STUDIES ON ENHANCING SEED GERMINATION AND SEEDLING VIGOUR IN TEAK (*TECTONA GRANDIS*)

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MANONMANI, V. & VANANGAMUDI, K. 2003. Studies on enhancing seed germination and seedling vigour in teak (*Tectona grandis*). Several seed treatments were tried to improve the germination of fresh teak drupes taken from Kallar, India. These drupes had earlier been characterised by poor germination. Scarification using commercial grade sulphuric acid at 50 ml/100 g of drupe for 1 h followed by soaking in water for 24 h improved the germination from 17.0 to 45.0%. The germination was early by 8.6 days and seedling vigour parameters in terms of root and shoot lengths, dry matter production and vigour index were also higher. Soaking of acid scarified drupes in 2% KNO_3 improved the germination from 17.6 to 54.5%. The germination was early by 10.2 days. The seedling vigour parameters were also higher in this treatment. Seeds soaked in 1% KNO_3 performed equally well (54.0% mean germination). Hence it is recommended that acid scarified drupes be soaked in 1% KNO_3 to enhance the germination and seedling vigour.

Key words: Drupes - teak - India - seed treatment - acid scarified - soaking

MANONMANI, V. & VANANGAMUDI, K. 2003. Kajian membaiki percambahan biji benih dan kecergasan anak benih jati (*Tectona grandis*). Drup jati segar dari Kallar, India mempunyai percambahan yang lemah. Untuk meningkatkan percambahannya, beberapa rawatan biji benih dicuba. Pelelasan drup menggunakan asid sulfurik gred komersial pada nisbah 50 ml/100 g drup selama satu jam diikuti dengan rendaman di dalam air selama 24 jam meningkatkan percambahan daripada 17.0 hingga 45.0%. Percambahan adalah 8.6 hari lebih awal dan parameter kecergasan anak benih dari segi panjang akar dan pucuk, pengeluaran bahan kering dan indeks kecergasan juga lebih tinggi. Drup terlelas yang direndam dalam 2% KNO_3 meningkatkan percambahan daripada 17.6 hingga 54.5%. Percambahan adalah 10.2 hari lebih awal. Parameter kecergasan anak benih juga tinggi dalam rawatan ini. Biji benih yang direndam dalam 1% KNO_3 menghasilkan percambahan yang sama baik (54.0%). Oleh itu disyorkan supaya drup yang dilelas asid direndam dalam 1% KNO_3 untuk meningkatkan percambahan dan kecergasan anak benih.

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Introduction

Teak (*Tectona grandis*), one of the most well-known timber species, has fine grain, beautiful golden colour, strength and durability, and also immunity against some insects and fungi. With increasing demand for teak timber, planting of teak has attracted both government and private sectors such that investments in this field have multiplied rapidly.

Germination of teak drupe is generally poor and sporadic. Delay in germination may be due to insufficient after-ripening, a phenomenon sometimes classified as a kind of dormancy. Recent research indicates that the main reason for dormancy in teak is mechanical resistance caused by the hard stony endocarp. The presence of inhibitors in the soft felty mesocarp may also be a contributory factor. The complex nature of dormancy and the means of overcoming it are major problems in the nursery. Extensive work has been carried out on many different methods of pretreatment to improve the germination of harvested fresh drupes of teak. None of these is applicable for all types of teak drupe; in fact different seed sources require different pretreatments. Although pre-treatments may vary in length and intensity, they all aim at softening the hard endocarp, removing or reducing the effect of the soft mesocarp and shortening the dormancy period.

Materials and methods

Mature drupes of *Tectona grandis* were collected directly from the crown of selected plus trees of four different seed sources, viz. Top slip, Siruvani, Mudumalai and Kallar in the western zone of Tamil Nadu, India, during 1995. The physiographic features and environmental factors of different seed sources are given in Table 1. The drupes were then cleaned to remove ill-filled, immature and damaged seeds.

Drupes collected from Kallar which gave poor germination (25%) when compared to the other sources (30 to 37%) were subjected to different pretreatments to enhance their germination.

Table 1 Physiographic features and environmental factors of different seed sources of teak

Particulars	Top Slip	Siruvani	Mudumalai	Kallar
Elevation (m asl)	780	350	1300	360
Latitude	10°26°N	11°N	11°43°N	11°19°N
Longitude	70°48°E	77°E	76°45°E	76°56°E
Annual rainfall (mm)	2400	2300	2200	1400
Temperature (°C)				
Maximum	33	28–35	33	25–32
Minimum	20	22	20	19–20
Relative Humidity (%)	55	60	60	70–80

Experiment I. Effect of acid scarification on germination improvement in teak drupes

Fresh drupes were subjected to the following treatments:

1. No scarification (control) (A0)
2. Alternate soaking in water for 12 h overnight and shade drying for 12 h during the day for 6 days (A1)
3. Acid scarification with commercial grade sulphuric acid (50 ml/100 g of drupe) for 30 min (A2)
4. Acid scarification for 1 h (A3)
5. Acid scarification for 2 h (A4)
6. Acid scarification for 4 h (A5)
7. Acid scarification for 30 min followed by water soaking for 24 h (A6)
8. Acid scarification for 1 h followed by water soaking for 24 h (A7)
9. Acid scarification for 2 h followed by water soaking for 24 h (A8)
10. Acid scarification for 4 h followed by water soaking for 24 h (A9)

For acid scarification, 400 drupes in each treatment were placed in a plastic bucket and 50 ml of commercial grade (98%) sulphuric acid were added. Then they were stirred intermittently using pliable smooth bamboo stick. For treatments 3 to 6, after the prescribed durations, the drupes were thoroughly washed four or five times with tap water until the drupes were free of acid. For treatments 7 to 10, the acid scarified drupes were soaked in tap water for 24 h before rinsing and drying. All the shade dried drupes were then used for seed quality evaluations.

Experiment II. Influence of growth stimulants on germination enhancement in teak drupes

Fresh drupes after acid scarification for 1 h were fortified with different plant growth regulators, thiourea and potassium nitrate at various concentrations and for different soaking times as detailed below:

1. No fortification (control)
2. Water soaking for 12, 24 and 48 h
3. Soaking in indole acetic acid (IAA) at 100, 200 and 300 ppm for 12, 24 and 48 h
4. Soaking in indole butyric acid (IBA) at 100, 200 and 300 ppm for 12, 24 and 48 h
5. Soaking in gibberellic acid (GA_3) at 0.1, 0.2 and 0.3% for 12, 24 and 48 h
6. Soaking in kinetin at 0.1, 0.2 and 0.3% for 12, 24 and 48 h
7. Soaking in thiourea at 0.5, 1.0 and 2.0% for 12, 24 and 48 h
8. Soaking in potassium nitrate (KNO_3) at 0.5, 1.0 and 2.0% for 12, 24 and 48 h

After this pretreatment, 4 × 100 drupes were set for germination using sand medium in a germination room maintained at 25±1 °C and 95±2% RH. The experiments were set up in completely randomized design (CRD). Germination count was taken at 28 days after sowing. The normal seedlings produced were counted and the germination expressed in percentage (ISTA 1993). The number of days taken for the first seedling emergence from the date of sowing was also recorded.

On the final count day, the root length of ten random seedlings was measured from the base to the tip of the tap root and expressed in cm. The shoot length was also measured from the base of the tip of the growing point of the shoot and expressed in cm. To estimate dry matter production, ten normal seedlings were oven-dried at 85±1 °C for 48 h, cooled in a desiccator for 30 min and weighed in a top pan balance with the weight expressed as g seedling^{-1}. The vigour index was calculated as the integral of the germination percentage times the seedling length in cm (Adbul-Baki & Anderson 1973). Data were subjected to an analysis of variance after Panse and Sukhatme (1967).

Results and discussion

In the present investigation, scarification using commercial sulphuric acid at 50 ml per 100 g of drupe for 1 h followed by water soaking for 24 h improved the germination from 17 to 45% (A_7). Due to this treatment, the germination was early by 8 days and seedling vigour was also higher (Table 2).

Table 2 Effect of acid scarification on germination and seedling growth of teak in the nursery

Treatment	Days of first emergence	Germination (%)	Root length (cm)	Shoot length (cm)	Dry matter production (g seedling^{-1})	Vigour index
A_0	15.8	17.0 (24.3)	4.90	6.72	0.616	198
A_1	12.2	31.0 (33.8)	5.50	6.64	0.710	342
A_2	10.4	24.6 (29.7)	5.96	6.76	0.796	313
A_3	10.4	26.2 (30.8)	6.52	6.90	0.798	352
A_4	10.6	25.2 (30.1)	6.72	7.22	0.796	351
A_5	10.2	23.8 (29.2)	5.64	6.70	0.768	294
A_6	8.2	31.4 (34.1)	6.30	7.76	0.829	442
A_7	7.2	45.0 (42.1)	7.88	8.54	0.887	739
A_8	7.2	43.0 (40.9)	6.02	7.74	0.877	592
A_9	7.2	37.0 (37.5)	5.98	6.56	0.858	464
SEd	0.3	0.39	0.21	0.18	0.001	18
CD (p=0.05)	0.7	0.79	0.42	0.37	0.003	36

(Figures in parentheses indicate arc sine transformed values).

Table 3 Effect of growth stimulants on days to first emergence, germination and root length of teak in the nursery

Treatment		Days to first emergence				Germination (%)				Root length (cm)			
		12 h	24 h	48 h	Mean	12 h	24 h	48 h	Mean	12 h	24 h	48 h	Mean
IAA	100 ppm	8.8	8.8	7.8	8.5	34.4 (35.9)	34.2 (35.8)	32.0 (34.4)	33.5 (35.4)	6.38	6.48	6.64	6.50
	200 ppm	9.0	9.2	7.4	8.5	50.8 (45.4)	51.6 (45.5)	50.0 (45.9)	50.8 (45.5)	8.72	8.68	6.18	7.86
	300 ppm	8.4	8.8	7.6	8.3	45.0 (42.1)	46.4 (43.0)	50.8 (45.5)	47.4 (43.5)	7.76	7.38	7.68	7.61
IBA	100 ppm	9.6	9.2	7.6	8.8	30.4 (33.5)	31.2 (34.0)	30.8 (34.0)	30.8 (33.7)	5.66	5.88	6.40	5.98
	200 ppm	9.4	9.2	7.4	8.7	32.2 (34.6)	33.0 (35.1)	33.0 (35.1)	32.7 (34.9)	6.86	5.94	6.64	6.48
	300 ppm	9.2	9.0	7.6	8.6	31.2 (33.9)	32.4 (34.7)	31.8 (34.3)	31.8 (34.3)	7.14	5.04	6.20	6.13
GA_3	0.1%	10.4	9.6	9.0	9.7	30.4 (33.5)	31.4 (34.1)	41.6 (40.2)	34.5 (35.9)	5.54	7.68	7.68	6.97
	0.2%	10.6	9.4	10.0	10.0	31.6 (34.2)	30.4 (33.5)	32.0 (34.4)	31.3 (34.0)	6.08	6.94	6.42	6.48
	0.3%	10.8	9.4	9.8	10.0	28.4 (32.2)	28.8 (32.5)	30.6 (33.6)	29.3 (32.7)	5.80	5.82	5.20	5.61
Kinetin	0.1%	11.0	10.2	8.6	9.9	33.6 (35.4)	36.4 (37.1)	46.8 (43.2)	38.9 (38.6)	7.58	7.76	7.42	7.59
	0.2%	11.4	10.6	8.6	10.2	33.6 (35.4)	31.6 (34.2)	34.2 (35.8)	33.1 (35.1)	7.28	6.94	4.64	6.29
	0.3%	11.4	10.4	8.6	10.1	48.2 (43.9)	50.4 (45.2)	51.8 (46.0)	50.1 (45.1)	8.04	7.90	7.00	7.65
Thiourea	0.5%	11.6	10.8	9.6	10.7	25.6 (30.4)	26.8 (31.1)	28.2 (32.1)	26.9 (31.2)	6.22	6.24	6.04	6.17
	1.0%	11.6	10.8	10.4	10.9	26.0 (30.7)	31.2 (33.9)	31.2 (33.9)	29.5 (32.9)	5.42	6.62	6.14	6.06
	2.0%	12.0	10.6	10.4	11.0	27.4 (31.6)	30.8 (33.7)	32.8 (34.9)	30.3 (33.4)	5.94	5.84	5.74	5.84
KNO_3	0.5%	7.4	6.8	6.6	6.9	46.4 (42.9)	52.8 (46.6)	50.6 (45.3)	49.9 (44.9)	7.44	8.88	8.46	8.26
	1.0%	7.4	7.4	7.2	7.3	46.4 (42.9)	57.2 (49.1)	58.4 (49.8)	54.0 (47.3)	7.94	8.72	8.20	8.29
	2.0%	7.4	6.6	7.0	7.0	51.2 (45.7)	55.2 (47.9)	57.2 (49.1)	54.5 (47.6)	7.98	8.76	8.72	8.49
Water soak		14.2	13.4	12.6	13.4	26.2 (30.7)	26.8 (31.2)	25.2 (30.1)	26.1 (30.7)	5.10	4.76	6.90	5.59
Dry drupe		17.2	17.2	17.2	17.2	17.6 (24.8)	17.6 (24.8)	17.6 (24.8)	17.6 (24.8)	4.06	4.06	4.06	4.06
Mean		10.4	9.9	9.1		34.8 (35.9)	36.8 (37.2)	38.3 (38.1)		6.65	6.82	6.62	
		C	D	CD		C	D	CD		C	D	CD	
SEd		0.23	0.09	0.39		0.32	0.12	0.55		0.11	0.04	0.19	
CD (p=0.05)		0.45	0.17	0.77		0.63	0.24	1.09		0.21	0.08	0.37	

(Figures in parentheses indicate are sine transformed values).

Table 4 Effect of growth stimulants on shoot length, dry matter production and vigour index of teak in the nursery

Treatment		Shoot length (cm)				Dry matter production (g seedling^{-1})				Vigour index			
		12 h	24 h	48 h	Mean	12 h	24 h	48 h	Mean	12 h	24 h	48 h	Mean
IAA	100 ppm	8.54	7.32	7.70	7.85	1.574	1.643	1.717	1.644	514	471	459	481
	200 ppm	10.38	9.00	7.12	8.83	1.687	1.690	1.796	1.724	971	881	665	839
	300 ppm	9.56	8.76	8.50	8.94	1.759	1.761	1.780	1.767	780	738	822	780
IBA	100 ppm	7.00	7.08	7.48	7.19	1.779	1.832	1.797	1.803	384	407	428	406
	200 ppm	8.04	7.80	7.44	7.76	1.821	1.936	1.834	1.864	480	453	464	465
	300 ppm	7.92	6.34	7.26	7.17	1.815	1.914	1.886	1.872	470	373	428	423
GA_3	0.1%	6.54	9.26	9.60	8.46	1.697	1.791	1.682	1.724	367	535	719	540
	0.2%	7.52	8.54	7.90	7.99	1.687	1.781	1.754	1.741	430	467	459	452
	0.3%	8.02	8.42	7.84	8.09	1.731	1.767	1.725	1.741	393	399	399	397
Kinetin	0.1%	9.46	9.28	9.22	9.32	1.753	1.778	1.885	1.806	573	616	778	656
	0.2%	9.28	8.86	6.84	8.33	1.721	1.776	1.984	1.827	557	466	392	472
	0.3%	9.60	9.34	9.00	9.31	1.742	1.777	1.887	1.802	850	872	828	850
Thiourea	0.5%	8.24	8.18	8.02	8.15	1.881	1.854	1.820	1.852	370	381	396	382
	1.0%	7.44	8.70	8.16	8.10	1.685	1.821	1.754	1.754	334	467	446	416
	2.0%	8.02	7.56	7.74	7.77	1.763	1.818	1.808	1.797	382	416	442	414
KNO_3	0.5%	9.44	10.42	10.34	10.07	2.079	2.224	2.209	2.171	783	1026	951	920
	1.0%	9.54	10.54	10.24	10.11	2.211	2.287	2.349	2.283	811	1101	1076	997
	2.0%	9.34	10.76	10.18	10.09	2.288	2.271	2.382	2.314	887	1059	1081	1009
Water soak		5.78	6.04	7.56	6.46	1.049	1.105	1.146	1.100	263	302	365	310
Dry drupe		4.44	4.44	4.44	4.44	0.958	0.958	0.958	0.958	150	150	150	150
Mean		8.21	8.33	8.13		1.734	1.789	1.808		537	579	587	
		C	D	CD		C	D	CD		C	D	CD	
SEd		0.13	0.05	0.23		0.011	0.004	0.019		12	4	20	
CD (p=0.05)		0.26	0.10	0.45		0.023	0.009	0.039		23	9	39	

The reasons ascribed to the enhanced germination are softening of the hard stony endocarp which renders it permeable to water and oxygen (Bonner 1984), coupled with the leaching-out of chemical inhibitors present in the soft felty mesocarp due to soaking in water (Gopal *et al.* 1972).

Similar enhancements in germination of teak drupe have also been reported due to acid scarification and water soaking (Troup 1921, Howard 1937, Wijesinghe 1963, Ngulube 1986, Yadav 1992). The beneficial effect of acid scarification followed by water soaking was also reported in other tree seeds by Elamin (1975), and Seeber and Agpaoa (1976).

Soaking of acid scarified drupes in 2% KNO_3 improved the germination from 17.6 to 54.5%. The germination was early by 10 days. The seedling vigour parameters in terms of root and shoot lengths, dry matter production and vigour index were also higher in this treatment (Tables 3 and 4).

The promotion of germination by nitrate treatment has been suggested to be due to the conversion to nitrate within the seed (Hendrics & Taylorson 1974). Nitrate has been shown to induce germination by enhancing pentose phosphate pathway activity through an inhibition of catalase and increased oxidation of NADPH2 (Roberts 1973).

It is also plausible that enhanced germination due to KNO_3 is the outcome of quantitative and qualitative shifts in protein synthesis induced by it (Leadem 1987). Dormancy is sometimes imposed by a paucity of oxygen caused by supraoptimal activity of the citric acid cycle, which utilizes all available nitrogen. Potassium nitrate has been reported to raise the ambient oxygen level by making less oxygen available for the citric acid cycle (Bewley & Black 1982). Similar results due to KNO_3 treatment were also reported in loblolly pine (Biswas *et al.* 1972), *Peltophorum ferrugineum* (Mukhopadhyay *et al.* 1990), *Casuarina equisetifolia* (Kajamaideen *et al.* 1990), *Albizia lebbeck* (Roy 1992) and *Acacia nilotica* (Palani *et al.* 1995).

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