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Pattern of Seed Germination in Different Accessions of *Calophyllum inophyllum* L. in South Gujarat

Pola Perkecambahan Benih pada Berbagai Aksesi Calophyllum inophyllum L. di Gujarat Selatan

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Abstract

The main objective of the present study is to assess seed germination performance of *C. inophyllum* in south Gujarat condition. Therefore, seeds were collected from different seed sources of Karnataka and Maharashtra and a preliminary study was carried out in the College of Forestry, ACHF, Navsari Agricultural University during 2015. Seeds were collected from 15 trees (good bearing) representing five populations of Maharashtra and Karnataka, and assessed for seed parameters and germination. Seed kernels were used for germination trials. Germination started from 10 to 20 days after sowing and completed maximum germination within 20-25 days after sowing. Seeds collected from CIMV1, CIMV2 and CIMN3 accessions resulted in early germination. The overall result showed that seed germination among 15 accessions ranged between 40% (CIMP4) to 100% (CIKK1; CIKK2). Considering each seed source, the seed germination was found to be highest in the seeds collected from Kumta, Karnataka. Tree to tree variation within a seed source for germination was also recorded and ranges of germination within each seed source are as follows: Dapoli (73.33-90%), Navare (60-93.33%), Purnagharh (40-93.33%), Vettye (93.33-96.67%) and Kumta (63.33-100%). In conclusion, the seed germination of *C. inophyllum* under south Gujarat condition showed a positive performance. This study may help for further assessment of seedlings at field condition of this region.

Keywords: *Accession, seed source, seed germination performance*

Abstrak

Tujuan utama dari penelitian ini adalah untuk menganalisis daya kecambah benih *C. inophyllum* yang terdapat di wilayah Gujarat Selatan. Untuk itu, benih dikumpulkan dari sumber benih yang berbeda di Karnataka dan Maharashtra dan studi pendahuluan dilakukan di Sekolah Tinggi Kehutanan, ACHF, Universitas Pertanian Navsari pada tahun 2015. Benih dikumpulkan dari 15 pohon yang berbuah baik mewakili lima populasi di Maharashtra dan Karnataka untuk dianalisis parameter benih dan perkecambahan. Perkecambahan dimulai pada 10 hingga 20 hari setelah tanam dan perkecambahan maksimum dicapai dalam 20-25 hari setelah tanam. Benih yang dikumpulkan dari aksesi CIMV1, CIMV2 dan CIMN3 berkecambah lebih awal. Hasil penelitian menunjukkan bahwa daya kecambah benih pada 15 aksesi berkisar antara 40% (CIMP4) sampai 100% (CIKK1; CIKK2). Berdasarkan sumber benih, daya kecambah benih ditemukan paling

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tinggi pada benih yang dikumpulkan dari Kumta, Karnataka. Variasi pohon dalam satu sumber benih untuk perkecambahan juga dicatat dan kisaran perkecambahan pada setiap sumber benih adalah sebagai berikut: Dapoli (73,33-90%), Navare (60-93,33%), Purnagharh (40-93,33%), Vettye (93,33-96,67%) dan Kumta (63,33-100%). Dengan demikian, disimpulkan bahwa daya kecambah *C. inophyllum* di Gujarat Selatan memperlihatkan hasil yang positif. Hasil penelitian ini menjadi landasan untuk penelitian lanjutan tentang pembibitan pada kondisi lapang di wilayah ini.
Keywords: Aksesi, hasil perkecambahan benih, sumber benih.

INTRODUCTION

Calophyllum inophyllum L. is a littoral tree species of the tropics, distributed on sandy beaches of seashore; sometimes scattered trees or groves of this species is also distributed in inland on sandy soils (Orwa *et al.* 2009). This species is found naturally in the coastal tracts of Kerala, Karnataka, Maharashtra, Tamil Nadu, Andhra Pradesh, Orissa and West Bengal. It is one of the ideal forest resources for making biodiesel (Saho *et al.* 2006) where oil is non-edible and kernel yields oil up to 65 per cent and fruits profusely (Hathurusingha and Ashwath 2007). It tolerates various environmental situations like acidity, salinity, drought and a range of temperature (Friday and Okano, 2006). Species have other potential usages like oil is used as lamp oil, timber is used in construction of boats, tree has aesthetic value and is planted along the roads and gardens (Friady and Okano, 2006). In addition to this, Kernel oil also has a high commercial value for pharmaceutical and cosmetic applications (Dweck and Meadows, 2002).

Looking into the huge demand of biofuel in the country, there is potential scope for seeds of *C. inophyllum* for production of biofuel. *The physico-chemical properties of seed oil fulfills requirement of fossil fuel as per* American Standards for Testing and Material *(ASTM)- 6751 / SNI 04-7182-2006* (Chavan and Kumbhar, 2013) and (Leksono *et al.* 2014) , hence, *seed oil of C. inophyllum may works as a sustainable feedstock for biodiesel production.*

There is potential scope for large scale plantation programme of this species along coastal line. The total length of coastal line of India is 7,516.6 km and Gujarat form the longest coastal line of all Indian states with 1600 km (Anonymous, 2017). Interestingly, there is no distribution of this species in the

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coastal line of Gujarat; however, this area may be used for raising plantation of *C. inophyllum* to meet out the requirement of biofuel.

Growth and yield potential of species highly depends upon growing situation and improved seed materials used in planting. It is reported that the seed oil varied among different seed sources and it ranged from 35.7 to 79.73 per cent [9,10]. Seed source also influences the seed germination and seedling vigour (Shinde *et al.* 2012 and Palanikumaran *et al.* 2015). Therefore, proper seed source and ideal nursery techniques help in meeting out the large-scale production of superior planting materials that assures better growth and yield (Rahul, 2016). With this background, a study was undertaken to understand the seed germination pattern as influenced by different seed sources in *C. inophyllum* under south Gujarat condition.

MATERIALS AND METHODS

In the present study, total 15 trees (Accessions) were selected randomly from five different parts of Maharashtra [3 accessions from Dapoli population, 3 accessions from Navare population, 4 accessions from Purnagharh population and 2 accessions from Vettye population] and Karnataka [3 accessions from Kumta population]. Trees which bear fruits profusely during end of June 2015 were marked for seed collection. Matured and healthy fruits were collected from selected 15 accessions to study seed source variation in seed germination and its attributes. Germination experiment was undertaken in the nursery of College of Forestry, Navsari Agricultural University, Navsari having geo-coordinates of 20° 55' 21.18" N and 72° 54' 29.24" E with an altitude of 9 m above MSL during 2015-16.

Site description

Navsari Agricultural University, Navsari, is situated in a typical tropical warm climate characterized by fairly hot summer, moderately cold winter and warm humid monsoon. Rainy period starts in second week of June and ends in September; however, peak rain occurs during July and August. Data regarding rainfall and temperature of study site were collected from Meterological station, Navsari Agricultural University, Navsari. Average annual rainfall during the study period (2015-16) was 1116 mm. The highest temperature (T_{Max}) was 31.8 to 38.5 °C recorded during April to May and lowest temperature (T_{Min}) of

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12.7 to 15.1 °C was recorded during December to February.

Experimental details

Seed kernels (Plate 1) were extracted from drupes and kernels were used for germination trials following Gunaga *et al.* (2011). Kernels of *C. inophyllum* were sown in polythene bags filled with mixture of soil, sand, and FYM in the ratio 2:1: ½. Total number of treatments was 15 accessions with three replications and each replication consisting of 50 seeds. All these nursery bags were arranged in CRD under the 50% shade net condition. Common nursery practices like weeding and watering were followed for all the treatments. The number of seeds germinated on each day was counted. Emergence of plumule above the soil was taken as the criteria for germination count. Daily germination count was made and germination per cent and its related parameters such as Mean Daily Germination (MDG), Germination Rate Index (GRI), Peak Value of Germination (PV), Germination Value (GV) and Mean Germination Time (MGT) were calculated as per Esechie (1994), Czabator (1962) & Orchard (1997).

Plate 1: Kernels and seeds of *C. inophyllum*

Data analysis

Data were subjected to statistical analysis and Analysis of variance (ANOVA) was constructed following completely randomized design (Jayaramana, 2001). The treatment (accession) differences were tested by

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'F' test of significance based on null hypothesis. The standard error of mean (SEm ±) was calculated in each case and critical difference (CD) at 5 per cent level of probability was worked out to compare the treatment means, where the treatment effects were significant.

RESULTS AND DISCUSSION

Results

There was a strong variation among 15 accessions for seed germination, Germination Rate Index (GRI), Mean Daily Germination (MDG), Peak Value of Germination (PV) and Germination Value (GV; $P < 0.05$). However, Mean Germination Time (MGT) did not vary significantly among accessions. Germination started from 10 to 20 days after sowing and extended up to 44 days. Maximum per cent germination occurred within 20-25 days after sowing in many of the seed sources like $CIMV_1$, $CIMV_2$ and $CIMN_3$. The dormancy release pattern of kernels of *C. inophyllum* from all the accessions is depicted in Fig. 1.

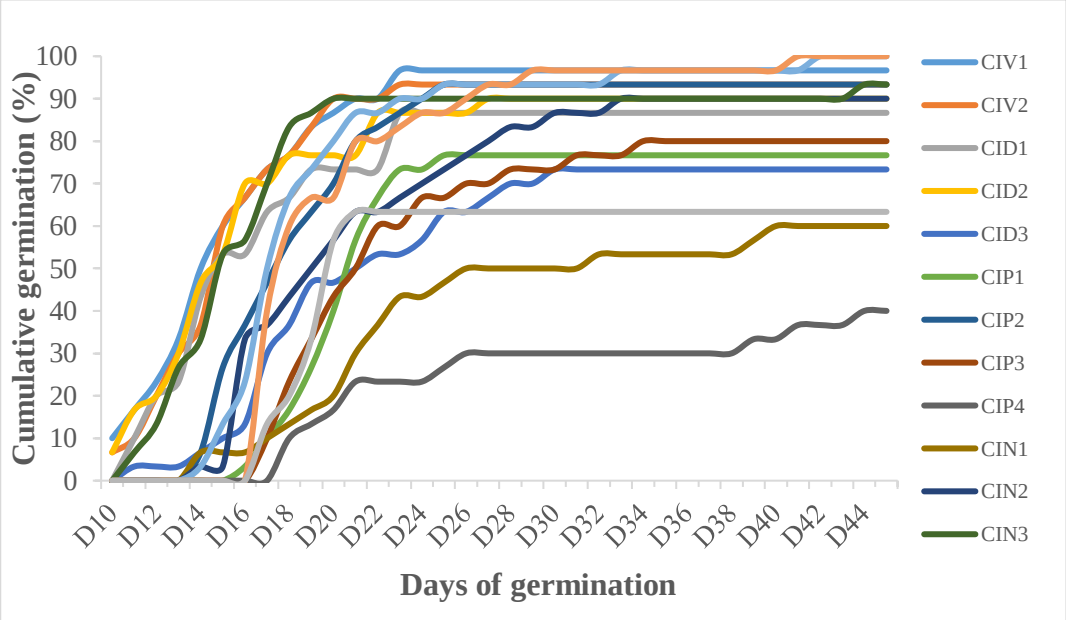

Fig. 1. Dormancy release pattern of different seed sources in *C. inophyllum*

In the study, the germination ranged from 40.0 to 100.0 per cent, where seeds collected from $CIKK_1$ and $CIKK_2$ accessions resulted in cent per cent germination (Table 1). Tree to tree variation within a region was also recorded for seed germination, where seeds collected from accessions of

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Purnagharh population showed 40.0 to 93.3 per cent germination. Similarly, accessions from Navare population also showed a wide range of variation from 60.0 to 93.3 per cent. In the case of Dapoli population, it was 73.3 to 90.0 per cent. Interestingly, variation within a population among accessions was minimum in Vettye population of Maharashtra (93.3 to 96.6 %) and Kumta population of Karnataka (63.3 to 100.0 %; Table 1). Remaining ungerminated seeds were examined and found that many seeds were rotten and few of them were hard.

Table 1. Seed source variation for seed germination and its co-parameters in *C. inophyllum*

Tree ID	Germination (%)		MDG	GRI	PV	GV	MGT
CIMV$_1$	96.67	(83.86)	4.54	6.75	1.89	8.55	68.62
CIMV$_2$	93.33	(77.71)	4.53	6.43	1.67	7.50	68.34
CIMD$_1$	86.67	(72.29)	4.01	5.80	1.80	7.30	63.08
CIMD$_2$	90.00	(75.00)	3.81	6.25	1.74	6.68	58.00
CIMD$_3$	73.33	(63.93)	2.66	3.92	1.02	2.85	52.61
CIMP$_1$	76.67	(65.85)	3.31	3.84	1.04	3.52	66.81
CIMP$_2$	93.33	(77.71)	4.01	5.31	1.37	5.49	72.21
CIMP$_3$	80.00	(63.43)	3.01	3.73	1.17	3.64	63.66
CIMP$_4$	40.00	(38.86)	1.15	1.59	0.56	0.64	28.85
CIMN$_1$	60.00	(51.14)	1.94	2.67	0.79	1.51	43.76
CIMN$_2$	90.00	(75.00)	3.09	4.55	1.88	5.91	62.15
CIMN$_3$	93.33	(77.71)	4.02	6.15	1.66	6.87	63.66
CIKK$_1$	100.00	(90.00)	3.64	5.48	1.57	5.81	68.75
CIKK$_2$	100.00	(90.00)	3.20	5.05	2.35	7.77	63.53
CIKK$_3$	63.33	(53.86)	2.57	2.87	1.06	3.67	49.10
Mean	**82.44**		**3.30**	**4.69**	**1.44**	**5.18**	**59.54**
SEm (±)	**8.46**		**0.57**	**0.52**	**0.21**	**1.25**	**8.86**
CD $_{P < 0.05}$	**24.50**		**1.56**	**1.51**	**0.60**	**3.61**	**NS**

Note: Figures in the parenthesis are arc-sign transformed values

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Germination rate index varied greatly (P <0.05) among 15 accessions and it ranged from 1.59 ($CIMP_4$) to 6.75 ($CIMV_1$). Four, out of fifteen accessions, scored > 6.0 GRI as compared to mean of 4.69 (Table 1). Accessions such as $CIMP_4$, $CIMN_1$ and $CIKK_3$ recorded the least GRI (< 3.0). Mean daily germination also varied significantly (P <0.05) among different accessions, where it ranged from 1.15 ($CIMP_4$) to 4.54 ($CIMV_1$) with mean MDG of 3.30. Peak value of germination also plays a vital role in germination and seedling vigour. Accessions such as $CIKK_2$, $CIMV_1$, $CIMN_2$ and $CIMD_1$ scored significantly higher PV values (P < 0.05) than $CIMP_4$ and others. Germination value is a product of MDG and PV and it also showed significant variation (P <0.05) with range from 0.64 ($CIMP_4$) to 8.55 ($CIMV_1$) among 15 accessions of *C. inophyllum* with mean GV of 5.18.

iscussion

C. inophyllum is one of the species of coastal ecosystem distributed along the coastal vegetation and sometimes it is associated with mangroves. Generally, it flowers during Apr-Jun, sometimes again in November and set fruits in the month of May to Aug, depending upon locations (Orwa *et al.* 2009) and (Gunaga *et al.* 2011). During our field visits to different location for germplasm collection, a great variation in flowering and fruiting phenology was noticed among the regions, where trees located in the northern regions flowers and fruits early as compared to the southern regions with a gap of about 30-45 days (Rahul, 2016). General germination percentage of seeds of this species is about 40-60. Seed of this species is reported as recalcitrant and vulnerable to chilling injury; besides, seeds maintain their viability for a period of 8 months, if stored in warmer environments (Hathurusingha, and Ashwath, 2012).

Further, Gunaga *et al.* (2011) initiated germination experiment to enhance seed germination using different pre-sowing treatments. Seeds without hard coat (*i.e.*, kernel) resulted in 95.8 % germination, which is followed by mechanical scarification (damage to the seed coat to imbibe water) with 86.4 per cent germination as against control (62.4 %). Therefore, in the present study, kernels instead of fruits/seeds were used for germination. Furthermore, Marques & Fischer (2009) reported that

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germination rates were greater for seeds with pulp removed by bats than for seeds in non-dispersed fruits of *Calophyllum brasiliense*. Thus, fruit manipulation by bats may provide a secondary benefit for plants in the form of increased seed germination.

Further, Smita *et al.* (2015) compared fresh and one-year old seeds for germination. In control treatment, one-year stored seeds did not germinate; however, one year old de-coated seeds (kernels) resulted in 20 per cent germination. Intra-population variation in seed germination and its attributes have been recorded in *C. inophyllum* at Dapoli, Maharashtra (2011), where germination ranged from 6.67 to 72 per cent with an overall mean of 32 per cent. Shinde (2010) evaluated seed germination among 21 candidate plus trees (CPTs) of *C. inophyllum* from Dapoli, Maharashtra and found that seeds collected from only 14 CPTs resulted in germination, which ranged from 25.5 to 89.25 per cent; however, remaining seven CPTs did not germinate within 45 days of sowing. Very recently, Palanikumaran *et al*. (2015) studied provenance variation in this species at TNAU, Tamil Nadu and they documented range of variation in seed germination from 46.67 to 78.00 per cent, where seeds collected from Honnavara resulted in highest germination, followed by Nagarcoil (68.33%) and Nagapattanam (68%).

The present study shows the great variation in seed germination among 15 selected accessions and it ranged from 40.00 (CIMP4) to 100.00 per cent (CIKK1; CIKK2). Nine out of fifteen accessions resulted in more than 90 per cent germination. The overall maximum germination recorded in the study could be due to use of direct kernels instead of seeds. Both the study shows that populations of *C. inophyllum* located in the Uttara Kannada district of Karnataka (Kumta-from this study and Honnavara-from Palanikumaran *et al*. (2015) resulted in maximum germination upto cent per cent than other sources. The study clearly shows that the nursery of *C. inophyllum* can be established under South Gujarat condition for large scale production of seedlings of this species (Rahul, 2016); however, information regarding plantation establishment of this species is scanty in this region, except few trees

which are growing well in the gardens of Gujarat (Anonymous, 2008).

CONCLUSIONS

The study shows that seeds collected from 15 different accessions across Konkan region of Maharashtra and Karnataka resulted in greater variation for seed germination and its attributes under South Gujarat condition. Seeds collected from $CIMV_1$, $CIMV_2$, $CIMD_2$, $CIMP_2$, $CIMN_2$, $CIMN_3$, $CIKK_1$ and $CIKK_2$ achieved significantly higher germination (> 90%) than other sources. There is wide scope for selection of superior genotypes in *C. inophyllum.* Such superior sources may be screened for early growth and fruit yield through field studies in Gujarat conditions.

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