Seed Source Variability in *Terminalia arjuna* (Roxb.) W.&A. and *Terminalia tomentosa* W.&A.

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Terminalia arjuna and *T. tomentosa* are perennial and hard wood trees and are of tremendous economic importance besides primary food plants of tasar silkworm *Antheraea mylitta* D. Seeds are the principal source of natural regeneration and propagation in these species. A wide variation for twelve seed traits was observed in different seed sources of diverse origin in both the species collected from various locations. A positive and significant correlation was found between seed germination and seed weight, total biomass production and vigour index. On the other hand, a negative and significant correlation was recorded for days taken for initial germination and complete germination with width of wings. Present study will help in identification of genotypes that can be propagated at mass scale through seedlings.

Key words: *Terminalia* (Roxb.) species, Seed variability, Germination, Vigour index

Terminalia arjuna (Roxb) W&A and *T. tomentosa* are perennial, hard wood tree species of family Combretaceae.The trees are of immense economic importance in various industries like, pharmaceutical, timber, paper, fuel, fodder and lastly the foliage of these trees is primary food for tasar silkworm *Antheraea mylitta* D. Despite its great importance, the information available on the genetic variability of these species is insufficient. *T. arjuna* and *T. tomentosa* are widely distributed throughout the humid and semi-humid tropical forests in India up to an elevation of 1200 m. This variability within a population of tree species has been exploited during the selection of superior provenance for a given site to evolve strategies for the conservation of genetic diversity within population of tree species. It is well established that seeds are principal means of propagation and contain a lot of variation depending upon the source of origin with regard to morphological and physiological characters (Mathur *et al.*, 1984 and Vakshasya *et al.*, 1992.). Seed weight and size give an idea about the supply of potential energy available for seedling during its initial growth. It also indicates the amount of reserves available to the embryo for its growth and development and total biomass production in seedling stage (Shukla *et al.*, 2000). Knowledge of genetic variability is also required to evaluate the composition of group variation and to see evolutionary potentialities of the group (Luna *et al.*, 2006). The significance of these studies and seed source/ provenance testing in forest tree improvement is well recognized. Therefore, it was thought it is prudent to study variation in seed traits and germination characteristics which could be used is index for the evaluation of provenance in *T. arjuna* and *T. tomentosa* for improvement.

Material and Methods

Fully matured seeds were collected in March-April 2002 from five best trees among each identified seed source following the method for selection of candidate plus trees. Table 1 shows the details of the site of collection of seeds. The selected trees were mature but of different ages as it is not possible to get trees of the same age. It is prudent that seeds of mature trees will not differ much in their physiological characters. After harvest, seeds were sun dried for three days and stored in cloth bags under ambient condition in laboratory. For variability studies, seed weight, length, diameter and width of wings were recorded with the help of vernier calipers. Germination test were conducted using four replicates of 25 seeds from each genotype. The seeds were subjected to pretreatment of soaking in ordinary water for 48 for *T. tomentosa* and 96 hours for *T. arjuna* (Anonymous, 1985).Presoaked seeds were sown in polybags of 10 x 40 cm size filled with sterile river sand. Each bag contained one seed. Though germination started a week after sowing final number of germinated seedlings were counted after 45 days of sowing. Time taken for commencement and complete germination was recorded in each replication. The length of root and shoot of the seedlings were measured after 45 days after complete germination when there was no further improvement in per cent germination. Fresh and dry weight of the seedlings was also recorded for calculating the total biomass production. Vigour index was calculated as per the method of Abdul Baki and Anderson (1973). All the data were analyzed statistically.

Table 1. Places of seed collection and variation in respect to seed characters

Species	Place of collection	State	Single Seed Weight (g)	Seed Diameter (cm)	Seed Length (cm)	Width of wing (cm)
T. arjuna	Nawegaon	Maharashtra	4.95	10.63	3.65	1.29
T. arjuna	Arjuni	Maharashtra	1.90	6.58	3.63	.51
T. arjuna	Pahela	Maharashtra	2.06	6.66	3.63	0.46
T. arjuna	Laxmapur	Andhra Pradesh	2.10	6.72	3.47	0.54
T. arjuna	Mudimyal	Andhra Pradesh	4.30	6.71	3.29	0.53
T. arjuna	Narsapur	Andhra Pradesh	2.80	2.82	4.05	1.05
T. arjuna	Harrawala	Uttaranchal	4.30	6.48	4.57	1.32
T. arjuna	U.S.Nagar	Uttaranchal	3.20	8.51	5.10	1.25
T. arjuna	Laldhang	Uttaranchal	2.06	6.42	3.17	1.22
T. arjuna	Baharagoda	Jharkhand	2.65	13.17	6.22	1.33
T. arjuna	Chakradharpur	Jharkhand	3.52	8.07	6.30	1.18
T. arjuna	Pakhandeeh	Jharkhand	2.55	6.23	2.97	1.17
T. tomentosa	Khapa	Maharashtra	1.59	8.08	3.47	1.45
T. tomentosa	Nishti	Maharashtra	1.64	11.95	3.57	1.55
T. tomentosa	Vitoli	Maharashtra	1.52	11.45	3.49	1.53
T. tomentosa	Jawahar forest	Andhra Pradesh	1.63	10.60	3.63	1.45
T. tomentosa	Garopally	Andhra Pradesh	1.49	12.19	3.49	1.76
T. tomentosa	Kothapally	Andhra Pradesh	3.14	9.18	4.29	1.26
T. tomentosa	Rudraprayag	Uttaranchal	1.24	13.40	6.53	1.32
T. tomentosa	Harbartpur	Uttaranchal	3.09	14.35	6.73	2.12
T. tomentosa	Amauta	Uttaranchal	2.05	8.28	3.60	1.90
T. tomentosa	Bahata	Jharkhand	3.31	14.08	6.90	2.02
T. tomentosa	Kuchai	Jharkhand	1.93	13.60	6.67	1.98
T. tomentosa	Ranka	Jharkhand	2.63	13.40	6.00	2.17
Mean			2.57	9.56	4.52	1.35
Range			1.24-4.95	2.82-14.35	2.97-6.90	0.46-2.17
SEm±			0.96	0.97	0.07	0.06
CD at 5%			1.60	1.62	0.12	0.10

Results and Discussion

The mean, range and variance of 24 genotypes of two species for 12 characters are presented in Tables 1 and 2. Range of seed weight varied between 1.9 to 4.95 g in *T. arjuna* and 1.24 to 3.31 g in *T. tomentosa*; seed length (2.97 to 6.3 cm in *T. arjuna* and 3.47 to 6.9 cm in *T. tomentosa*); width of wings (0.46 to 1.33 cm in *T. arjuna* and 1.26 to 2.17 cm. in *T. tomentosa*) and seed diameter 2.82 to 13.17 cm in *T. arjuna* and 8.08 to 14.35 cm in *T. tomentosa.*

Days taken for complete germination were 8.33 to 40.33 in *T. arjuna* and 9.0 to 22.33 days in *T. tomentosa.* Seed germination ranged between 6 to 76 % in *T. arjuna* as compared to 15.67 to 81 % in *T. tomentosa.* A wide range for root length in *T. arjuna* (25.10 to 33.14 cm) and *T. tomentosa* (25.68 to 32.67 cm) was observed. Similarly, variation in shoot length was also recorded in both species.There was not much difference in the range for total biomass production on dry and fresh weight basis in all the genotypes in both species. However, vigour index varied greatly and it was 68.23 to 1068.04 % in *T. arjuna* and 172.57 to1136.03 % in *T. tomentosa.*

Data indicate that significantly maximum values for seed weight (4.95 g), days taken for initial germination (38.67), days taken for complete germination (40.33) and root length (33.14 cm) were recorded for *T.arjuna.* Whereas, seed diameter (14.35 cm), seed length (6.90 cm), width of wings (2.17cm), seed germination (81.0 %), shoots length (18.70 cm), total biomass on fresh (3.80g) and dry weight basis (0.92 g) and vigour index (1136.03) were higher for *T. tomentosa.*

In character association analysis (Table 3) some of the important combinations showed positive and significant relationship such as seed weight with seed germination; seed diameter with seed length, width of wings and total biomass production; width of the wings with seed germination; dry biomass production and vigour index; seed germination with total biomass production and vigour index with biomass production. On the other hand, a negative and significant correlation was recorded for days taken for initial germination and complete germination with width of wings.

Similar results have been reported by Bhagat *et al.*, (1993) and Kumar and Gargi, (1998) in *Aesculus indica* and *Heteropanax fragrans*, respectively, wherein it was

Table 2. Mean values of various seed traits in *T. arjuna* and *T. tomentosa*

Species collection	Place of	State	DASIG	DASCG	SG (%)	SL (cm)	RL (cm)	BMFW (g)	BMDW (g)	VGI (%)
T. arjuna	Nawegaon	Maharashtra	19.33	21.33	76.00	16.82	32.92	3.60	0.87	1068.04
T. arjuna	Arjuni	Maharashtra	25.67	32.33	6.00	16.53	31.00	2.59	0.55	68.23
T. arjuna	Pahela	Maharashtra	38.67	40.33	23.00	13.61	33.14	2.19	0.45	325.42
T. arjuna	Laxmapur	Andhra Pradesh	34.67	35.33	16.33	12.90	28.23	1.96	0.46	198.63
T. arjuna	Mudimyal	Andhra Pradesh	18.67	20.33	25.33	12.91	32.84	1.81	0.48	356.67
T. arjuna	Narsapur	Andhra Pradesh	11.67	14.33	33.00	14.57	25.40	2.11	0.44	429.57
T. arjuna	Harrawala	Uttaranchal	6.33	8.67	70.67	9.33	30.68	2.70	0.60	497.74
T. arjuna	U.S.Nagar	Uttaranchal	11.67	15.33	41.33	14.23	25.10	2.14	0.46	1059.28
T. arjuna	Laldhang	Uttaranchal	6.67	8.33	20.67	16.67	31.83	2.84	0.54	493.84
T. arjuna	Baharagoda	Jharkhand	6.67	14.00	30.67	10.03	25.83	2.75	0.73	753.16
T. arjuna	Chakradharpur	Jharkhand	10.00	12.67	65.33	15.40	25.75	2.39	0.52	849.74
T. arjuna	Pakhandeeh	Jharkhand	11.33	13.00	58.00	15.60	28.73	3.09	0.65	726.53
T. tomentosa	Khapa	Maharashtra	10.67	15.67	46.00	9.97	25.93	2.67	0.63	509.77
T. tomentosa	Nishti	Maharashtra	11.33	15.67	41.33	9.50	30.83	2.76	0.64	414.38
T. tomentosa	Vitoli	Maharashtra	13.00	15.67	15.67	8.50	32.67	2.57	0.63	172.57
T. tomentosa	Jawahar forest	Andhra Pradesh	14.00	16.67	42.33	9.62	32.42	3.04	0.58	596.00
T. tomentosa	Garopally	Andhra Pradesh	12.33	15.00	32.33	8.53	25.68	2.65	0.58	1048.23
T. tomentosa	Kothapally	Andhra Pradesh	16.33	22.33	81.00	17.83	31.23	3.57	0.90	1136.03
T. tomentosa	Rudraprayag	Uttaranchal	6.67	9.00	40.00	17.18	32.67	3.67	0.93	270.84
T. tomentosa	Harbartpur	Uttaranchal	8.67	12.00	50.00	12.50	32.33	1.87	0.52	564.19
T. tomentosa	Amauta	Uttaranchal	11.33	12.33	60.67	13.00	27.83	2.12	0.47	338.48
T. tomentosa	Bahata	Jharkhand	11.00	14.00	65.33	18.70	32.43	3.79	0.97	842.81
T. tomentosa	Kuchai	Jharkhand	10.33	12.33	45.33	16.83	31.00	2.96	0.82	918.24
T. tomentosa	Ranka	Jharkhand	11.33	14.67	60.00	17.67	31.83	3.80	0.92	964.63
Mean			14.10	17.14	43.60	13.69	29.93	2.73	0.64	608.46
Range			6.33–38.67	8.33–40.33	6.00–81.00	8.50–18.70	25.10–33.14	1.81–3.80	0.44–0.97	68.23–1136.03
S Em			0.46	0.67	1.13	0.33	0.45	0.10	0.02	3.66
CD at5 %			0.79	1.11	1.88	0.54	0.75	0.16	0.03	6.11

DASIG days taken for initial germination; DASCG days taken for complete germination; SG seed germination; SL shoot length; RL root length; BMFW biomass on fresh weight basis; BMDW biomass on dry weight basis; VGI vigour index.

Table 3. Correlation coefficient for twelve characters of *T. arjuna* and *T. tomentosa*

	SSW(g)	SD(cm)	SEL(cm)	WW(cm)	DASIG	DASCG	SG (%)	SL(cm)	RL(cm)	BMFW(g)	BMDW(g)
SD(cm)	–0.1666										
SEL(cm	0.1444	0.638**									
WW(cm)	–0.1049	0.722**	0.510*								
DASIG	–0.0370	–0.356	–0.406	–0.667							
DASCG	–0.0542	–0.316	–0.370	–0.672	0.978**						
SG (%)	0.5279*	0.218	0.325	0.491*	–0.386	–0.397					
SL(cm)	0.2544	0.003	0.355	–0.006	0.069	0.056	0.295				
RL(cm)	0.0860	0.287	0.025	0.023	0.204	0.164	0.020	0.263			
BMFW(g)	0.0047	0.473*	0.281	0.393	–0.287	–0.251	0.495*	0.467*	0.360		
BMDW(g)	0.0835	0.643**	0.482*	0.468*	–0.304	–0.255	0.504*	0.472*	0.383	0.923**	
VGI (%)	0.3895	0.354	0.344	0.453*	–0.319	–0.291	0.649**	0.281	–0.216	0.452*	0.460*

SSW (g) Single seed weight in gram; SD (cm) seed diameter in cm; SEL (cm) seed length in cm; WW (cm) width of wings in cm; DASIG days taken for initial germination; DASCG days taken for complete germination; SG (%) seed germination; SL (cm) Shoot length in cm; RL (cm) root length in cm; BMFW (g) biomass on fresh weight basis in g; BMDW (g) biomass on dry weight basis in g; VGI (%) vigour index.

concluded that heavier seed weight classes performed significantly better in terms of germination, survival, seedling weight and dry biomass than lighter seed weight classes. Relationship between seed weight with seed germination and vigour index has also been reported in mulberry (Dandin *et al.*, 1991), mango (Giri and Chaudhary, 1996) and in Ber (Srivastava *et al.*, 2001). Mange and Sen (1995) also observed that germination percentage in *Prosopis cineraria* can be improved by selecting large and heavy seeds. Our findings are also in consonance with the above.

It is concluded from the present study that a significant amount of genetic variability for various seed traits (seed weight, diameter, germination per cent, vigour

index) is present in *T. arjuna* and *T. tomentosa* and heavy and large seeds have to be chosen for raising healthy seedlings. The identified genotypes have been established in the field gene bank at CTR. and TI., Nagri, Ranchi for utilization in large scale planting/tree improvement/ future breeding programme.

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