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Progeny testing and identification of superior plus tree genotypes in *Swietenia macrophylla* and *Ailanthus triphysa*

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Abstract

This study evaluated the growth and physiological performance of *Swietenia macrophylla* and *Ailanthus triphysa* plus tree progenies (2021–2023, Suhasini Hills, Thrissur) to identify superior genotypes. Genetic variability was observed in both species. In *Swietenia macrophylla*, accession FCV-SM-19 (Peruvennamuzhi) excelled in morphological traits (volume and growth rate), while FCV-SM-22 (Kottayam) showed superior physiological efficiency (photosynthetic rate and RWC). The FCV-AT-41 (Parappur) accession emerged as the overall top performer in *Ailanthus triphysa*. Genetic parameter analysis indicated moderate heritability for crown diameter, photosynthetic rate, and volume, suggesting significant potential for genetic gain. Strong positive correlations between growth and physiological traits confirm the value of integrating both for robust genotype selection, providing a scientific basis for the sustainable development of these commercially important species.

Keywords: *Ailanthus triphysa,* Genetic variability,Progeny testing, *Swietenia macrophylla*, Tree improvement

Introduction

The escalating global demand for high-quality timber has prompted a paradigm shift in forestry practices, transitioning from traditional management systems to production-oriented approaches that emphasize fast-growing, commercially valuable species (Muona, 1990). Among these, *Swietenia macrophylla* King (big-leaf mahogany) and *Ailanthus triphysa* (Dennst.) Alston (Matti) have garnered significant attention due to their rapid growth rates, desirable wood properties, and versatile applications in industries such as furniture manufacturing, match splints, and agroforestry systems (Kumar, 2000; Ali et al., 2018).

Ailanthus triphysa, indigenous to India and predominantly found in the evergreen forests of the Western Ghats, is characterized by its fast growth and straight bole, reaching merchantable girth within 6–8 years (Jamaludheen, 1994). Its lightweight wood is highly prized in the match industry, commanding premium prices of up to ₹ 6900 per cubic meter ex-depot (Government of Kerala, 2016). Beyond its economic value, the species holds ethnomedicinal significance, with various plant parts traditionally used to treat ailments such as bronchitis, dysentery, and snakebite (Ali et al., 2018). Its deep-rooted system and minimal competition with crops like ginger make it an ideal component in Kerala's agroforestry systems (Jamaludheen, 1994). Despite these advantages, the optimization of its productivity is constrained by limited studies on its genetic variability, growth performance, and physiological traits (Isaac & Nair, 2006).

Similarly, *S. macrophylla* is a globally recognized tropical hardwood species, esteemed for its premium timber utilized in high-end furniture and carpentry (Blundell, 2004). Introduced to India from Belize in 1872 (Soerianegara & Lemmens, 1993), it is extensively cultivated across the country, including in Kerala's North Forest Division plantations (Shanavas& Kumar, 2003). However, *S. macrophylla* faces significant challenges, notably damage caused by the *Hypsipyla* shoot borer, which adversely affects apical shoots, reduces timber quality, and hampers natural regeneration (Chacko et al., 2002; Entwistle, 1967; Whitmore, 1992). These issues underscore the necessity for genetic improvement programs aimed at developing superior genotypes with enhanced growth, wood quality, and resilience (Arun, 1996; Kumar et al., 2013).

Progeny testing is a cornerstone of tree improvement programs, facilitating the evaluation of parental breeding values through the assessment of progeny performance under field conditions (Dorman, 1976). This method yields more reliable genetic estimates than phenotypic selection alone, particularly for traits with moderate to high heritability (Dorman, 1976; Ghosh & Gulati, 2001). Integrating genetic diversity analysis with progeny testing further fortifies breeding programs by ensuring a broad genetic base, thereby enhancing both conservation and long-term productivity

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(Rao & Hodgkin, 2002). Recent studies have emphasized the importance of such integrated approaches. For instance, Aleena et al. (2021) conducted a comprehensive evaluation of plus trees of *S. macrophylla* in Kerala, revealing significant genetic variability among selected trees. Similarly, Lalnunpuia et al. (2021) assessed the genetic diversity of *A. triphysa* in Kerala, identifying promising candidate plus trees for future breeding programs.

Despite the critical role of these approaches, studies combining field-based progeny evaluation with genetic diversity assessments in *S. macrophylla* and *A. triphysa* remain limited. Addressing these gaps, the present study aims to evaluate the field performance, variability, and genetic diversity of plus tree seed progenies of *S. macrophylla* and *A. triphysa*. By integrating morphological, physiological, and genetic analyses, this research seeks to provide a scientific foundation for identifying superior genotypes and developing sustainable breeding strategies for these economically important species in tropical forestry.

Materials and methods

The study was conducted at Suhasini Hills (Aramkallu), under the Department of Forest Biology and Tree Improvement, College of Forestry, Kerala Agricultural University, Vellanikkara, Thrissur, during 2021–2023. The site is characterized by a warm, humid climate with an annual rainfall of less than 3000 mm, and has porous, well-drained soils conducive to plant growth. Climatic data for the study period were obtained from the Agrometeorological Observatory, College of Agriculture, Vellanikkara.

The experimental material comprised plus tree progenies of *Swietenia macrophylla* and *Ailanthus triphysa*, collected from various locations across Kerala. For *S. macrophylla*, 135 seed progenies were sourced from 45 selected plus trees distributed across the districts of Kasaragode, Kannur, Kozhikode, and Wayanad. These were established in a randomized block design (RBD) with three replications, with each accession represented by three seedlings. For *A. triphysa*, 180 seed progenies were collected from 30 plus tree populations across Thrissur district and planted in an RBD with two replications, also with three seedlings per accession (Table 1 and Table 2). Systematic morphological and physiological observations were recorded for both species throughout the study period. Four observations were taken at intervals of two months.

Morphological observations included plant height, measured from the collar to the terminal bud using an aluminum telescopic staff; collar girth, measured at the base using a measuring tape; crown width, recorded by averaging the longest and shortest crown diameters; and the number of leaves. The volume of the tree was estimated using the quarter-girth formula, and absolute growth rate was calculated as the difference in height over time.

Table 1. Details of the 45 selected plus tree mother plant of *S. marcophylla*

Altitude(m)	Locality	Accession No.	Location
High land (above 100m)	Kalpetta	FCV-SM-01	11°36’43"N76°04’14"E
		FCV-SM-02	11°36’45"N76°05’18"E
		FCV-SM-03	11°36’30"N76°04’22"E
	SulthanBathery	FCV-SM-04	11°41’25"N76°15’23"E
		FCV-SM-05	11°41’22"N76°15’24"E
		FCV-SM-06	11°41’21"N76°15’23"E
	Padinjarethara	FCV-SM-07	11°40’12"N75°58’29"E
		FCV-SM-08	11°40’28"N75°58’26"E
		FCV-SM-09	11°40’31"N75°58’22"E
	Eramanellur	FCV-SM-10	11°41’52"N76°06’17"E
		FCV-SM-11	11°41’57"N76°06’18"E
		FCV-SM-12	11°42’01"N76°06’16"E
	Mananthavady	FCV-SM-13	11°48’33"N75°56’57"E
		FCV-SM-14	11°48’43"N75°56’58"E
		FCV-SM-15	11°48’45"N75°56’45"E
Mid land (20–100m)	Puduppady	FCV-SM-16	11°27’11"N75°59’48"E
		FCV-SM-17	11°27’18"N75°59’46"E
		FCV-SM-18	11°27’54"N75°59’27"E
	Peruvennamuzhi	FCV-SM-19	11°36’07"N75°49’24"E
		FCV-SM-20	11°36’09"N75°49’30"E
		FCV-SM-21	11°36’08"N75°49’23"E
	Kottayam	FCV-SM-22	11°49’13"N75°32’59"E
		FCV-SM-23	11°49’08"N75°32’59"E
		FCV-SM-24	11°49’03"N75°32’55"E
	Taliparamba	FCV-SM-25	12°10’09"N75°23’18"E
		FCV-SM-26	12°10’10"N75°23’20"E
		FCV-SM-27	12°10’25"N75°23’30"E
	Koorachundu	FCV-SM-28	11°30’47"N75°53’18"E
		FCV-SM-29	11°30’41"N75°53’19"E
		FCV-SM-30	11°30’26"N75°53’34"E
Low land (Below 20m)	Elathur	FCV-SM-31	11°20’25"N75°44’20"E
		FCV-SM-32	11°20’02"N75°44’17"E
		FCV-SM-33	11°20’06"N75°44’12"E
	Vadakara	FCV-SM-34	11°35’31"N75°35’20"E
		FCV-SM-35	11°35’27"N75°35’22"E
		FCV-SM-36	11°35’26"N75°35’27"E
	Trikaripur	FCV-SM-37	12°08’48"N75°10’42"E
		FCV-SM-38	12°08’45"N75°10’37"E
		FCV-SM-39	12°08’45"N75°10’46"E
	Neeleswaram	FCV-SM-40	12°15’23"N75°07’41"E
		FCV-SM-41	12°15’28"N75°07’41"E
		FCV-SM-42	12°15’37"N75°07’40"E
	Padne	FCV-SM-43	12°15’10"N75°06’52"E
		FCV-SM-44	12°15’06"N75°06’49"E
		FCV-SM-45	12°14’58"N75°06’49"E

Physiological observations included chlorophyll content, measured using a SPAD-502 chlorophyll meter (Minolta) by averaging values from three heights on the plant; photosynthetic rate, transpiration rate, and stomatal conductance, recorded using a LI-6400 Portable Photosynthesis System (LI-COR) under ambient light

Table 2. List of thirty selected plus trees of *A.triphysa*

Altitude(m)	Locality	Accession No.	Location
Low lands (Below 7.5m)	Anthikad	FCV-AT-21	10°27′58.18½076°07′18.44½
		FCV-AT-22	10°27′57.67½076°07′16.96½
		FCV-AT-23	10°28′03.45½076°07′28.32½
	Manalur	FCV-AT-24	10°29′58.28½076°06′30.33½
		FCV-AT-25	10°29′57.26½076°06′31.15½
		FCV-AT-26	10°29′55.95½076°06′07.81½
Mid lands (Between 7.5 -75 m)	Pudukkad	FCV-AT-27	10°28′17.86½076°18′41.96½
		FCV-AT-28	10°28′15.52½076°18′46.49½
		FCV-AT-29	10°28′15.08½076°18′44.56½
	Chalakudy	FCV-AT-30	10°18′36.52½076°18′09.26½
		FCV-AT-31	10°18′37.01½076°18′07.94½
		FCV-AT-32	10°18′54.22½076°18′35.88½
	Wada-kkanchery	FCV-AT-33	10°39′54.68½076°16′22.07½
		FCV-AT-34	10°39′59.47½076°16′01.58½
		FCV-AT-35	10°39′55.62½076°16′24.55½
	Vengara	FCV-AT-36	11°03′01.45½075°57′53.65½
		FCV-AT-37	11°03′01.24½075°57′56.12½
		FCV-AT-38	11°02′42.06½075°56′24.74½
	Parappur	FCV-AT-39	11°02′16.91½075°59′22.49½
		FCV-AT-40	11°02′08.62½075°59′50.68½
		FCV-AT-41	11°01′49.34½075°59′51.90½
High lands (Above 75 m)	Thrikka-deeri I	FCV-AT-42	10°50′41.79½076°22′21.14½
		FCV-AT-43	10°50′42.31½076°22′21.11½
		FCV-AT-44	10°50′43.30½076°22′22.16½
	Ananganadi	FCV-AT-45	10°49′59.31½076°20′37.29½
		FCV-AT-46	10°49′59.42½076°20′37.16½
		FCV-AT-47	10°49′59.40½076°20′37.73½
	Urakam	FCV-AT-48	11°03′02.66½075°59′22.00½
		FCV-AT-49	11°03′03.17½075°59′42.17½
		FCV-AT-50	11°02′00.75½075°59′55.58½

conditions (1000–1500 lux) as per the method described by McDermitt et al. (1989); and relative water content (RWC), estimated by determining the fresh, turgid, and dry weights of leaf discs and calculating the percentage of water retained. Genetic parameters such as genotypic variance, phenotypic variance, phenotypic and genotypic coefficients of variation, heritability (broad sense), and genetic advance were calculated using standard methods described by Johnson et al. (1955), Burton and De-Vane (1953), and Lush (1940). The selection intensity for calculating genetic advance was assumed to be 2.06, corresponding to 5% selection pressure. Statistical analyses, including estimation of genetic parameters, correlation analysis, and significance testing, were performed using the R software package (R Core Team, 2023).

Results and discussion

Evaluation of the Seed Progenies

Morphological Traits

The evaluation of morphological traits among the seed progenies of *Swietenia macrophylla* and *Ailanthus triphysa* revealed significant variability across plant height, collar girth, crown diameter, volume, and absolute growth rate (AGR), highlighting the genetic diversity and potential for selection within these species. In *S. macrophylla*, plant height ranged from 1.32 to 4.67 m, collar girth from 0.10 to 0.33 m, crown diameter from 0.50 to 1.37 m, and volume from 0.005 to 0.041 m^3. Similarly, *A. triphysa* progenies showed plant height from 1.15 to 3.42 m, collar girth from 0.08 to 0.27 m, crown diameter from 0.45 to 2.44 m, and volume from 0.004 to 0.029 m^3. AGR analysis indicated higher growth rates among certain progenies in both species.

Overall, FCV-SM-19 (Peruvennamuzhi) in *S. macrophylla* and FCV-AT-41 (Parappur) in *A. triphysa* emerged as the top-performing progenies, with FCV-SM-19 showing superior performance in volume and absolute growth rate, and FCV-AT-41 consistently excelling across all morphological and physiological traits studied. Other accessions such as FCV-SM-07, FCV-SM-12, FCV-SM-13, FCV-SM-22 (*S. macrophylla*) and FCV-AT-31, FCV-AT-35, FCV-AT-46 (*A. triphysa*) also demonstrated strong growth potential. Conversely, progenies like FCV-SM-15, FCV-AT-24, and FCV-AT-36 consistently showed lower growth across parameters, indicating limited potential for inclusion in breedingprograms (Table 3).

These findings align with earlier studies (Lalnunpuia*et al*., 2021; Kumar et al., 2013), emphasizing the utility of morphological traits in identifying superior genotypes for tree improvement. The strong positive correlations observed among traits further support their use as reliable selection criteria in breeding programs.

Detailed trait-wise measurements for all accessions and observation intervals are presented in Supplementary Tables S1–S6 and S11–S15.

Physiological Traits

The assessment of physiological traits, including chlorophyll content, photosynthetic rate, transpiration rate, stomatal conductance, and relative water content (RWC), revealed considerable variability among progenies, reflecting the combined influence of genetic and environmental factors. In *S. macrophylla*, chlorophyll content ranged from 41.20 to 59.60 SPAD units, photosynthetic rate from 6.12 to 11.71 $\mu mol\ m^{-2}\ s^{-1}$, and RWC from 75.33% to 90.67%. For *A. triphysa*, values ranged from 34.12 to 46.07 SPAD units

Table 3. Summarising top progenies for each species across traits

Trait	*S. macrophylla* Top Performers	*A. triphysa* Top Performers
Plant Height	FCV-SM-19, FCV-SM-07	FCV-AT-41, FCV-AT-31
Collar Girth	FCV-SM-19, FCV-SM-07	FCV-AT-41, FCV-AT-45
Crown Diameter	FCV-SM-19, FCV-SM-07	FCV-AT-31, FCV-AT-46
Volume	FCV-SM-19, FCV-SM-07	FCV-AT-41, FCV-AT-46
Chlorophyll Content	FCV-SM-22, FCV-SM-19	FCV-AT-41, FCV-AT-31
Photosynthetic Rate	FCV-SM-22, FCV-SM-19	FCV-AT-41, FCV-AT-31
RWC	FCV-SM-22	FCV-AT-41

(chlorophyll), 4.10 to 8.67 µmol $m^{-2} s^{-1}$ (photosynthetic rate), and 70.15% to 90.23% (RWC).

Across both species, FCV-SM-22 (Kottayam; *Swietenia macrophylla*) and FCV-AT-41 (Parappur; *Ailanthus triphysa*) consistently demonstrated superior physiological efficiency, characterized by higher chlorophyll content, photosynthetic rate, and relative water content. Among the other well-performing progenies, FCV-SM-19 (Peruvennamuzhi), FCV-SM-13 (Mananthavady), FCV-SM-07 (Padinjarethara), FCV-AT-31 (Chalakudy), FCV-AT-42 (Thrikkadeeri I), and FCV-AT-46 (Ananganadi) also exhibited strong physiological performance. In contrast, FCV-SM-14 (Mananthavady), FCV-AT-24 (Manalur), FCV-AT-25 (Manalur), and FCV-AT-36 (Vengara) consistently exhibited lower physiological values, suggesting limited adaptability and resilience (Table 3).

These results underscore the importance of physiological traits in supporting growth and adaptability, as further reinforced by strong positive correlations between physiological parameters (chlorophyll content, photosynthetic rate, RWC) and morphological traits (height, girth, volume). This pattern aligns with earlier findings in *Tectona grandis* (Huang et al., 2019), and *Populus nigra* (Chu et al., 2010).

Heritability estimates for physiological traits were generally lower than for morphological traits, indicating stronger environmental influence. Stomatal conductance and transpiration rate exhibited low heritability, while photosynthetic rate showed moderate heritability ($H^2 = 0.57$ in *A. triphysa*), suggesting potential for selection under optimized site conditions.

Detailed trait-wise measurements for all accessions and observation intervals are presented in Supplementary Tables S7–S10 and S16–S19.

Genetic Parameters of Morphological and Physiological Traits

Genetic parameter analysis revealed that in *S. macrophylla*, the phenotypic coefficient of variation (PCV) consistently exceeded the genotypic coefficient of variation (GCV) for all traits, indicating substantial environmental influence. Plant height exhibited a PCV of 25.32% and a GCV of 10.92%, with low heritability ($H^2 = 0.18$) and genetic advance (9.70%). Girth showed a PCV of 23.55%, a GCV of 11.77%, heritability of 0.25, and a genetic advance of 12.12%. Crown diameter demonstrated a PCV of 20.17%, a GCV of 12.05%, moderate heritability (0.35), and a genetic advance of 14.84%.

Physiological traits in *S. macrophylla* exhibited higher variability but lower heritability. Photosynthetic rate had a PCV of 89.29%, a GCV of 29.88%, low heritability (0.11), and a genetic advance of 20.60%. Stomatal conductance showed a PCV of 51.76%, a GCV of 9.29%, very low heritability (0.03), and a genetic advance of 3.44% (Table 4).

In *A. triphysa*, physiological traits such as photosynthetic rate, RWC, and volume exhibited moderate to high heritability, suggesting stronger genetic control. For example, photosynthetic rate showed higher heritability, indicating that it could be improved through selection. Volume exhibited the highest variability (PCV 45.18%, GCV 19.67%) with a heritability of 0.19, indicating scope for genetic improvement (Table 5). Traits like height, girth, crown diameter, and chlorophyll content demonstrated lower heritability, highlighting the influence of environmental factors. These findings are consistent with reports from *Melia dubia* (Kumar et al., 2013), *Ailanthus excelsa* (Daneva et al., 2018), and *Leucaena leucocephala* (Sathyaand Parthiban, 2018).

Morpho-Physio CharacterCorrelation Studies

The correlation analysis of morphological and physiological traits in *Swietenia macrophylla* (Table 6) and *Ailanthus triphysa* (Table 7) revealed strong, positive relationships among key growth parameters, highlighting their interconnected roles in determining overall tree performance. In *S. macrophylla*, height showed significant positive correlations with girth (r = 0.94**), crown diameter (r = 0.80**), photosynthetic rate (r = 0.93**), chlorophyll

Table 4. Estimated genetic parameters of morphological and physiological traits of *Swietenia macrophylla* plus tree seed progenies

Parameters	GV	PV	EV	CV(%)	PCV (%)	GCV (%)	H^2	GA (%)(i=5%)
Height	0.07	0.38	0.31	22.84	25.32	10.92	0.18	9.70
Girth	0.00	0.00	0.00	20.39	23.55	11.77	0.25	12.12
Crown Diameter	0.00	0.02	0.01	16.17	20.17	12.05	0.35	14.84
Photosynthetic rate	1.53	13.7	12.18	84.14	89.29	29.88	0.11	20.60
Stomatal conductance	0.01	0.02	0.02	50.92	51.76	9.29	0.03	3.44
Transpiration rate	0.05	1.54	1.53	46.95	47.03	2.68	0.00	0.31
Chlorophyll content	6.93	38.35	31.4	13.82	15.27	6.49	0.18	5.69
RWC	5.62	26.76	21.14	5.97	6.72	3.08	0.21	2.91
Volume	0.02	0.10	0.08	52.12	58.3	26.28	0.20	24.37

*PV:Phenotypic variation,GV:Genotypic variation, H^2:Heritability, PCV: Phenotypic coefficient of variation, GCV: Genotypic coefficient of variation, GA: Genetic Advance

Table 5. Estimated genetic parameters of morphological traits and of physiological traits of *A.triphysa* plus tree seed progenies

Parameters	GV	PV	EV	CV(%)	PCV (%)	GCV (%)	H2	GA (%)(i=5%)
Height	0.02	0.11	0.09	14.71	16.13	6.64	0.17	5.62
Girth	0.01	0.01	0.01	16.34	17.65	6.67	0.14	5.20
Crown Diameter	0.01	0.08	0.07	18.22	19.18	6.01	0.10	3.88
Photosynthetic rate	1.06	1.88	0.81	8.28	12.57	9.47	0.57	14.68
Stomatal conductance	0.02	0.11	0.09	11.20	12.32	5.14	0.17	4.42
Transpiration rate	0.00	0.00	0.00	18.54	20.02	7.57	0.14	5.89
Chlorophyll content	7.75	16.20	8.44	3.47	4.81	3.33	0.48	4.74
RWC	8.62	20.41	11.79	8.63	11.36	7.38	0.42	9.88
Volume	0.02	0.09	0.07	40.67	45.18	19.67	0.19	17.64

*PV: Phenotypic variation, GV: Genotypic variation, H2:Heritability, PCV: Phenotypic coefficient of variation, GCV:Genotypic coefficient of variation, GA: Genetic Advance

content (r = 0.95**), RWC (r = 0.89**), and volume (r = 0.96**). Similar associations were observed for girth, crown diameter, and photosynthetic traits. A negative correlation between transpiration rate and photosynthetic rate (r = -0.95**) suggests a trade-off between carbon assimilation and water loss.

In *A. triphysa*, height correlated positively with girth (r = 0.94**), crown diameter (r = 0.61**), photosynthetic rate (r = 0.72**), chlorophyll content (r = 0.83**), RWC (r = 0.89**), and volume (r = 0.92**). Girth also showed strong correlations with other traits, reinforcing the trend that more vigorous trees tend to exhibit higher photosynthetic efficiency and water retention.

These findings are consistent with previous studies in *A. triphysa* (Lalnunpuia et al., 2021), and *Tectona grandis* (Huang et al., 2019), emphasizing the value of integrating physiological traits like photosynthetic rate, chlorophyll content, and RWC into selection strategies. Multi-trait selection approaches that combine morphological and physiological traits provide a robust framework for identifying superior plus tree genotypes in *S. macrophylla* and *A. triphysa*.

Conclusion

This study demonstrates the extent of genetic variability and performance differences among plus tree seed progenies of *Swietenia macrophylla* and *Ailanthus triphysa*, highlighting their potential for targeted selection in breeding programs. Morphological evaluations revealed that FCV-SM-19 (Peruvennamuzhi) in *S. macrophylla* and FCV-AT-41 (Parappur) in *A. triphysa* consistently outperformed other accessions across plant height, collar girth, crown diameter, volume, and absolute growth rate, while FCV-SM-22 (Kottayam) in *S. macrophylla* recorded the highest chlorophyll content, photosynthetic rate, and relative water

Table 6. Correlation study of the morphological and physiological characters of plus tree seed progeny *Swietenia macrophylla*

	H	G	CD	PR	SC	TR	CC	RWC	V
H	1								
G	0.94**	1							
CD	0.8**	0.96**	1						
PR	0.93**	0.86**	0.67**	1					
SC	0.41	0.44	0.99**	0.51**	1				
TR	0.54**	0.28	0.46	-0.95**	0.65	1			
CC	0.95**	0.68	0.76**	0.99**	0.27	0.90**	1		
RWC	0.89**	0.97**	0.76**	0.94**	0.26	0.76	0.78**	1	
V	0.96**	0.63	0.78**	0.68**	0.47	0.36	0.99**	0.90**	1

** H: Height, G: Girth, V: Volume, CD: Crown diameter, CC: Chlorophyll content, PR: Photosynthetic rate, SC:Stomatal conductance,TR:Transpiration rate, RWC: Relative water content

Table7. Correlation studyof the morphological and physiological characters of plus tree seed progeny of *Ailanthus triphysa*

	H	G	CD	PR	SC	TR	CC	RWC	V
H	1								
G	0.94**	1							
CD	0.61**	0.69**	1						
PR	0.72**	0.68**	0.41**	1					
SC	0.56**	0.67**	0.29*	0.48**	1				
TR	0.42**	0.45**	0.67**	0.38**	0.147	1			
CC	0.83**	0.76**	0.51**	0.66**	0.46**	0.41**	1		
RWC	0.89**	0.84**	0.60**	0.66**	0.47**	0.44**	0.77**	1	
V	0.92**	0.99**	0.61**	0.71**	0.70**	0.40**	0.75**	0.81**	1

**H:Height, G:Girth, V:Volume , CD:Crown diameter, CC: Chlorophyll content, PR: Photosynthetic rate, SC: Stomatal conductance, TR: Transpiration rate, RWC: Relative water content

content, indicating superior physiological efficiency. In *A. triphysa*, FCV-AT-41 (Parappur) also emerged as a top performer across physiological traits, suggesting its adaptability and resilience.. Genetic parameter analysis showed moderate heritability for crown diameter, photosynthetic rate, and volume, indicating potential for genetic improvement through selection, while traits such as stomatal conductance and transpiration rate exhibited low heritability, reflecting stronger environmental influence. Correlation studies highlighted strong positive associations among key morphological and physiological traits, suggesting that improving physiological efficiency, particularly chlorophyll content and water-use traits, can indirectly enhance growth performance. These findings emphasize the importance of integrating physiological traits into selection strategies alongside morphological traits for developing high-performing and adaptable tree populations. The study identifies FCV-SM-19 (Peruvennamuzhi) and FCV-SM-22 (Kottayam) of *Swietenia macrophylla*, along with FCV-AT-41 (Parappur) of *Ailanthus triphysa*, as promising candidates for future breeding programs and seed orchard development aimed at improving productivity and resilience in these species. However, the study is limited to a single-site evaluation under specific environmental conditions; therefore, multi-location trials and long-term monitoring are essential to validate the stability and adaptability of these progenies across diverse environments.

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