

Germination Performance in Sowing Media and Root Trainer Performance of Indian Kino Tree

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Abstract – In order to study the germination pattern and to develop root trainer technology for *Pterocarpus marsupium* the Indian kino tree, seeds were procured from two places of central Kerala and their germination studies were conducted in six different sowing media using fresh, pretreated and seeds stored up to three months in tree consecutive years. Germination value (GV) for all the field trials was calculated that showed highest for fresh seeds without pretreatments sown in germination tray (GT). Maximum GV for pretreated seeds were recorded in control and in gibberellin 100ppm treated seeds sown in GT. Analysis of variance shows significance at 1% level between medium, between pretreatments and between years of study. Transplantation shock, bulkiness, and frequent change of polythene bags cause additional labor by conventional method but root trainers do not requires change of medium, least possibility of transplantation shock, advantage of air pruning, prevention of root coiling due to antispiral design and requirement of small area for mass production of seedlings.

Keywords – Germination Value, *Pterocarpus marsupium*, Rooting Media, Root-Trainers.

I. INTRODUCTION

Indian forests are blessed with high level of genetic plant diversity, which are known for their multifarious functions, and hence form an important component of the life supporting system. During the last decade Indian government together with other governmental and non-governmental agencies have given more importance on the use of local species for plantation, as they are eco-friendly and environmentally safe [1]. The lack of technology in mass propagation of seedlings in mechanized forest nurseries is a hurdle in promoting plantation activities [2] for most of the local, indigenous, endemic and little known under-utilized plant species. *Pterocarpus marsupium*, Roxb. is such a tree species which is known for its avenue and medicinal value. It occurs in the greater parts of the Peninsular India, extending from Gujarat up to West Bengal [3] and in Kerala, it occurs in moist, dry deciduous and semi-evergreen forests up to 1,300m [4]. The cut bark yields a deep red gum (*kino*) that forms small (3-5mm), angular, brittle, very dark ruby-red, transparent fragments on drying. In Kerala, it occurs in the evergreen and semi-evergreen forests up to 1300m, and also grown in homesteads [5]. Conventional seed and vegetative propagation with pods has not recorded successful results for the species [6]. For the mass propagation of Kino tree, root trainer technique is important and hence this study concentrates on comparative germination results and interpretation in root trainer performance so that the technology may be useful for the future forestry programs.

II. MATERIALS AND METHODS

Mature fruits were collected from cultivated mother plants at Prof. T C Joseph memorial Garden (P2), Union Christian College, Aluva and from Peechi natural stands, Thrissur (P2). All experiments in the present study was conducted during 2007 (Y1), 2008 (Y2) and 2009 (Y3) in the nursery of T.C Joseph Memorial Botanical Garden, Department of Botany, Union Christian College, Aluva, +10° 7' 30.65", +76° 20' 3.32", Kerala State, India and a pilot plantation plot was established in 2013 in the garden.

Germination studies of fresh seeds without pretreatments, with pretreatments and stored seeds up to 3 months at one-month intervals were carried out in six different media such as raised standard nursery bed (NB), germination tray with polyurethane sheets (GT), polythene bag with potting mixture (PBPM), polythene bags with coir pith (PBCP), root trainers with potting mixture (RTPM) and root trainers with coir pith (RTCP) and their results showing Germination Percentage, Percentage of sound seeds which do not germinated (obtained by embryo cut test), Viability Percentage, Peak Value (PV), Final Mean Daily Germination (MDG) FINAL, and Germination Value (GV) were obtained for each tests. Germination value was calculated by the formula proposed by [7].

III. RESULTS

Germination studies of fresh seeds without pretreatments, with pretreatments and stored seeds up to 3 months at one-month intervals were carried out in six different media and tabulated (Table I, Table II and Table III).

A. Germination performance of fresh seeds in different sowing media

Germination studies of fresh seeds without pretreatments, with pretreatments and stored seeds up to 3 months at one-month intervals were carried out in six different media such as raised standard nursery bed (NB), germination tray (GT), polythene bag with potting mixture (PBPM), polythene bags with coir pith (PBCP), root trainers with potting mixture (RTPM) and root trainers with coir pith (RTCP) and their results showing Germination Percentage, Percentage of Sound Seeds which do not Germinated (obtained by embryo cut test), Viability Percentage, Peak Value (PV), Final Mean Daily Germination (MDG) FINAL, and Germination Value (GV) were obtained for each tests and tabulated (Table I, Table II and Table III).

In the germination study of fresh seeds without pretreatments, maximum sound seeds which did not germinate after the completion of germination was observed when sown in nursery bed and the maximum viability

percentage obtained was 93%, when seeds sown in germination tray. Highest Peak Value (PV), Final MDG and Germination Value were observed in seeds sown in

germination tray. Germination value (GV) was minimum for seeds sown in raised standard nursery bed and in polythene bag with potting mixture (Table. I).

Table I: Germination of fresh seeds without pretreatments in *Pmarsupium*

Sowing Medium	Place Of Collection	Germination Percentage	% of sound ungerminated seeds	Viability Percentage	Peak Value (PV)	MDG Final	Germination Value (GV)
NB	P1	43%	12.50%	56%	0.54	2.69	1.4526
	P2	43%	10.50%	54%	0.54	2.53	1.3662
GT	P1	91.66%	0.00%	92%	2	11.46	22.92
	P2	93.05%	0.00%	93%	2.16	13.29	28.7064
PBPM	P1	45.83%	10.00%	56%	0.46	2.54	1.1684
	P2	44.44%	8.33%	53%	0.46	2.46	1.1316
PBCP	P1	54.17%	4.17%	58%	0.58	3.39	1.9662
	P2	54.17%	4.17%	58%	0.56	3.39	1.8984
RTPM	P1	45.83%	8%	54%	0.46	2.55	1.173
	P2	44.44%	8.33%	53%	0.46	2.55	1.173
RTCP	P1	56.94%	4.17%	61%	0.58	3.8	2.204
	P2	56.94%	4.17%	61%	0.58	3.56	2.0648

B. Effect of pretreatments in the germination of fresh seeds in different sowing media

In the germination study of fresh seeds with pretreatments, maximum percentage of sound seeds that did not germinate after the completion of germination was observed when seeds were pretreated with hot water and concentrated sulphuric acid and the maximum viability percentage obtained was 100 % when treated with 100ppm gibberellin. Highest Peak Value (PV) was observed in the germination result of seeds pretreated with 100ppm gibberellin acid for 20 minutes and sown in germination

tray and the lowest Peak Value obtained was 0.11 when seeds sown after treatment with concentrated sulphuric acid and sown in root trainers with potting mixture. Maximum value for Final MDG recorded was 10.18 for seeds germinated in germination tray after treatment with gibberellin 100ppm and the minimum was 0.37, when seeds were sown after pretreatment with and concentrated sulphuric acid. Maximum Germination Value recorded was 23.78194 for seeds sown in germination tray after treatment with 100ppm gibberellin (Table. 2).

Table II: Effect of pretreatments on germination in the seeds of *P. marsupium*

Sowing medium	Pretreatment	Germination percentage	% of sound ungerminated seeds	Viability percentage	Peak Value (PV)	MDG Final	Germination value (GV)
NB	Cold water	16.67%	12.50%	29%	0.16	0.98	0.1568
GT		20.83%	4.17%	25%	0.66	2.5	1.65
PBPM		20.83%	8.33%	29%	0.23	1.22	0.2806
PBCP		16.67%	8.33%	25%	0.23	1.15	0.2645
RTPM		20.83%	4.17%	25%	0.16	0.98	0.1568
RTCP		25%	2.50%	28%	0.27	1.15	0.3105
NB		Hot water	4.17%	8.33%	12%	0.1	0.46
GT	4.17%		4.17%	8%	0.12	0.92	0.1104
PBPM	4.17%		6.50%	11%	0.11	0.32	0.0352
PBCP	4.17%		4.17%	8%	0.12	0.37	0.0444
RTPM	8.33%		6.50%	15%	0.11	0.35	0.0385
RTCP	8.33%		4.17%	13%	0.1	0.37	0.037
NB	Concentrated sulphuric acid		4.17%	0.00%	4%	0.11	0.37
GT		4.17%	4.17%	8%	0.27	0.37	0.0999
PBPM		8.33%	0.00%	8%	0.11	0.35	0.0385
PBCP		8.33%	0.00%	8%	0.12	0.37	0.0444
RTPM		4.17%	4.17%	8%	0.11	0.37	0.0407
RTCP		12.50%	0.00%	13%	0.12	0.66	0.0792
NB		Seed coat removed	25%	20.88%	46%	0.27	1.38
GT	20.83%		20.88%	42%	0.67	2.31	1.5477

PBPM		20.83%	16.67%	38%	0.27	1.22	0.3294
PBCP		20.8335	20.88%	42%	0.27	1.22	0.3294
RTPM		25%	16.67%	42%	0.23	1.38	0.3174
RTCP		25%	16.67%	42%	0.47	1.38	0.6486
NB	Control	41.67%	12.50%	54%	0.46	2.31	1.0626
GT		91.67%	2.50%	94%	2	2	4
PBPM		54.17%	16.67%	71%	0.35	9.16	3.206
PBCP		41.67%	16.67%	58%	0.66	2.31	1.5246
RTPM		58.33%	12.50%	71%	0.35	3.43	1.2005
RTCP		75%	12.50%	88%	0.66	4.41	2.9106
NB	Gibberrellic acid 100ppm	83.33%	8.33%	92%	0.78	4.62	3.6036
GT		100.00%	0.00%	100%	2.33	10.18	23.7194
PBPM		83.33%	0.00%	83%	0.85	4.9	4.165
PBCP		83.33%	8.33%	92%	0.84	4.9	4.116
RTPM		96%	0.00%	96%	0.78	5.65	4.407
RTCP		100%	0.00%	100%	1	6.25	6.25

C. Effect in germination of stored seeds using different sowing media

Germination study of stored seeds show maximum viability percentage obtained was 83.33% when seeds sown in germination tray after one month of storage. Highest Peak Value (PV) recorded was 1.33 in the germination result of seeds sown after one month of

storage in germination tray and the lowest Peak Value obtained was 0.1, when seeds were sown after three months of storage. Maximum value for Final MDG was obtained when seeds stored for one month were germinated in germination tray. Maximum Germination Value recorded was, 18.5 for seeds germinated in germination tray after one month of storage (Table.III).

Table III: Effect of seed storage on germination in the seeds of *P.marsupium*

Sowing medium	Period of Seed Storage	Germination Percentage	% of Sound Ungerminated Seeds	Viability Percentage	Peak Value (PV)	MDG Final	Germination Value (GV)
NB	M1	70.83%	8.33%	79%	0.6	4.17	2.502
GT		83.33%	4.17%	88%	2	9.25	18.5
PBPM		70.83%	6.50%	77%	0.64	4.17	2.6688
PBCP		75.00%	4.17%	79%	0.77	4.16	3.2032
RTPM		70.83%	8.33%	79%	0.6	4.17	2.502
RTCP		75.00%	4.17%	79%	0.77	4.16	3.2032
NB	M2	50.00%	10.00%	60%	0.5	2.94	1.47
GT		62.50%	4.17%	67%	1.33	6.94	9.2302
PBPM		54.17%	8.33%	63%	0.46	3	1.38
PBCP		54.17%	4.17%	58%	0.53	3.61	1.9133
RTPM		50.00%	6.50%	57%	0.46	2.94	1.3524
RTCP		58.33%	2.50%	61%	0.61	3.88	2.3668
NB	M3	12.50%	7.00%	20%	0.1	0.69	0.069
GT		20.83%	0.00%	21%	0.5	2.08	1.04
PBPM		12.50%	8.33%	21%	0.1	0.73	0.073
PBCP		16.67%	4.17%	21%	0.1	1.11	0.111
RTPM		12.50%	6.50%	19%	0.1	0.69	0.069
RTCP		12.50%	4.17%	17%	0.1	0.89	0.089

D. Analysis of variance for comparing germination percentage of fresh seeds:

The results of ANOVA for comparing germination percentage with out pretreatment show significance at 1% level between media of seed sowing and significant at 5% level between Place x Year of study (Table. IV). Maximum mean

germination was 92.36^a in germination tray. The mean germination of seed samples collected from the two places (P1 56.25^a and P2 56.25^a) and between years of study (Y1 55.21^a, Y2 56.94^a, Y3 56.60^a) shows homogeneity in mean germination percentage.

Table IV: Results of ANOVA for comparing germination percentage of fresh seeds without pretreatments in *P.marsupium*

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F-value	p-value
Medium	4760.634	5	952.127	185.946	<0.001**
Place	0.067	1	0.067	0.013	0.911 ^{ns}
Year	6.760	2	3.380	0.660	0.538 ^{ns}
Medium * Place	5.377	5	1.075	0.210	0.951 ^{ns}

E. Analysis of Variance for comparing germination percentage of pretreated seeds:

Among the six types of pre-treatments used, the F – value appears significant at 1% level in the results of ANOVA found in Table. V. The mean germination under

different medium and its comparison show homogenous result in six media. The maximum germination after treatment was observed when treated with gibberellin 100ppm 92.36^a followed by control 60.42^b, sulphuric acid 6.95^d and hot water 5.56^d.

Table V. Results of ANOVA for comparing germination percentage of fresh seeds with pretreatments in *P.marsupium*

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F-value	p-value
Treatment	18249.396	5	3649.879	87.303	<0.001**
Medium	513.461	5	102.692	2.456	0.061 ^{ns}
Error	1045.171	25	41.807		
Total	19808.027	35			

** Significant at 1 % level; * significant at 5% level; ns non significant at 5 % level



Fig. 1.Pods of *Pterocarpusmarsupium*

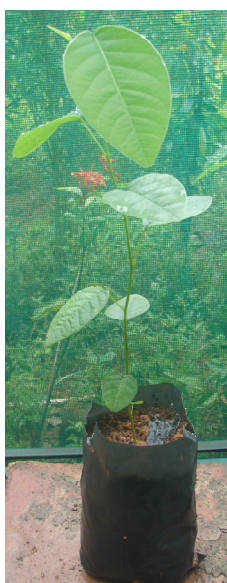


Fig.2. Seedling of *Pterocarpusmarsupium* in poly bag

F. Analysis of variance for comparing germination percentage of stored seeds:

It is obvious from the of ANOVA results for comparing germination percentage of stored seeds that there is significance at 1% level between period of storage and media of study (Table. 6). Maximum mean germination was 55.55^a in GT and minimum mean value was observed in seeds sown in NB(44.44^c) and RTPM (44.44^c). It is obvious from Table. 13 that mean germination percentage decrease as the time period of storage increases. It is obvious from the results (M1 44.44^c, 54.86^b, M3 14.58^c) that mean germination percentage decrease as the time period of storage increases.

Table VI: Results of ANOVA for comparing germination percentage of stored seeds in *P.marsupium*

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F-value	p-value
Medium	118.285	5	23.657	16.726	<0.001**
Period	4357.977	2	2178.988	1540.598	<0.001**
Error	14.144	10	1.414		
Total	4490.405	17			

** Significant at 1 % level; * significant at 5% level; ns non significant at 5 % level

IV. DISCUSSION AND CONCLUSION

Conventional seed and vegetative propagation with pods of Indian kino tree has not recorded successful results for the species [6]. Kalimuthu and Lakshmanan[8] reported 30% natural regeneration for the plant species. Wilkins [9] is of the opinion that the native natural stands of this leguminous tree species are fast disappearing, also Chaudhari and Sarkar[10] has listed the species in the list

of depleted plant species. In this contest the technology for mass propagation of Kino tree using root trainers was considered important and was developed after extensive field trials using seeds from two collection points sown in six sowing medium with and without pretreatments and also period of storage.

The germination studies of the Indian kino tree, *Pterocarpus marsupium*, Roxb., the analysis of variance for comparing germination percentage of fresh seeds in different sowing medium show that there is no significance between the two collection points within the Kerala state in the present study. From Table I it is obvious that the mean germination percentages have homogenous value in all the study species with respect to collection points. Results in table VI shows that seeds samples collected during (Y2) attained maximum mean germination percentage (90%) whereas mean germination percentage was homogenous in the samples obtained during (Y1) and (Y3).

Comparing the results in analysis of variance for comparing germination percentage in show differences in mean germination due to different pretreatments. Seeds of *P. marsupium* have maximum germination performance with gibberellin 100ppm treatment, removal of seed coat and control seeds without pretreatments. Pretreatment with soaking seeds in concentrated H₂SO₄ and treatment in hot water results poor germination in *P. marsupium*. There may be some detrimental effect on cotyledons together with portions of embryo as it was found that surface tissues were damaged. Concentrated sulphuric acid can consequently desiccate tissues and eventually cause cell separation [11][12].

The analysis of variance shows there is significance at 1% level between periods of storage *P. marsupium*. Luna [13] points that germination percentage of many tree species vary when seed samples from different regions are used but it is not proved through the present results. Maximum mean germination was 55.55^a in GT and minimum mean value was observed in seeds sown in NB (44.44 °) and RTPM (44.44 °). It is obvious from the results (M1 44.44 °, 54.86 °, M3 14.58 °) that mean germination percentage decrease as the time period of storage increases, which was previously established in recalcitrant seeds [1].

Root trainers used in forest nurseries have been found effective as they have ridges of the specified type (antispiralling rib design) which force the developing roots to grow downward to the drainage hole, where they stop growing because of low humidity and air pruning effect which is effective when they are placed above the soil surface with the help of stand. The growth and survival of an out planted tree seedling is much related to the ability of its root system to promote regeneration of new roots, known as root growth potential (RGP) and its growth into the surrounding soil [14]. Generally, containers for seedling generation and its maintenance are designed in such a way that it can promote generation of good root system in the nursery and also to protect these roots until out planting of seedlings [15]. For raising seedlings of tree species in plant nurseries, polythene bags of different gauges and size are the most common form of containers used widely. Even though, they are handy and economical

they have inherent problem of root coiling which influences considerably the growth of seedlings after out planting in the field as the spiral roots prevent the seedling from becoming properly established in the surrounding soil [16], and eventually leading to strangulation [17]. Although it can occur in any container type, root spiraling is most prominent in round and smooth walled plastic containers. To overcome the problem of root coiling in seedlings at least partially, the alteration of design in containers with vertically oriented ridges, ribs or grooves that protrude into the growing medium and present an obstacle to spiral and Kinghorn, [18] recommended ribs about 2mm (0.08 inch) high on the inner cavity wall.

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