year-old bamboo has high culm diameter, wall thickness, internode length compared to the age of second and third year old bamboo culms. The superior values for culm diameter and internodal length by the

Table 2: Growth parameters and light intensity of bamboo species

Species	Growth parameters				
	Clump height (m)	Clump girth (m)	Total No. of culms/ clump	Canopy density (%)	Light intensity ($\times 10^2$ lux)
1. <i>Dendrocalamus brandisii</i>	6.17 ^a	3.15 ^c	11.9 (3.45) ^a	85.36 (67.50) ^c	143.59 ^b
2. <i>Bambusa tulda</i>	8.89 ^b	2.54 ^b	16.7 (4.08) ^c	77.78 (61.87) ^b	193.54 ^c
3. <i>Bambusa nutans</i>	5.99 ^a	3.55 ^d	14.7 (3.83) ^{bc}	92.53 (74.14) ^d	105.95 ^a
4. <i>Bambusa balcooa</i>	7.09 ^c	1.64 ^a	10.1 (3.17) ^a	66.80 (54.82) ^a	240.84 ^d
5. <i>Thyrsostachys oliveri</i>	6.64 ^{ac}	2.47 ^b	16.3 (4.03) ^c	76.34 (60.90) ^b	198.67 ^c
6. <i>Dendrocalamus latiflorus</i>	9.47 ^d	3.37 ^{cd}	20.9 (4.57) ^d	93.91 (75.71) ^d	93.12 ^a
SEM (\pm)	0.3	0.15	0.11	1.50	8.31
LSD (0.05)	0.84	0.42	0.31	4.52	24.94

(Parenthetical values are the arcsine transformed values; SEM- Standard Error of Mean; LSD- Least Significant Difference)

first-year culms may be attributed to the higher moisture content in the younger culms and the vigorous growth of the bamboo clump after the initial establishment period due to a well-grown root system. The third-year culms have the lowest values for the former attributes due to the thickening of the parenchyma cells in the inner wall of the culms and the reduction in the overall moisture content upon aging. Uchida *et al.* (2022) reported a concurrent thickening of parenchyma cell walls in the culm tissues of *Phyllostachys pubescens* where the inner cell wall has been thickened from 0.95 μm to 3.5 μm from the first year to the fourth year of planting.

Performance of *Indigofera tinctoria* in bamboo-based agroforestry

An ideal agroforestry system should be practically feasible and economically viable for its applicability in the farmer fields. Hence it is very important to understand the performance of intercropping in an

agroforestry practice. In the present study, it was evident that the different bamboo species significantly influenced the growth and yield of the Indigo (Table 4). The plant height was maximum under Indigo + *B. balcooa* (1.1 m) followed by sole crop (0.98 m) and the least was observed under Indigo + *D. latiflorus* (0.43 m). Several researchers reported that the height growth of the plants increases with lower light interception (Kunhamu *et al.*, 2011). Other intercrop parameters *viz.*, number of branches, herbage yield and biomass were higher in the control (sole crop) compared to the intercrop under bamboo species. In line to the study, higher height and lower number of branches were observed in the plants growing in agroforestry compared to the sole crop which may be attributed to the amount of Photosynthetic Active Radiation (PAR) availability in the understory. A higher yield was obtained in the sole crop treatment and the statistical analysis revealed a significant result

Table 3: Growth parameters of bamboo species with respect to age of the culms

Species	Number of culms				Culm diameter (cm)			Internodal length (cm)		
	Red	Yellow	Blue	Total	Red	Yellow	Blue	Red	Yellow	Blue
1. <i>D. brandisii</i>	6.1 (2.46) ^a	3.4 (1.83) ^b	2.1 (1.46) ^{ab}	11.9 (3.45) ^a	3.20 ^b	1.95 ^a	1.32 ^a	33.02 ^b	21.99 ^a	17.37 ^{ac}
2. <i>B. tulda</i>	9.5 (3.08) ^c	4.6 (2.14) ^c	2.5 (1.58) ^{bc}	16.7 (4.08) ^c	3.43 ^b	2.49 ^b	1.5 ^b	37.33 ^c	29.67 ^b	20.27 ^b
3. <i>B. nutans</i>	7.7 (2.78) ^{ba}	4.1 (2.02) ^c	2.7 (1.66) ^c	14.7 (3.83) ^{bc}	3.02 ^b	2.11 ^{ac}	1.35 ^{ac}	32.53 ^b	22.48 ^a	16.34 ^a
4. <i>B. balcooa</i>	5.7 (2.38) ^b	2.5 (1.58) ^a	1.8 (1.34) ^a	10.1 (3.17) ^a	2.72 ^a	1.97 ^a	1.27 ^a	32.69 ^b	21.19 ^a	15.74 ^a
5. <i>T. oliveri</i>	8.4 (2.90) ^c	4.7 (2.17) ^{cd}	2.9 (1.71) ^c	16.3 (4.03) ^c	2.70 ^a	1.96 ^a	1.21 ^a	21.26 ^a	17.16 ^c	14.82 ^c
6. <i>D. latiflorus</i>	12.6 (3.55) ^d	5.2 (2.27) ^d	3 (1.73) ^c	20.9 (4.57) ^d	3.17 ^b	2.24 ^c	1.31 ^a	41.54 ^d	33.40 ^d	27.02 ^d
SEM (\pm)	0.09	0.06	0.07	0.11	0.08	0.07	0.05	0.76	0.79	0.74
LSD (0.05)	0.26	0.18	0.19	0.31	0.26	0.21	0.13	2.13	2.20	2.08

Table 4: Indigo crop growth and yield under different bamboo species

Treatments	Plant height (m)	Number of branches	Dry herbage yield (kg ha ⁻¹)	Dry biomass (kg ha ⁻¹)
Indigo + <i>D. brandisii</i>	0.61 ^b	14.68 (3.83) ^b	721.25 ^b	912.03 ^b
Indigo + <i>B. tulda</i>	0.84 ^c	21.27 (4.61) ^{cd}	1159.84 ^c	1369.17 ^c
Indigo + <i>B. nutans</i>	0.48 ^{ab}	12.04 (3.47) ^{ab}	473.90 ^a	570.53 ^a
Indigo + <i>B. balcooa</i>	1.10 ^d	23.15 (4.81) ^d	1350.07 ^d	1559.82 ^d
Indigo + <i>T. oliveri</i>	0.79 ^c	18.43 (4.29) ^c	1004.87 ^c	1202.88 ^c
Indigo + <i>D. latiflorus</i>	0.43 ^a	9.42 (3.07) ^a	413.27 ^a	514.50 ^a
Sole Indigo (Control)	0.98 ^d	31.24 (5.58) ^c	1605.50 ^e	1857.60 ^c
S.Em \pm	0.05	0.14	55.89	63.12
CD (0.05)	0.14	0.46	165.98	187.47

between the treatments. The light availability, its interception and the efficiency with which the intercepted light is converted to biomass play a crucial role in determining the growth and yield of the intercrop Indigo. In the study, the yield reduction under bamboo is mainly due to the lower light intensity compared to the control. Ahlawat *et al.* (2008) reported that bamboo as well as other agroforestry species becomes more competitive with the advancement of growth and there may be yield reductions in the adjacent agricultural crops.

Similar results were obtained by Dev *et al.* (2016) where the after fourth year the yield of the intercrops was significantly lower compared to the control. On the contrary Garima *et al.* (2021) reported that in the intercropping with bamboo species (*Dendrocalamus asper* and *Dendrocalamus hamiltonii*), ginger yield increased by 10.5–15.6 (%) in comparison to the open field condition. Similarly, Akoto *et al.* (2020) reported that agroforestry fields recorded significantly higher grain yield (1.17 t ha⁻¹) than monocropped fields (1.05 t ha⁻¹).

Spacing of the bamboo also plays a prominent role in the bamboo agroforestry system, wider spacing tends to have a lesser effect on intercrop yields when compared to closer spacing. In the current study spacing adopted between the bamboo clumps was 4 m × 4 m which is relatively a closure spacing for the bamboo. Kittur *et al.* (2016) reported that, under *Dendrocalamus strictus* least rhizome yield of 8 Mg ha⁻¹ was obtained under closure spacing (4 m × 4 m) which was 58 (%) less compared to the widest spacing of 12 × 12 m (19.32 Mg ha⁻¹). Also, Manasa (2023) in bamboo + okra / black gram-based agroforestry found a higher Okra yield in wider spacing (5 m × 5 m) compared to the closure spacing (5 m × 4 m).

The harvest index computed for the intercrop under different bamboo species is presented in Fig.1. It is a critical concept that plays a significant role in determining the efficiency and productivity of crop production. It measures and quantifies the proportion of the total yield of a crop that is usable or economically marketable to the total biomass produced by the plant. In the present study, the maximum harvest index for fresh weight was obtained in Indigo + *B. tulda* (91.04 %) and for dry weight it was higher in Indigo + *B. balcooa* (86.05 %). A higher harvest index is obtained in agroforestry even though the total yield is higher in sole crop. This is due to the higher root growth in the plants growing in open condition which increased the total biomass yield compared to the agroforestry treatments. Dhanyashri *et al.* (2020) recorded a

harvest index ranging from 28.4 % to 35.5 % for spice crops under bamboo-based agroforestry. According to Kaur *et al.*, (2016) the maximum harvest index for *Brassica campestris* was found to be 63.89 % in an agroforestry system. Similarly, Manasa (2023) recorded a harvest index of 30.72 % for Okra under bamboo-based agroforestry.

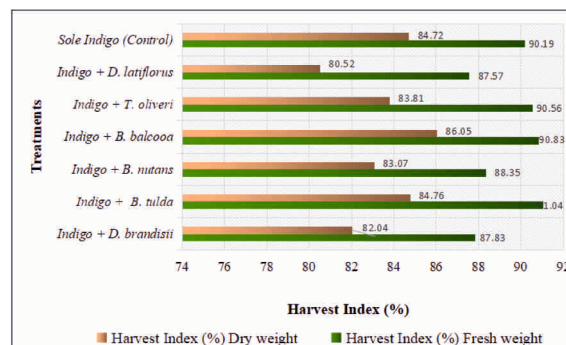


Fig. 1: Harvest Index (%) for Indigo crop grown under different bamboo

The land equivalent ratio (LER) is an effective way to quantify the intercropping benefits and defined as ratio between the relative yield of each tree and crop species in an agroforestry system in comparison with the yield of the same tree and crop species in a monoculture over the same period (Dev *et al.*, 2020). A closure perusal on the LER of Indigo under bamboo-based agroforestry has been presented in the Fig.2. Among the bamboo species, maximum LER was found in *B. balcooa* (0.94) followed by *B. tulda* (0.88). This means that the productivity of one hectare under intercropping in agroforestry is equivalent 0.8 ha to 0.9 ha in monocropping. In the current study, the LER are slightly lower for agroforestry as it was calculated only for the intercrop component excluding the bamboo productivity. Hence, if the combined productivity of both the components in agroforestry was calculated, the LER for agroforestry will be very much higher compared to monocropping. In line with the study, Rajesh *et al.* (2014) reported that, the range of LER in bamboo based agroforestry was 1.1-1.2.

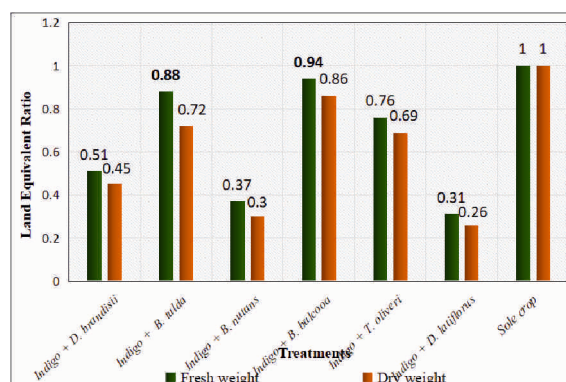


Fig. 2: Land Equivalent Ratio (LER) for the fresh and dry herbage yield of Indigo crop

4. CONCLUSION

The examination of various bamboo species and the intercrop revealed notable variations among the treatments. The findings clearly indicate that, in humid climatic conditions, *Dendrocalamus latiflorus* and *Bambusa tulda* outperformed other bamboo species in terms of clump height, culm diameter, internodal length, and the number of culms. While the agroforestry system's intercrop yield was lower than the control, *B. balcooa* and *B. tulda* maintained a consistent intercrop yield comparable to the sole crop. Consequently, cultivating Indigo under *B. balcooa* and *B. tulda* as part of a bamboo-based agroforestry system is a viable option. Despite a slight reduction in yield, this shortfall can be offset by the harvestable bamboo culms emerging from the fourth to fifth year onwards. Consequently, the overall profitability in the agroforestry system is anticipated to surpass that of monocropping, emphasizing the economic advantages of integrating bamboo-based agroforestry practices.

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