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Seed Development And Maturation And Storage Studies On An Endemic Tree *Vateria Indica* Linn.

Sekaran S[1], Arya S Raj[1], Nisha Raj S[2], and Paulsamy S[3]*.

[1]PG and Research Department of Botany and Biotechnology SN College, Kollam, Kerala.
[2]PG Department of Biotechnology, SASSNDP Yogam College, Konni, Kerala.
[3]PG and Research Department of Botany, Kongunadu Arts and Science College, Coimbatore.

ABSTRACT

The present study was carried out on development and maturation of the seeds and morphometric changes happened during seed storage of medicinally important endangered and threatened tree species *Vateria indica* (Dipterocarpaceae). In this species the harvestable maturity was determined to be fixed on 10th week (70 days) after anthesis as the highest dry weight (9.23 g/seed) coupled with lower fresh weight of seeds (18.56 g/seed). The germination rate of the seeds was also higher (90%) during that period. For seed germination the sand medium was determined to be suitable. To know the suitable storage condition for maximum longevity of seeds, experiments on storage of seeds under three different storage temperatures such as room temperature (28 ± 2°C), fridge (5°C) and deep fridge (-5°C) conditions were conducted. Storage of *V. indica* seeds under fridge condition was found to be suitable for maintaining viability upto 1 month.

Keywords: Seed maturity, *Vateria indica,* storage

Corresponding author

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INTRODUCTION

Seeds are the major units of trees linking with the establishment of forest systems. From fertilization to harvest the seeds undergo a series of physico chemical changes and the sum total of which is termed as seed maturation [1]. For harvesting quality seeds in time, the knowledge about the optimum stage of maturity in terms of physical, physiological and biochemical indices are necessary. It is rather essential to know the occurrence of various sequential changes taking place during the seed development and maturation, because the self life of the seeds is directly related to the level of maturity of the seed at the time of harvest [2,3]. The harvestable maturity of seeds is species specific also. The necessity for increased rate of tree planting emphasizes the need of good seed because seed quality has critical effect on the quality of trees established. Tree seeds are also required for both reforestation and *in situ* and *ex-situ* conservations of forest genetic resources [4].

Vateria indica (Family-Dipterocarpaceae) commonly known as White Dammar of South India and also known as white pine. The status of this endemic tree was described as threatened as per IUCN Red list [5]. It is distributed in tropical evergreen and west coast semi-ever green forests of southern Western Ghats. The timber is used for packing cases, plywood making and the dried kernels of *V. indica* yield by solvent extraction about 22 per cent of fat known as Piney Tallow used for candle making, soap manufacturing and piney-gum resin from the tree used as substitute for official resin. Owing to these uses it is considered to be one of the important tree species in southern India [6]. Therefore, establishment of this tree species in suitable areas is most needed not only for green cover but also for economic use.

The demand for the seeds of this multipurpose tree is now considerably increased. However, no work has been made on seed quality and germination rate of this species. To address this lacuna, the present study was carried out to elucidate the information on seed development and maturation for collection of seeds at optimum time and to study the germination and storage potential of the recalcitrant seed of *V. indica.*

MATERIALS AND METHODS

COLLECTION OF SEEDS

Seeds of the study species, *V. indica* were obtained from the plus trees from Asaramam of Kollam, Kerala which is located at an altitude of 100 m above m.s.l. The experimental work in seeds was carried out in the Department of Botany, Sree Narayana College, Kollam.

PHYSICAL CHARACTERS OF SEEDS

The seeds of the study species were taken randomly for measuring the following physical characters: length and breadth and roundness were measured by using tag and scale with 10 seeds of 5 replications. The purity analysis of sample was carried out for the selected seeds as per ISTA [7] rules.

The seed moisture content was estimated for the whole seed (including endocarp) by monitoring weight lost during drying, and by using low-constant-temperature oven method [7]. Blotting papers were used for this experiment.

To calculate germination percentage, four replicates of 100 seeds [7] were germinated in sand media in plastic germination tray (sized 30 x 20 cm) in germination room at 25 $\pm$ 2°C temperature with 90 $\pm$ 5% relative humidity and wetted daily. The number of seeds germinated were counted and the germination percentage was calculated by using the following formula:

$$\text{Germination percentage} = \frac{\text{Number of seeds germinated}}{100} \times 100$$

Measurement of root and shoot lengths and dry matter production and calculation of vigour index were made at different occasions *viz.,* storage condition and in nursery during the study period by adopting the following methods:

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SEED DEVELOPMENT AND MATURATION

The flowers of the two tree species were tagged separately at the rate of 100 flowers/tree/species, considering the time of anthesis as the main criteria for the determination of physiological maturity.

The fruits/seeds were collected from the tagged flowers at weekly interval to tag more number of flowers to overcome the problem of heavy flower/fruit shedding with most care. One hundred fruits were forwarded at each stage for studying the development and maturation of fruit and seed. The results were expressed as S_1, S_2, S_3 ….. S_{12}. The physical characters *viz.,* length, breadth, fresh weight, dry weight and moisture content of fruit and seed were measured during every sampling time. Per cent germination was studied in the above seeds periodically [7].

ROOT AND SHOOT LENGTHS

Ten seedlings from each treatment were taken 30 days after sowing random. The seedlings were removed from the germination tray without damaging the root and shoot, washed thoroughly to remove the adhering soil particles. The length of root and shoot was measured individually for the entire seedling selected. The shoot length was measured from collar region to the tip of the leaf and root length from collar region to the tip of the primary root and their means were expressed in centimeters (cm).

The vigour index was calculated adopting the formula proposed by Abdul Baki and Anderson [8].

Vigour index = Germination per cent × (Root length + Shoot length (cm)).

EFFECT OF STORAGE TEMPERATURE ON SEED QUALITY

To study the effect of temperature and to obtain optimum storage temperature for prolonging self-life, the seeds were stored at three different temperatures and tested.

T_1 - 26 $\pm$ 4°C (Ambient - room temperature)
T_2 - 5 to 10°C (Fridge)
T_3 - 0 to –5°C (Deep fridge)

The viability and vigour indices were determined during every sampling at weekly interval [9] with the parameters *viz.,* germination, root length, shoot length, dry matter production and measure of vigour index.

SELECTION OF SUITABLE MEDIA FOR VIABILITY TEST

To find out suitable seed testing media for viability the following media were attempted: Sand/red soil/sand + red soil (1:1 by volume) sand + red soil + FYM (1:1:1 by volume).

RESULTS AND DISCUSSION

Development and maturation of the seeds, seed physiological and germination attributes during seed storage were varied widely for the study species, *V. indica* (Table 1). The physiological maturity of seeds determined on the basis of accumulation of higher dry weight (9.23 g/seed) coupled with minimum fresh weight (18.56 g/seed) and maximum germination was determined to be fixed on 10^{th} week (70 days) after anthesis. To test the germination potential of seed, the sand medium used was identified as suitable. To know the suitable storage condition for maximum longevity of seeds, experiments conducted on storage of seeds under various storage temperatures indicate that storage of *V. indica* seeds under fridge condition was found to be suitable for maintaining viability up to 1 month (Table 2).

The trend of capsule development in terms of its physical characters *viz.,* length and breadth was steadily increased and attained peak value at S_{10} stage for *V. indica*. In most of the tree species it is determined that the capsule development is completed at S_{10} stage (*Humboldtia decurrens* - Sabu *et al*. [10] and *Diploknema butyracea* - Nawa Bahar, [11].

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Table 1: Changes in seed attributes of *Vateria indica* during seed development and maturation.

Fruit(Capsule) and seed characters		Stages											
		S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}	S_{11}	S_{12}
Fruit (capsule)	Fresh weight (gm)	0.77 (±0.02)	1.68 (±0.08)	2.41 (±0.05)	3.41 (±0.09)	7.92 (±0.07)	11.59 (±0.17)	15.38 (±0.24)	17.55 (±0.27)	19.37 (±0.11)	23.57 (±0.3)	23.57 (±0.3)	23.57 (±0.3)
	Length (cm)	0.38 (±0.1)	1.06 (±0.2)	1.66 (±0.1)	2.08 (±0.3)	2.32 (±0.5)	2.64 (±0.2)	3.08 (±0.4)	3.68 (±0.8)	4.04 (±0.07)	4.96 (±0.06)	4.96 (±0.06	4.96 (±0.06)
	Breadth (cm)	0.24 (±0.02	0.58 (±0.08)	0.76 (±0.11)	1.1 (±0.10)	1.32 (±0.08)	1.42 (±0.08)	1.48 (±0.08)	2.06 (±0.11)	2.42 (±0.09)	2.56 (±0.09)	2.56 (±0.09)	2.56 (±0.09)
	Dry weight (gm)	0.06 (±0.02)	0.63 (±0.03)	0.93 (±0.04)	1.44 (±0.02)	3.58 (±0.07)	6.25 (±0.05)	8.48 (±0.07)	10.32 (±0.06)	12.46 (±0.1)	15.77 (±0.1)	15.77 (±0.1)	15.77 (±0.1)
	Moisture content (%)	73.13 (±1.1)	62.15 (±0.8)	60.52 (±2.3)	57.74 (±1.9)	54.80 (±2.3)	46.01 (±1.8)	44..93 (±1.2)	40.99 (±1.1)	35.65 (±0.5)	33.11 (±1.3)	33.11 (±1.3)	33.11 (±1.3)
Seed	Fresh weight(g)	-	-	-	-	1.69 (±0.05)	3.67 (±0.04)	5.29 (±0.06)	8.63 (±0.07)	10.92 (±0.03)	12.46 (±0.05)	18.82 (±0.08)	18.56 (±0.06)
	Dry weight(g)		-	-	-	0.16 (±0.03)	1.38 (±0.03)	2.63 (±0.07)	4.58 (±0.05)	6.33 (±0.03)	7.59 (±0.08)	9.23 (±0.01)	9.23 (±0.09)
	Moisture content (%)	-	-	-	-	90.10 (±1.3)	62.88 (±0.83)	50.18 (±0.43)	46.76 (±1.3)	42.09 (±1.6)	39.19 (±1.3)	37.96 (±0.21)	35.24 (±0.31)
	Germination (%)	-	-	-	-	-	-	-	-	36.0 (±2.5)	58.0 (±2.8)	70.0 (±5.5)	78.0 (±5.2)

(±) : Standard deviation

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Table 2: Effect of storage temperature on germination, root length, shoot length, dry matter production and vigour index of *Vateria indica.*

Period of collection (week)	Germination (%)			Root length (cm)			Shoot length (cm)			Dry matter production (mg)			Vigour index		
	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3
0	98 (±5.2)	98 (±4.7)	98 (±5.8)	8.3 (±0.8)	8.8 (±0.6)	8.6 (±0.9)	31.4 (±0.3)	31.4 (±1.0)	31.4 (±0.6)	18.5 (±1.2)	18.7 (±1.1)	18.5 (±1.2)	2779 (±105.3)	3296 (±120.8)	3770 (±101.3)
1	70 (±3.7)	80 (±5.5)	98 (±4.5)	11.1 (±0.5)	10.9 (±0.5)	10.3 (±0.6)	32.4 (±0.7)	31.9 (±0.8)	32.4 (±0.7)	16.1b (±1.1)	16.7aa (±1.0)	16.3ab (±1.1)	1819b (±98.9)	1989ab (±107.8)	1940ac (±98.3)
2	60 (±4.8)	70 (±5.9)	78 (±3.6)	10.5 (±0.2)	10.1 (±0.2)	9.9 (±0.3)	32.4 (±0.7)	31.9 (±0.8)	32.4 (±0.7)		15.1ab (±0.9)	14.2ac (±1.0)	1230c (±111.5)	1646ac (±99.9)	1378ad (±87.6)
3	52 (±2.4)	60 (±3.9)	62 (±3.6)	10.3 (±0.3)	9.8 (±0.4)	9.6 (±0.5)	32.4 (±0.7)	31.9 (±0.8)	32.4 (±0.7)	14.5d (±0.6)	15.8ac (±0.7)	14.8ad (±0.9)	965d (±58.9)	1218ad (±96.7)	1019ae (±85.5)
4	45 (±1.8)	56 (±2.5)	58 (±2.4)	8.0 (±0.4)	9.0 (±0.5)	9.4 (±0.2)	32.4 (±0.7)	31.9 (±0.8)	32.4 (±0.7)	14.1e (±1.0)	14.5ad (±1.2)	13.5ae (±0.4)	435e (±31.8)	1064ae (±85.5)	883af (±42.6)
5	37f (±1.2)	47 (±2.3)	52 (±2.2)	7.9 (±0.1)	8.4 (±0.2)	9.1 (±0.7)	32.4 (±0.7)	31.9 (±0.8)	32.4 (±0.7)	13.8f (±0.7)	14.0ae (±0.8)	12.3af (±0.4)	287f (±15.5)	851af (±63.8)	754ag (±35.7)
6	30 (±0.2)	40 (±1.5)	46 (±1.8)	7.8 (±0.5)	8.7 (±0.6)	8.9 (±0.4)	32.4 (±0.7)	31.9 (±0.8)	32.4 (±0.7)	11.7g (±0.5)	11.2af (±0.4)	11.0ag (±0.2)	81g (±5.8)	724ag (±58.9)	537ah (±31.7)
7	25 (±0.2)	31 (±1.9)	42 (±1.4)	7.3 (±0.4)	8.5 (±0.1)	8.5 (±0.6)	32.8 (±1.3)	32.0 (±1.0)	32.8 (±1.6)	-	10.8ag (±0.3)	10.0ah (±0.3)	-	543ah (±31.9)	381ai (±17.5)
8	25 (±0.20)	20 (±0.5)	40 (±0.2)	6.3 (±0.8)	5.8 (±0.6)	7.6 (±0.9)	32.8 (±1.3)	32.0 (±1.0)	32.8 (±1.6)	-	10.2ah (±0.2)	9.8ai (±0.5)	-	220ai (±10.8)	150aj (±9.6)
9	20 (±0.2)	16 (±0.4)	35 (±0.1)	6.3 (±0.8)	5.8 (±0.6)	7.6 (±0.9)	32.8 (±1.3)	31.8 (±1.0)	32.4 (±1.6)	-	9.5ai (±0.3)	8.2aj (±0.2)	-	130aj (±7.5)	47ak (±2.3)
10	20 (±0.2)	12 (±0.4)	32 (±0.1)	6.3 (±0.8)	5.8 (±0.6)	7.6 (±0.9)	32.6 (±1.3)	31.6 (±1.0)	32.0 (±1.6)	-	-	-	-	-	-
11	20 (±0.2)	12 (±0.4)	30 (±0.4)	6.3 (±0.8)	5.8 (±0.6)	7.8 (±0.9)	31.4 (±0.8)	31.2 (±1.0)	31.7 (±1.6)	-	-	-	-	-	-
12	20 (±0.2)	10 (±0.2)	30 (±0.4)	6.3 (±0.8)	5.8 (±0.6)	7.6 (±0.9)	31.4 (±0.9)	31.4 (±1.0)	30.4 (±2.6)	-	-	-	-	-	-

T_1 – Ambient (28 ± 2°C), T_2 – Fridge (0 - +5°C), T_3 – Deep fridge (0 -5°C), (±) : Standard deviation.

The accumulation of maximum dry weight of seeds at S_{12} stage indicates the physiological maturity in this stage for *V. indica*. The increase in dry weight of seed might be due to the decrease in the moisture content coupled with increased accumulation of food reserve materials. Similar trend of increase in dry weight of fruit and seed at S_{12} stage during development and maturation was reported by Hasnat *et al.* [12] for various species of *Dipterocarpus*.

In the present study, it was noted that the seeds of *V. indica* did not germinate until S_5 stage (Table 1). The maximum germination percentage was found in matured stages at S_{12} stage, which also confirms the physiological maturity. Umarani *et al.* [13] investigated that in certain members of Dipterocarpaceae the S_{12} stage of seed development accumulated higher dry weight coupled with larger germination rate. It shows that in *V. indica* S_{12} stage in seed development is the suitable stage not only for harvesting the seeds but also to germinate the seeds.

Composition of germination medium has considerable impact on the seed germination and other seedling attributes for *V. indica* (Table 3). Among the four composition attempted, sandy soil was determined to be an effective germination medium in which the germination rate, root and shoot lengths, collar diameter and vigour index were considerably greater than the other media attempted. Better aeration due to large pore spaces and higher water retaining capacity are attributed as the factors for this fact in sandy soil [14]. In addition, nutrient requirement during seed germination is not a critical factor as the reserves in seeds can meet out the requirements even after germination upto certain period. Sukesh and Chandrashekar [15] also determined that sand medium is most suitable for the seed germination of certain Dipterocarpaceae members.

Table 3: Effect of different seed testing media on germination percentage, shoot and root length, collar diameter and vigour index of *Vateria indica.*

Seed testing media	Germination %	Root length (in cm)	Shoot length (in cm)	Collar diameter (in cm)	Vigour index
Sandy soil	87.5	16.5	27.6	1.8	2432
Red soil	50	11.6	25.4	1.5	1282
Sandy soil + Red soil (1:1 by volume)	60	12.8	24.6	1.4	1489
Sand soil + Red soil + Organic matter (1:1 by volume)	52.5	12.5	25.2	1.3	1336

Long term storage provides the most convenient, safe and economic way of conserving the genetic sources of most of the species [16]. In the present study, the changes in germination parameters for the seeds stored in different temperature conditions revealed that the species *V. indica* possess recalcitrant seeds which rapidly deteriorates them within a short period of 1 month. Singh *et al.* [17] reported that the moisture content of seeds is the major limiting factor for the recalcitrant seeds to control the growth performance. Therefore, after collecting the seeds during 10th week from anthesis, they must be attempted for germination in nursery beds. Maintaining the seedlings in nursery and supplying them to the growers according to need are the ways to make plantation and to protect the valuable germplasm of this species as well.

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